Society of Cable Telecommunications Engineers

ENGINEERING COMMITTEE
Energy Management Subcommittee

SCTE OPERATIONAL PRACTICE

SCTE 228 2016

Inventory of Energy Efficiency Practices for Broadband Provider Facilities

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1. Introduction

1.1. Executive Summary

SCTE 228 2016 is a resource intended to aid multiple system operator (MSO) stakeholders involved in decisions related to reduction of energy consumption at sites, with the intended outcome of increasing energy efficiency, reaching sustainability targets and reducing grid dependency.

This Operational Practice looks to consolidate best practices for reduction of energy consumption into an easy reference format. This format provides indications on what types of facilities each practice applies to as well information regarding value versus cost and goals achieved.

Key provisions of this Operational Practice include:

- A consolidated list of energy efficiency measures applicable to MSO facilities.
- Indicator of what types of facilities each energy efficiency measure applies to.
- Prioritization of energy efficiency measures based on applicability, cost, value, and impact on Energy 2020 goals.

1.2. Scope

This document is meant to apply to the cable industries facilities including critical facilities, office space, call centers and warehouses. The scope of this document does not include the outside plant.

1.3. Benefits

Some of the benefits of adopting this Operational Practice include:

- More informed and streamlined decision support for energy efficiency projects in facilities.
- Increase cost savings and return on investment for energy efficiency projects.
- Achieve the long term goal of increased operational efficiency.

Some of the benefits of this Operational Practice to SCTE Energy2020 Roadmap include:

- Useful guidelines pertaining to all critical and non-critical facility types in the cable industry.
- Positive impacts to industry's power consumption and energy cost reduction goals by increasing awareness of energy efficiency opportunities and improving project prioritization and decision-making.
- Positive impacts to industry's grid independence goal by providing information on renewable and alternative energies that will help diversify power supply.

1.4. Intended Audience

This Operational Practice is intended for anyone involved in decisions related to energy consumption reduction, energy efficiency, and sustainability at MSO facilities. Stakeholders include, but are not limited to, energy and sustainability teams, design and construction teams, network engineering, critical infrastructure engineering, other engineering units, business management, financial managers, budget coordinators, technical operations and corporate real-estate.

1.5. Areas for Further Investigation or to be Added in Future Versions

This Operational Practice helps to prioritize energy measures based on a qualitative feedback from cable industry subject matter experts (SMEs). It does not contain quantitative analysis of costs and measures. SCTE will further investigate the energy measures included in this Operation Practice, including review of user case studies and quantitative cost analysis. Specifically, future versions of this draft can consider incorporating:

1. Operational Practice Feedback – SCTE can update cost and value metrics used in Section 7 to prioritize measures after it receives feedback and case studies from users in the industry. Feedback and case studies will be compiled into the table seen in Appendix B.
2. Quantitative Analysis of Energy Measures – SCTE and/or a third party can conduct research on the energy measures recommended in Table 8.1 and the tables and figures from Section 7 to determine actual quantitative cost and value of each measure to the cable industry. SCTE EMS-028 will then be revised to reflect this analysis.
3. Methodologies in Integrated Energy Management –Future iterations of this Operational Practice will include more information on employing a staged and macro-level approach to energy management improvements, including energy efficiency, renewable energy, energy resilience, and energy demand reduction opportunities.
4. Technologies Progression – SCTE can update this Operational practice based on technological advances are made related to facility energy efficiency in the cable industry. As new applicable technologies arise, SCTE can add them to the list of energy measures and assigned a relative cost and value. Furthermore, since these new technologies may replace or make existing energy measures less attractive, SCTE can evaluate the applicability and cost/value of the existing measures and remove or modify them as appropriate.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- SCTE 226 2015 – Cable Facility Classification Definitions and Requirements
- SCTE 218 2015 Alternate Energy Taxes, Incentives & Policy Resources

2.2. Standards from Other Organizations

- No normative references are applicable.

2.3. Published Materials

- No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

- SCTE 226 2015, Cable Facility Classification Definitions and Criteria
- SCTE 218 2015, Alternate Energy Taxes, Incentives & Policy Resources
- SCTE Expo 2013, CCAP Case Study: Enabling Converged Video + Data thru Space & Power Savings
- SCTE 137-7 2010, Modular Headend Architecture Part 7: EQAM Architectural Overview Technical Report

3.2. Standards from Other Organizations

- No informative references are applicable.

3.3. Published Materials

- No informative references are applicable.

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
should	This word or the adjective "*recommended*" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
should not	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
may	This word or the adjective "*optional*" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
deprecated	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

Abbreviation	**Term**
AC	alternating current (electricity)
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
CCAP	converged cable access platform
CHP and CCHP	combined heat and power and combined cooling, heat and power

Abbreviation	Term
CMTS	cable modem termination system
DC	direct current (electricity)
EQAM	edge-QAM modulator
HVAC	heating, ventilation and air conditioning
ICT	information and communications technology
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt hour
LED	light emitting diode
MSO	multiple system operator
OTP	optical transition point
ROI	return on investment
SCTE	Society of Cable Telecommunications Engineers
SMEs	subject matter experts
SMATV	satellite master antenna television

5.2. Definitions

Term	Definition*
alternating current (electricity)	In alternating current, the flow of electric charge periodically reverses direction, whereas in direct current circuits, the flow of electric charge is only in one direction. The abbreviations AC and DC are often used to mean simply alternating and direct, as when they modify current or voltage. AC is the form in which electric power is delivered to businesses and residences. The usual waveform of an AC power circuit is a sine wave.
American Society of Heating, Refrigerating, and Air-Conditioning Engineers	Global society, founded in 1894, focused on advancing sustainable technology and energy efficiency in building systems.
converged cable access platform	Technology that integrates the functions of a CMTS and EQAM into a single platform. See Appendix B for more information.
combined heat and power and combined cooling, heat and power	CHP is the use of a heat engine or power station to generate electricity and useful heat at the same time. Trigeneration or CCHP refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector. Cogeneration is a thermodynamically efficient use of fuel. In separate production of electricity, some energy must be discarded as waste heat, but in cogeneration this thermal energy is put to use. All thermal power plants emit heat during electricity generation, which can be released into the natural environment through cooling towers, flue gas, or by other means. In contrast, CHP captures some or all of the by-product for heating, either very close to the plant.
cable modem termination System	A headend component that provides the operator network side termination. A CMTS communicates with a number of cable modems to provide data services. See SCTE 137-7 for more details.
direct current (electricity)	Direct current is the unidirectional flow of electric charge. Direct

Term	**Definition***
	current is produced by sources such as batteries, solar cells, thermocouples, and commutator-type electric machines of the dynamo type. Direct current *may* flow in a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric current flows in a constant direction, distinguishing it from alternating current.
edge quadrature amplitude modulation modulator (edge-QAM modulator)	A headend or hub device that receives packets of digital video or data from the operator network. See SCTE 137-7 for more details.
heating, ventilation and air conditioning	HVAC is important in the design of industrial and office buildings where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors. The three central functions of heating, ventilation, and air-conditioning are interrelated, especially with the need to provide thermal comfort and acceptable indoor air quality within reasonable installation, operation, and maintenance costs. HVAC systems can provide ventilation, reduce air infiltration, and maintain pressure relationships between spaces.
information and communications technology	Application of telecommunications equipment and technologies to manage information/data (hardware, software, electronics, etc.).
kilovolt-amperes	One thousand volt amperes – metric for measuring the apparent power in an electrical circuit.
kilowatt	One thousand watts – metric for measuring the electricity flow through a customer meter
kilowatt hour	The amount of kilowatts used in one hour. If a customer uses 100 kW an hour for two hours the total kilowatt hours for the two hour period would be 200 kWh.
light emitting diode	A two-lead semiconductor light source that can be used in lamps or light bulbs. LED lamps are more energy efficient and have a lifespan longer than most other lamp types.
multiple system operator	A corporate entity that owns and/or operates more than one cable system.
optical transition point	A critical facility for transport aggregation or extension to support the edge facility's service delivery and typically contains amplifiers for optical links or transmitters and receivers feeding optical nodes.
return on investment	Performance measurement used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. In economic terms, it is one way of considering profits in relation to capital invested or how quickly an investment will repay itself.
Society of Cable Telecommunications Engineers	SCTE is a membership organization, founded in 1969, that provides technical and applied science resources and programs for the cable telecommunications industry.
subject matter experts	A person or persons that have an in-depth understanding or knowledge on a specific subject.
satellite master antenna television	A legacy critical facility for receiving video signals for processing and distribution directly to the customer, where no connection to an Operator's Core Network exists.

**Some definitions taken from SCTE 218, SCTE 137-7 and SCTE EMS 025.*

6. Methodology

6.1. Approach

SCTE collected information on all possible energy measures applicable to MSO buildings from SMEs including energy engineers and cable industry leaders. All energy measures were consolidated into a master list of energy measures, organized into categories based on impact applicability within cable-specific facility classifications.

For each energy measure, SCTE identified or defined the following:

1. Category – major system or section of the facility the energy measure impacts (e.g. HVAC, Lighting);
2. Sub-Category – minor system or section of the facility the energy measure impacts (e.g. Cooling, Heating, Lighting Controls);
3. Energy Measure Name – short common reference name of the energy measure;
4. Description – more detailed description of the measure and its components;
5. Objective – description of what the energy measure is trying to achieve (e.g. how to achieve energy savings);
6. Applicable Facility Types – indication on what type(s) of facilities the practice applies to; and
7. Value/Cost – value and cost metric (scale of 1-5 for each) for the energy measure based on its potential for energy savings and capital cost (described in more detail below in 6.3).

6.2. Energy Measure Categories

Table 1 – List of Energy Measure Categories for SCTE EMS-028

Category	**Definition**
Power Generation and Distribution	Measures that help reduce energy consumption by limiting conversion losses and increasing the efficiency of equipment in the power generation and distribution chain.
Heating, Ventilation and Air Conditioning (HVAC)	Measures that help reduce energy consumed by systems and equipment that support facility heating, cooling and ventilation.
Lighting	Measures that help reduce energy consumed by facility interior and exterior lighting systems and equipment.
Building Envelope	Measures that help decrease energy consumption by reducing heating and cooling losses due to leaks and solar absorption.
Miscellaneous	Any energy reduction measure that does not apply to the other four categories.

6.3. Facility Types

This operational practice provides energy conservation opportunities applicable to both critical and non-critical MSO facility types. The scope of this document does not include the outside plant. The following tables list and define the critical and non-critical facility classifications applicable to this document (adopted from SCTE 226 – see Figure 1).

Table 2 – Critical Facility Classification Levels

Critical Facility Classification	Definition
Class A	Critical facility such as data center servicing thousands or more customers requiring multiple megawatts redundant power availability
Class B	Technical facility such as headend or core aggregation servicing multiple neighborhoods with a megawatt of redundant power availability
Class C	Edge facility such as hub site servicing specific neighborhoods with smaller number of customer dependency and less than a megawatt of power availability required
Class D	Cabinet, Optical transport network supporting device servicing a focused customer base requiring power in the kilowatt range
Class E	Access Network level facility or enclosure utilized to support aggregation of a subset of an Edge Data Center's total access network

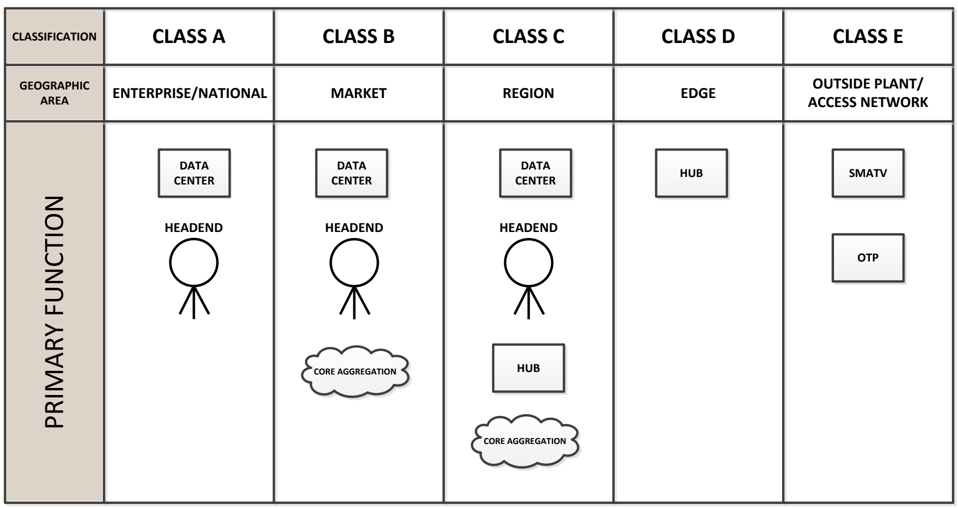

Figure 1 – Critical Facility Classification Quick Reference (refer to SCTE 226)

Table 3 – Non-Critical Facility Classification Levels

Non-Critical Facility Classification	
Admin	Administrative offices, multi-story buildings, high occupancy
Call Center	Call center, multi-story buildings, high occupancy
Lab	Research and Development laboratory space
Warehouse	Warehouse, work center or service depot
Retail	Public facing retail establishment

6.4. Value/Cost Assignment

To assist in prioritizing energy measures across a portfolio of facilities, this operational practice depicts a value and cost for each measure. Value and cost metrics were determined based on feedback from subject matter experts (SMEs) with energy engineering, technology implementation and cable industry experience.

1. **Value** – assigned based on the relative potential for energy and energy cost savings with measure implementation (scale of 1 [low value] to 5 [high value]).
2. **Cost** – assigned based on the relative capital cost of implementing the energy measure (scale of 1 [high cost] to 5 [low cost]).

The value and cost metrics are represented in the following tables are qualitative, and based on feedback from subject matter experts rather than quantitative analysis of cost and value. Future iterations of this Operations Practice will contain refined value and cost estimates based on feedback from case studies using this Practice, and future quantitative analysis (see Section 8 for more information).

Cable industry stakeholders utilize the recommended value and cost assigned to each measure in addition to the value-cost quadrant matrix develop informed return on investment (ROI) potential within a facility portfolio.

- **High ROI**: Quadrant 1 – low cost and high potential for energy savings.
- **Moderate ROI**: Quadrants 2 and 4 –Quadrant 2 with a low cost but relatively lower potential for energy savings, and Quadrant 4 with a high potential for energy savings but high initial cost.
- **Low ROI**: Quadrant 3 –high cost with a relatively lower potential for energy savings.

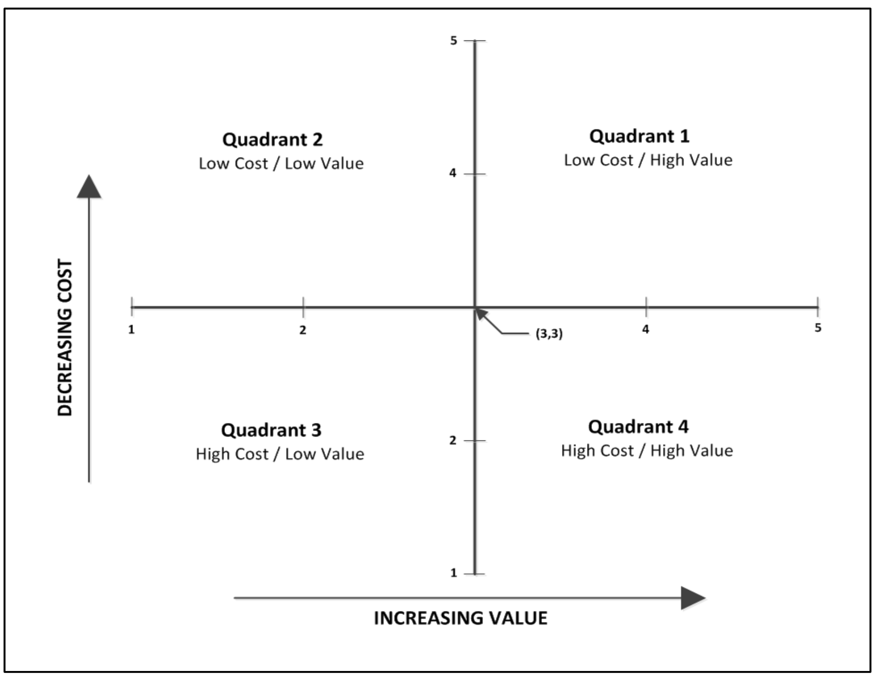

Figure 2 – Cost/Value Quadrant Matrix for Energy Efficiency Measures

6.5. Building the Business Case for Energy Measures

It is important for stakeholders looking to implement energy efficiency measures to build a complete business case so they fully understand if a project is worthwhile and technically and financially feasible. The following considerations will help to bolster understanding of the ROI for proposed measures.

Table 4 – Energy Measure Business Case Considerations

Consideration	Definition
Added Cost Savings	When prioritizing and selecting energy measures for implementation, organizations *should* also consider non-energy cost savings that measure implementation will create. Examples include water consumption savings, maintenance savings, space consolidation, and extended equipment life.
Alternative Energy Efficiency Financing	If funding is unavailable to cover the initial capital cost of energy efficiency measures, MSOs can utilize various alternative financing. Common examples include: Energy Savings Performance Contracts Power Purchase Agreements
Energy Management Systems	Installing, upgrading and/or commissioning of advanced energy management and control systems can yield significant operational savings and improved facility comfort.
Facility Energy Audits	It is a best practice to have utility or third party analysis of existing facility infrastructure and historical energy consumption and provide recommendations on applicable measures and available incentives for key efficiency upgrades.
Impact on SCTE Energy 2020 Goals	Make impactful decisions on what energy measures to implement and where they are most applicable in order to meet SCTE Energy 2020 goals.
Standardized Purchasing	Create minimum efficiency standards for common equipment purchases.
Tax Incentive Programs	<u>Property Tax Incentives</u> – Most property tax incentives for renewable energy systems exclude the added cost of the system in the overall assessment of the property for taxation purposes. These incentives include exemptions, exclusions, and credits. <u>Sales Tax Incentives</u> – Sales tax exemptions, typically at the state sales tax level, for the retail sale of energy efficiency technology implementation and renewable energy systems. (Adopted from SCTE 218)
Utility Incentive Programs	State and local governments' pair up with utility providers in order to promote and offer rebates for the installation of renewable energy systems and energy efficient technology (see SCTE 218). To maximize returns for grid connected applications, it is recommended to check local state and utility incentives related to proposed implementation, many of which are compiled in the Database of State Incentives for Renewables and Efficiency (desireusa.org).

6.6. Additional Energy Management Considerations

The SCTE Energy Efficiency in Facilities Working Group determined that the following measures are out of scope for this Operational Practice since they do not impact energy efficiency in a facility. However, stakeholders are encouraged to review them for applicability at their facilities as they have other energy-related benefits.

Table 5 – Additional Energy Measure Considerations

Measure	Description
Combined Heat & Power (CHP) / Combined Cooling, Heat & Power (CCHP)	Cogeneration (or CHP) is simultaneous generation of electricity and useful heat. Trigeneration (or CCHP) is simultaneous generation of electricity, useful heat and cooling from the combustion. Both CHP and CCHP can be beneficial as they are thermodynamically efficient uses of fuel. *See Section 5.1 and SCTE 218 for more details.*
Demand Response	Demand Response is a voluntary utility program that compensates end-use customers for reducing their electricity load when requested by the utility, during periods of high power prices or when the reliability of the grid is threatened.
Fuel Cells	A fuel cell is a device that generates electricity via chemical reaction. Fuel cells are being deployed more often as a means to reduce grid dependency and total cost of electricity. *See SCTE 218 for more information on fuel cell types and their benefits.*
Load Balancing	Load Balancing is a technique used to reduce energy demand costs by storing excess electrical power (e.g. with batteries and/or a smart grid system) during low demand periods for use during high demand periods. Reducing peak demand can yield lower utility costs.
Microturbines	Use of on-site or off-site micro-turbines can be an effective way to generate electrical and heat energy. *See SCTE 218 for more details.*
On-Site Renewables	Biomass - Biomass based energy systems utilize waste wood, and cellulose type materials to generate energy. Photovoltaics - Energy production technology that is solid state and composed of semi-conductor materials that can be deployed via rooftop or building rooftop mounting (with/without envelope penetrations). Solar Water Heating – The conversion of sunlight into renewable energy for water heating using a solar thermal collector. Wind Energy - Energy production technology that can be captured via small rooftop units and large off-site turbines. *See SCTE 218 for more details.*
Power Factor Correction	When apparent power (kVA) is greater than working power (kW), the utility must supply the excess reactive current plus the working current, and will often charge a fee for this service. Improvements to power factor can be achieved by adding power factor correction capacitors to the plant distribution system.
Utility Grade Renewables	Increased utilization of large-scale utility renewables. Examples include: Purchasing renewable energy credits. Buying into local solar or wind farms. Coordinating with the local utility to provide land for large scale projects. *See SCTE 218 for more details and benefits of these and other utility-grade renewable energy practices.*

7. Results – Energy Measures

The following figures and tables show the resulting list of energy efficiency measures identified by industry SMEs, and their corresponding cost and value. To assist users in identifying and prioritizing energy measures applicable to their facility portfolio, this Operational Practice organizes measures according to applicable category (see Section 6.2). For each category, the Operational Practice provides the following:

1) A scatterplot figure depicting where each measure (applicable to that category) falls in the value and cost matrix, and
2) A table providing additional details on each energy measure.

To further assist users in identifying and prioritizing energy measures, **Appendix A** at the end of this document organizes energy measures by facility type. This is useful for stakeholders who only manage one or two facility type(s).

As stated in Section 6.4, note that the cost and value metrics in this Operational Practice are qualitative, and based on feedback from subject matter experts rather than quantitative analysis of cost and value. Future iterations of this Operations Practice will contain refined value and cost estimates based on feedback from case studies using this Practice, and future quantitative analysis (see Section 8 for more information).

7.1. Power Generation and Distribution

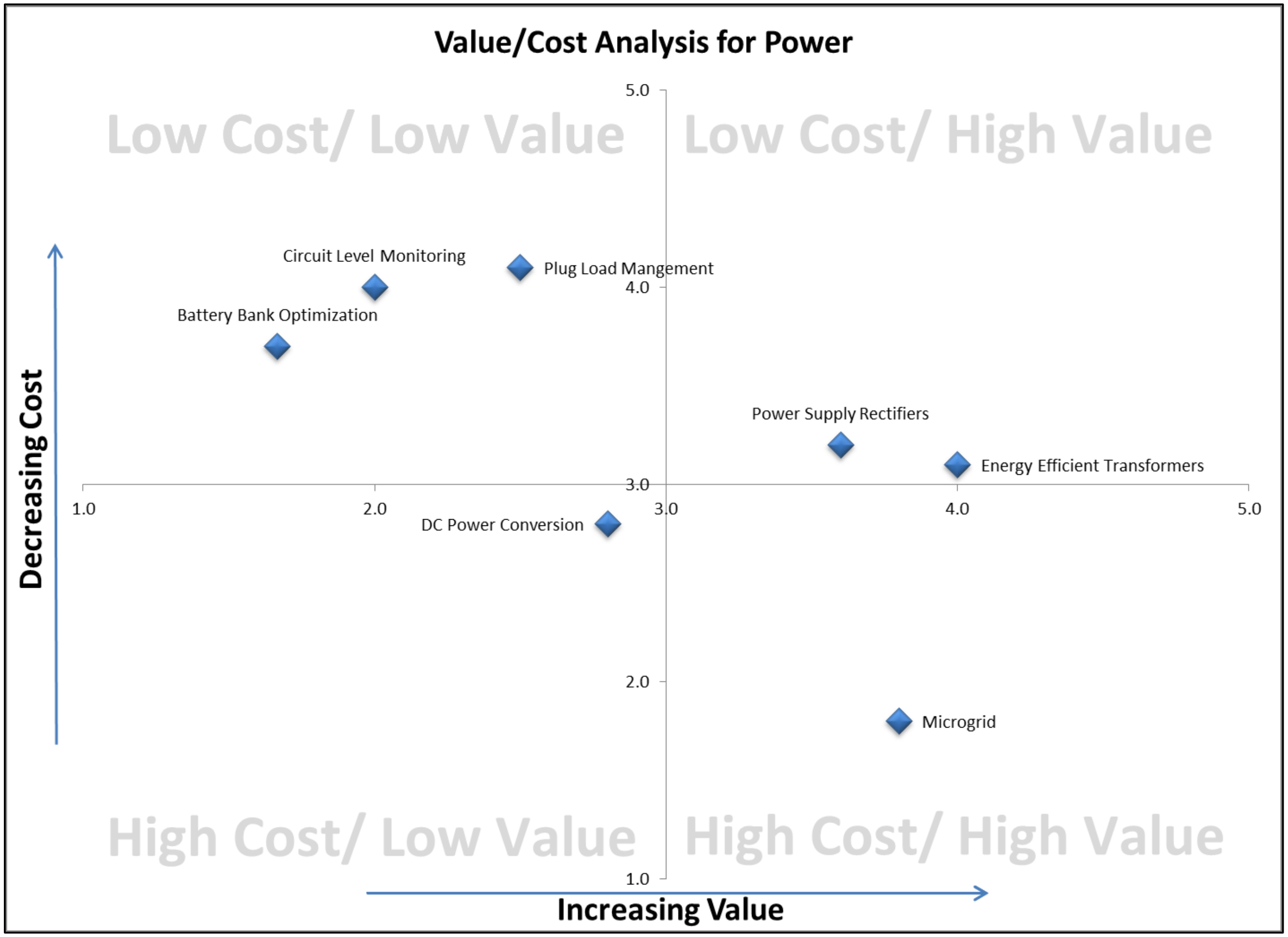

Figure 3 – Cost/Value Analysis of Energy Efficiency Measures for Power Generation and Distribution

Table 6 – Energy Efficiency Measures for Power Generation and Distribution

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
Power Generation and Distribution					
(3.8,1.8)	Class A-E, Admin, Lab, WH	Power	Energy Generation	Micro-grid	Installation and use of an on-site microgrid (localized grouping of electricity sources and loads) to generate DC power for a facility or facilities.
(2.0,4.0)	Class A-E	Power	Energy Distribution	Circuit Level Monitoring	Software and hardware for distributed network monitoring and management. DC equipment monitoring at circuit-level, optimizing the network and equipment protection.
(1.7,3.7)	Class A-E	Power	Energy Distribution	Battery Bank Optimization	Utilize control strategies for increased system performance in back up DC power supplies.
(2.5,4.1)	Class A-E	Power	Energy Distribution	Plug Load Management	Optimizing electrical plug loads by assessing current plug loads and implementing changes to reduce load and energy consumption, especially at peak demand periods.
(2.8,2.8)	Class A-E	Power	Energy Distribution	Eliminate conversion Steps – transition to DC	Transitioning to DC power will reduce the number of conversions power must go through before reaching the equipment
(3.6,3.2)	All	Power	Energy Distribution	Power Supply Rectifiers	Ensure purchasing most energy efficient units when doing replacements and new deployments for increased energy efficiency.
(4.0,3.1)	Class A-E, Admin, Lab, WH, Retail	Power	Energy Distribution / Supply Chain	Energy Efficient Transformers	Where transformers must be used, energy efficient transformers can reduce the losses from energy conversion.

* Refer to EMS-025 for Critical Facility Classification descriptions

7.2. Heating, Ventillation and Air Conditioning

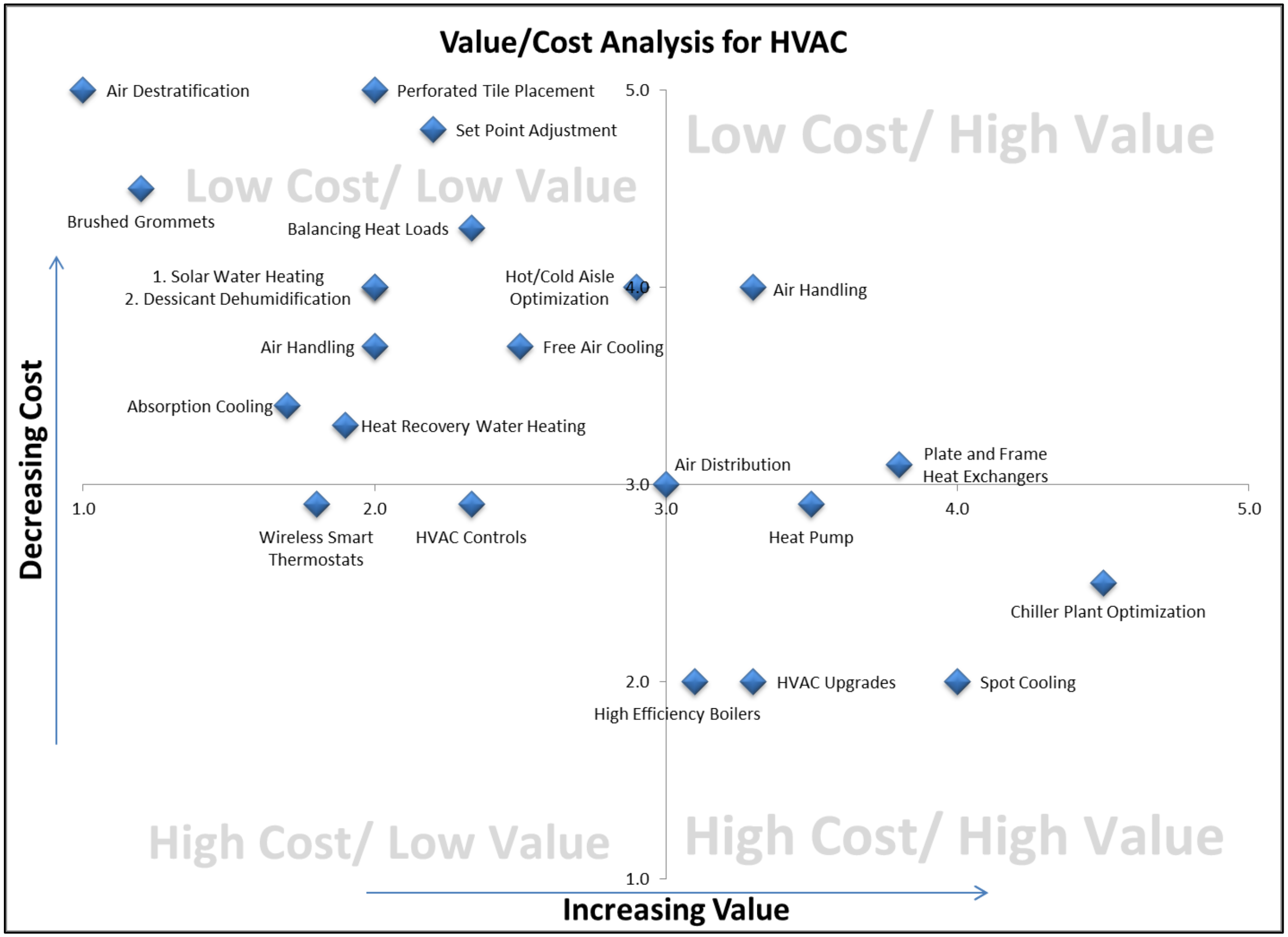

Figure 4 – Cost/Value Analysis of Energy Efficiency Measures for Heating, Ventillation and Air Conditioning

Table 7 – Energy Efficiency Measures for Heating, Ventillation and Air Conditioning

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
HVAC/Cooling/Mechanical Plant					
(2.2, 4.8)	All	HVAC	Cooling	Set Point Adjustment	Align temperature set-point settings with American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommendations. Every one degree increase in temperature (in summer months) can deliver up to 4% in energy savings.
(2.5, 3.7)	Class A-E, Admin	HVAC	Cooling	Free Air Cooling	Installation of an air-wide economizer to utilizes cool outside air whenever feasible to reduce cooling costs.
(2.3, 4.3)	Class A-E, Admin	HVAC	Cooling	Balancing Heat Loads	Minimizes hot spots and provides for equal heat dissipation.
(2.9, 4.0)	Class A-E, Lab	HVAC	Cooling	Hot/Cold Aisle Optimization	Provides more efficient cooling and higher HVAC inlet temperatures.
(4.0, 2.0)	Class A-E, Admin	HVAC	Cooling	Spot Cooling	Direct cooling service to high-heat generation rack-based equipment reducing overall cooling delivery requirement.
(2.3, 2.9)	All	HVAC	Controls	HVAC Controls	Utilization of advanced control system to minimize power usage while cooling a space.
(3.1, 2.0)	Class A-E, Admin	HVAC	Heating	High Efficiency Boilers	A high efficiency boiler is a closed vessel in which water or other fluid is heated. The fluid does not necessarily boil. (In North America the term "furnace" is normally used if the purpose is not actually to boil the fluid.) The heated or vaporized fluid exits the boiler for use in various processes or heating applications, including water heating, central heating, boiler-based power generation, cooking, and sanitation.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
(3.5, 2.9)	Class A-E, Admin, Lab, Warehouse	HVAC	Heating	Ground/Air Source Heat Pump	Ground source heat pumps are electrically powered systems that tap the heat/energy underground. Another technology application is the use of air source heat pumps to preheat emergency backup generators – resulting in high system energy savings (up to 75%). The is most applicable to large generators (over 500 horsepower). See Appendix B for more information.
(2.0, 4.0)	Admin, Lab, Warehouse	HVAC	Alternative Energy	Solar Water Heating	Solar hot water systems can be cost effective energy saving option in pre-heating a facilities hot water and *may* have available incentives.
(1.9, 3.3)	Class A-E, Admin	HVAC	Alternative Energy	Heat Recovery Water Heating	Recapture of heat from hot water and put back into the system to increase operational efficiency.
(4.5, 2.5)	Class A-E, Admin, Warehouse	HVAC	Cooling	Chiller Plant Optimization	Installation of controls, sensors, and equipment in a chiller plant to optimize the chilled water and/or condenser water cycle, reducing the total energy needed to achieve required cooling for the building.
(3.8, 3.1)	Class A-E, Admin, Warehouse	HVAC	Cooling	Plate and Frame Heat Exchanger	Heat exchangers provide indirect free cooling for building HVAC systems through water-to-water heat transfer in both the condenser and chiller water loops. Plate and frame heat exchangers provide increased surface area of heat transfer, making them one of the most efficient types on the market.
(1.7, 3.4)	Class A-E	HVAC	Cooling	Absorption Cooling	Absorption chillers use heat to drive the refrigeration cycle, they produce chilled water while consuming just a small amount of electricity to run the pumps on the unit. Absorption chillers generally use steam or hot water to drive the lithium bromide refrigeration cycle but can also use other heat sources.
(2.0, 4.0)	Class A-E, Admin, Warehouse	HVAC	Cooling	Desiccant Dehumidification	Air dehumidification can be achieved by two methods: (I) cooling the air below its dew point and removing moisture by condensation, or (2) sorption by a desiccant material. Desiccants in either solid or liquid forms have a natural affinity for removing moisture.
(3.3, 2.0)	Class A-E, Admin	HVAC	Air Flow Management	HVAC Upgrades	Replace current air handling equipment in an HVAC system with more efficient models (e.g. install more energy efficient fans).

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
(3.0, 3.0)	All	HVAC	Air Flow Management	Air Distribution	Optimized Central heating and cooling systems using an air distribution or duct system to circulate heated and/or cooled air to all the conditioned rooms in a house.
(1.2, 4.5)	Class A-C	HVAC	Air Flow Management	Brush Grommets	Equipment installed in a data center to prevent air leaks from the system, resulting in less energy consumed for data center cooling.
(4.0, 3.7)	Class A-E, Lab	HVAC	Air Flow Management	Air Handling	Reduce the amount of air leakage, improve aisle containment.
(1.0, 5.0)	Class A-E, Admin, Warehouse	HVAC	Air Flow Management	Air Destratification	Process of mixing internal air in a building to achieve temperature equalization and remove stratified layers.
(1.8, 2.9)	All	HVAC	Heating and Cooling	Wireless Smart Thermostats	Installation of advanced wireless thermostats with improved controls and tracking of temperature and energy savings.
(2.0, 5.0)	Class A-E, Lab	HVAC	Air Flow Management	Perforated Tile Placement	Improper placement of perforated tiles is a major culprit behind cooling problems in data centers.

* Refer to EMS-025 for Critical Facility Classification descriptions

7.3. Lighting

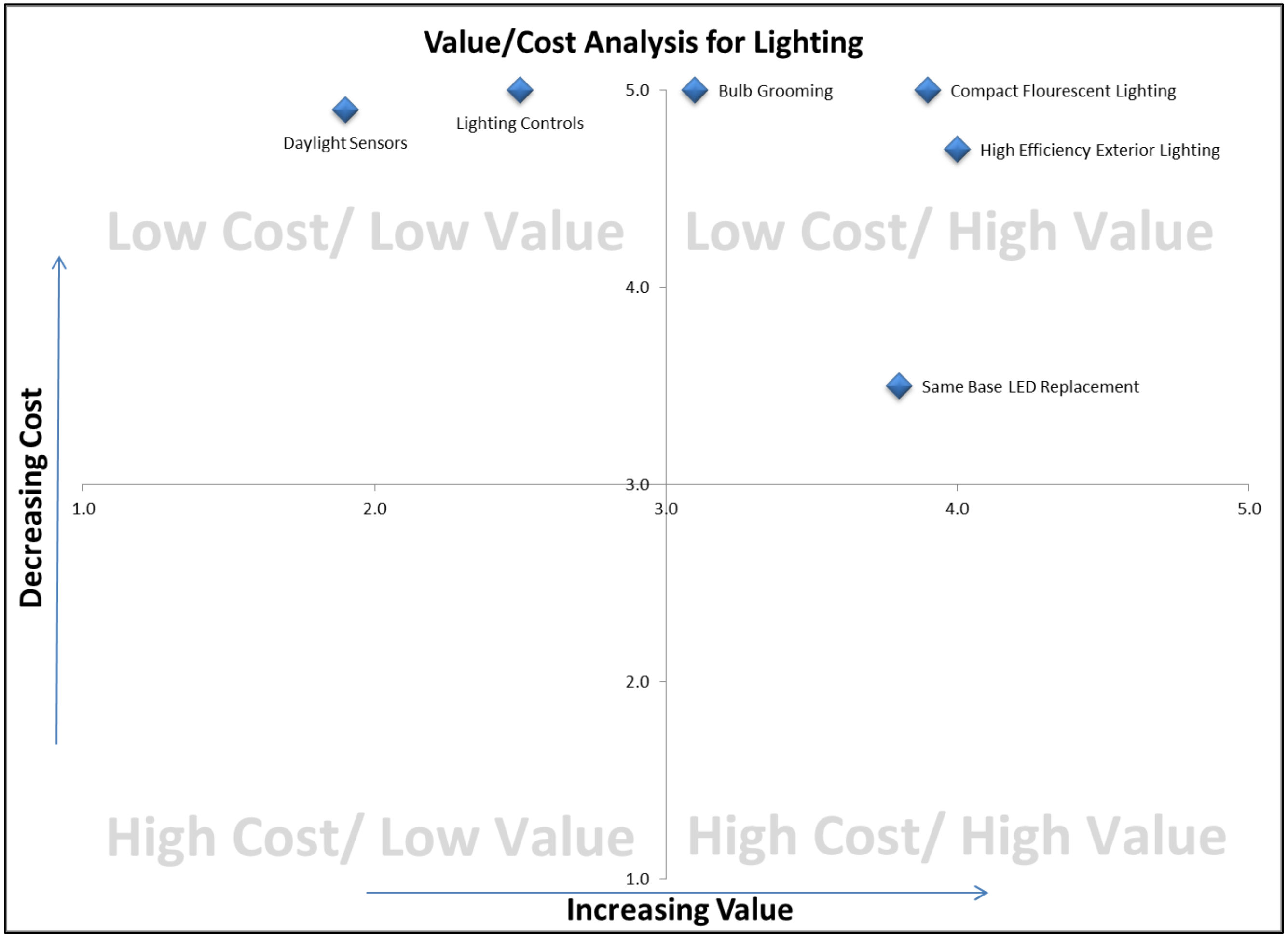

Figure 5 – Cost/Value Analysis of Energy Efficiency Measures for Lighting

Table 8 – Energy Efficiency Measures for Lighting

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
Lighting					
(3.1, 5.0)	Class A-E, Admin, Lab, Retail	Lighting	Bulb Grooming	Replace 3 older 30W bulbs with 2 new 25W bulbs	This reduces each fixture from 90W to 50W. As long as ballasts do not require replacement this is an extremely inexpensive energy saver if performed on an ongoing basis as bulbs require replacement.
(3.8, 3.5)	Class A-E, Admin, Lab	Lighting	Relamp	Replace Incandescent with new same base LED	Replacement of incandescent bulbs with of LED bulbs will save energy as LED requires less power and decreases heat loss.
(2.5, 5.0)	All	Control	Lighting Controls	Install lighting controls	Implementing occupancy sensors and other lighting controls to turn of lights when areas are unoccupied or do not need additional light.
(1.9, 4.9)	Admin	Control	Daylight Sensors	Install daylight lighting sensors	Implementing daylight sensors enables facilities to automatically turn off lights then there is sufficient ambient lighting.
(3.9, 5.0)	Class A-E, WH, Lab	Lighting	Efficiency Lighting	Install compact fluorescent lighting	More energy efficient than incandescent.
(4.0, 4.7)	All	Building	Efficiency Lighting	High Efficiency Exterior Lighting	Use of higher efficiency bulbs and systems for lighting outdoor areas (e.g. LED bulbs).

* Refer to EMS-025 for Critical Facility Classification descriptions

7.4. Building Envelope

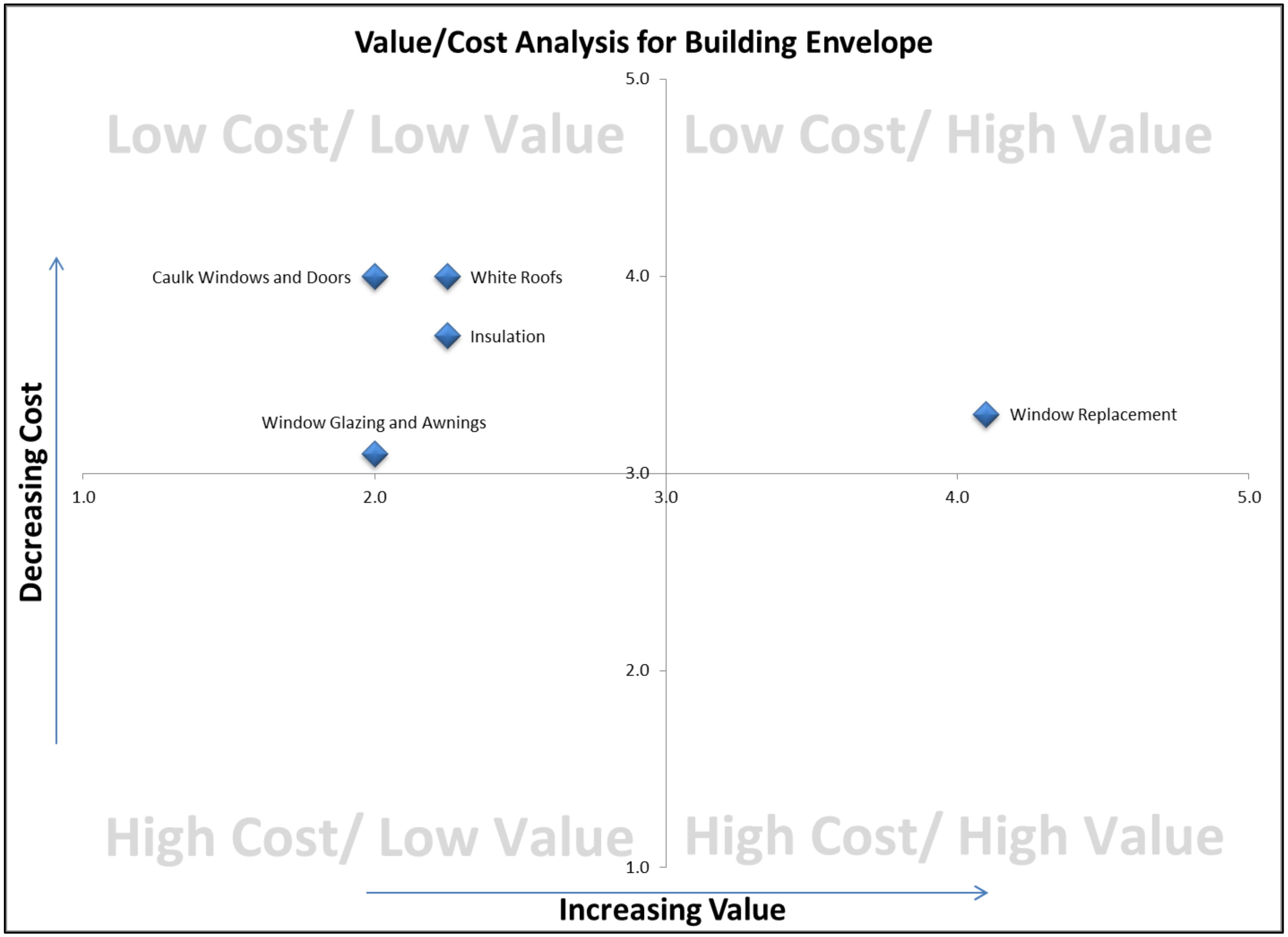

Figure 6 – Cost/Value Analysis of Energy Efficiency Measures for Building Envelope

Table 9 – Energy Efficiency Measures for Building Envelope

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
Building Envelope					
(2.0, 3.1)	All	Building	Envelope	Window Glazing and Awnings	Use of glazing and awnings to reduce solar heating.
(4.1, 3.3)	All	Building	Envelope	Window Replacement	Replace existing with high efficiency models to reduce cooling costs.
(2.3, 3.7)	All	Building	Envelope	Proper Insulation	Installing insulation to reduce heating and cooling losses in the building.
(2.3, 4.0)	All	Building	Envelope	White Roofs	Replacing black roofs with white to increase reflection of sunlight, thereby decreasing cooling requirements for buildings (most applicable in hot climates).
(2.0, 4.0)	All	Building	Envelope	Caulk Windows and Doors	Caulking windows and doors that have aging or improper caulking to reduce heat and cooling losses.

* Refer to EMS-025 for Critical Facility Classification descriptions

7.5. Miscellaneous

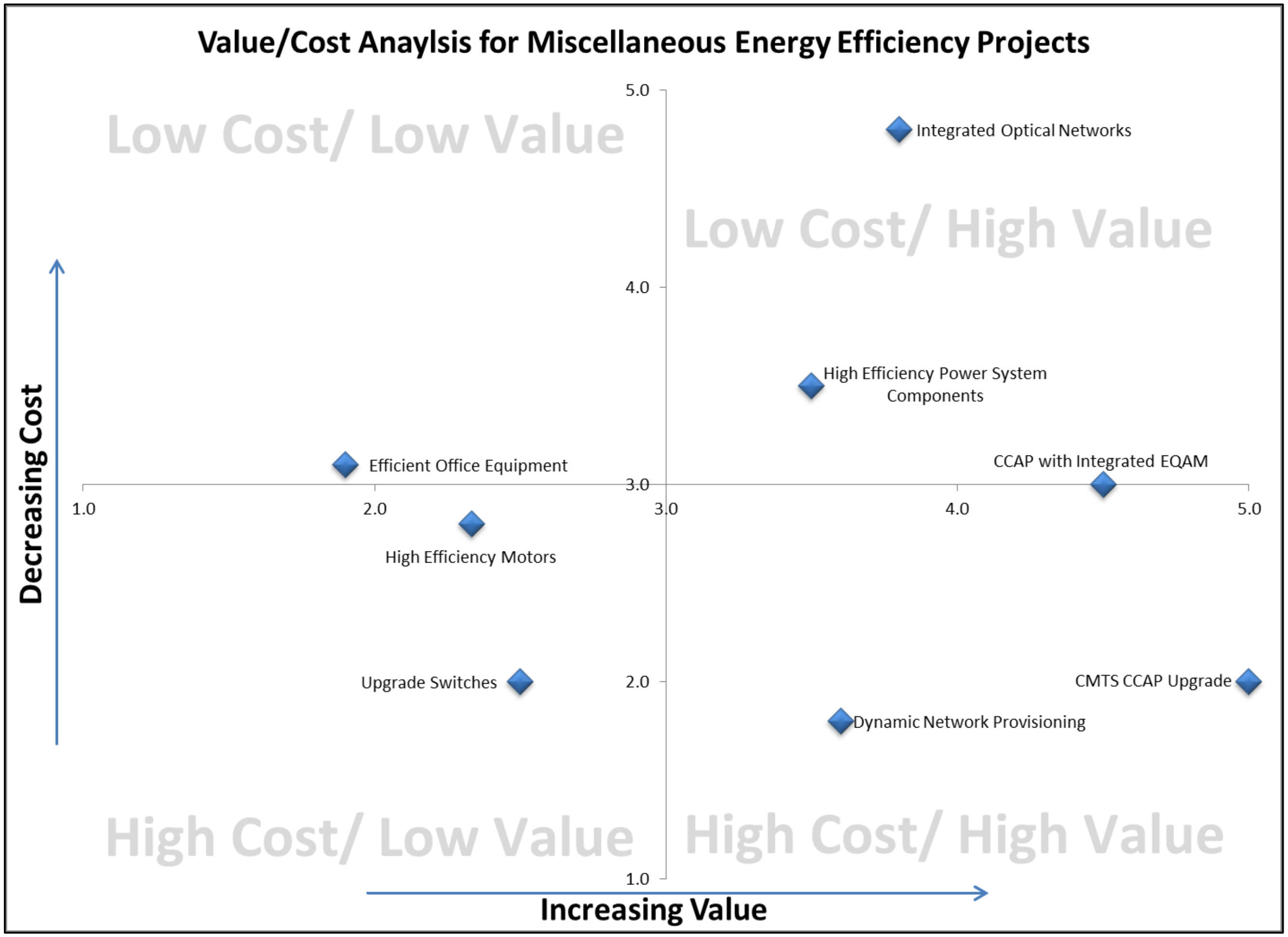

Figure 7 – Cost/Value Analysis of Miscellaneous Energy Efficiency Measures

Table 10 – Miscellaneous Energy Efficiency Measures

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure	Description/Objective
Miscellaneous					
(3.5, 3.5)	Class A-E	Power	Equipment	High Efficiency Power System Components	Efficiency gains in Information and Communications Technology (ICT) equipment and software drive savings in all areas by reducing loads.
(2.5, 2.0)	Class A-E	HVAC	Equipment	Upgrade Switches	Install better switches in an HVAC system to improve controls and protect equipment.
(2.3, 2.8)	All	Mechanical Plant	Equipment	High Efficiency Motors	Energy-efficient motors are typically 2 to 8% more efficient than standard motors. Motors *may* qualify for various incentives if they meet or exceed standard efficiency levels.
(3.6, 1.8)	Class A-E	Equipment	Software	Dynamic Network Provisioning	Sequencing equipment and radio cycling to obtain highest efficiency.
(3.8, 4.8)	Class A-E	Equipment	Software	Integrated Optical Networks	All optical networks are very often considered to be the main candidate for constituting the backbone that will carry global data whose volume has been growing at astounding rates.
(5.0, 2.0)	Class A-E	Equipment	Upgrade	(CMTS) converged cable access platform (CCAP) Upgrade	Significant operational savings can be achieved through the CMTS/EQAM/CCAP upgrade, especially if replacing older equipment. Business case *may* be justified by the need for more bandwidth capacity. (see Appendix B)
(4.5, 3.0)	Class A-E	Equipment	Software	converged cable access platform (CCAP) with integrated EQAM	Additional operational savings can be achieved by integrating EQAM inside CCAP. Assumes that newer equipment is already installed. (see Appendix B)
(1.9, 3.1)	Admin, Warehouse, Retail	Office	Equipment	Efficient Office Equipment	All office equipment *should* be evaluated to determine power usage and opportunities to replace with higher efficiency models.

* Refer to EMS-025 for Critical Facility Classification descriptions

8. Recommendations and Next Steps

8.1. Analysis of Results and Examples

The following table depicts 16 energy measures that *should* be considered a high priority based on the qualitative value and cost metrics assigned by SCTE subject matter experts. Users of this operational practice are encouraged to review this table to see if any of these measures are applicable to their facility types. See descriptions in Section 7 for more information on the measures in this list.

Table 11 – List of High Priority Energy Measures for All Facility Types and All Categories

Note – Value is on a scale of 1-5, with 5 being a high value. Cost is on a scale of 1-5, with 5 being a low cost.

Value,Cost	Facility Types*	Category	Sub-Category	Energy Measure
Power Generation and Distribution				
(4.0,3.1)	Class A-E, Admin, Lab, WH, Retail	Power	Energy Distribution / Supply Chain	Energy Efficient Transformers
(3.6,3.2)	All	Power	Energy Distribution	Power Supply Rectifiers
HVAC				
(4.0, 3.7)	Class A-E, Lab	HVAC	Air Flow Management	Air Handling
(2.2, 4.8)	All	HVAC	Cooling	Set Point Adjustment
(4.5, 2.5)	Class A-E, Admin, Warehouse	HVAC	Cooling	Chiller Plant Optimization
(3.8, 3.1)	Class A-E, Admin, Warehouse	HVAC	Cooling	Plate and Frame Heat Exchanger
Lighting				
(3.9, 5.0)	Class A-E, WH, Lab	Lighting	Efficiency Lighting	Install compact fluorescent lighting
(4.0, 4.7)	All	Building	Efficiency Lighting	High Efficiency Exterior Lighting
(3.1, 5.0)	Class A-E, Admin, Lab, Retail	Lighting	Bulb Grooming	Replace 3 older 30W bulbs with 2 new 25W bulbs
(2.5, 5.0)	All	Control	Lighting Controls	Install lighting controls
(3.8, 3.5)	Class A-E, Admin, Lab	Lighting	Relamp	Replace Incandescent with new same base LED
Building Envelope				
(4.1, 3.3)	All	Building	Envelope	Window Replacement
Miscellaneous				
(3.8, 4.8)	Class A-E	Equipment	Software	Integrated Optical Networks
(3.5, 3.5)	Class A-E	Power	Equipment	High Efficiency Power System Components
(5, 2.0)	Class A-E	Equipment	Upgrade	Upgrade older CMTS/EQAM to CCAP
(4.5, 3.0)	Class A-E	Equipment	Software	CCAP with integrated EQAM

* Refer to EMS-025 for Critical Facility Classification descriptions

8.2. Procedures for SCTE EMS-028 Use

When using this Operational to identify and prioritize energy efficiency measures for facilities, users *should* follow these procedures:

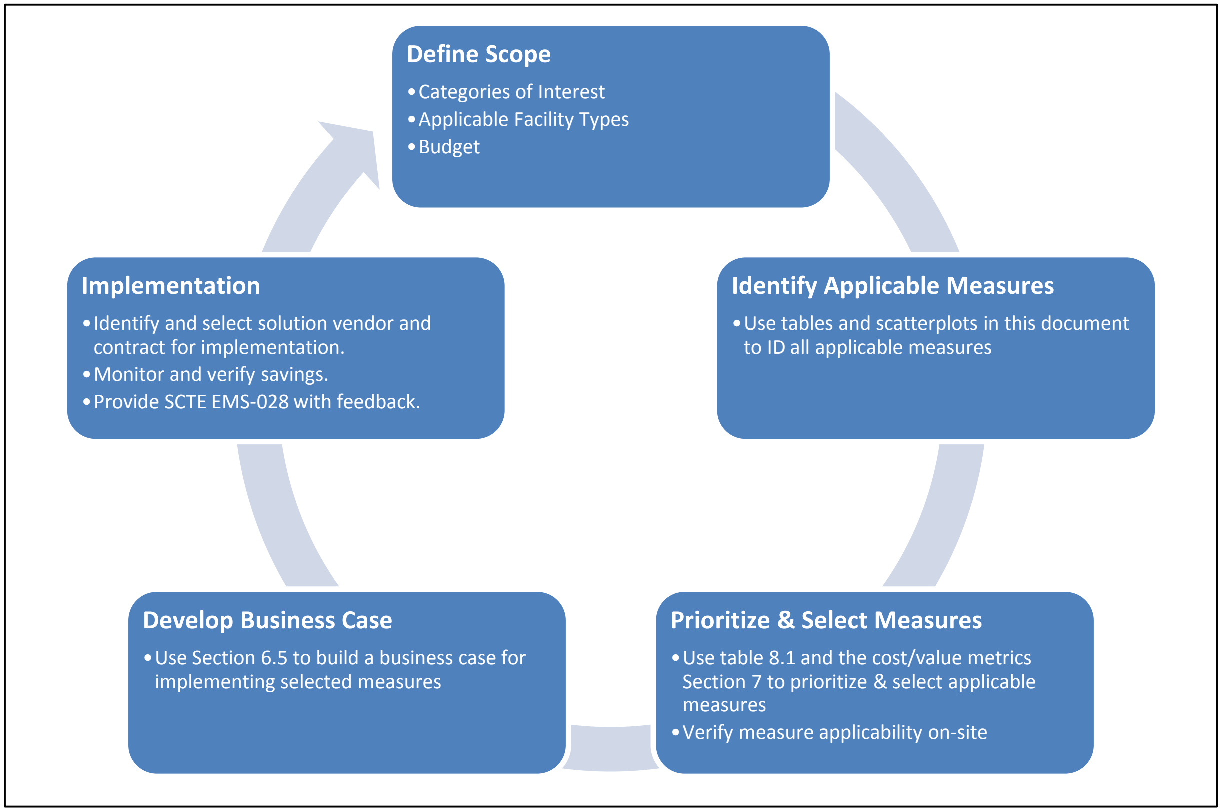

Figure 8 – Procedure Flow Chart

1. Define Scope – Organizations must first determine the scope of their energy improvements by defining:
    a. What facility types are in their property portfolio (Section 6.3)?
    b. What categories are applicable and/or of interest for their facilities (Section 6.2)?
    c. What budget is available for initial energy measure capital costs?
2. Identify Applicable Measures – Using the scope of energy improvements defined in step 1, organizations can group all applicable energy measures using the tables and scatterplots available in Section 7 and Appendix A.
3. Prioritize & Select Measures – After a full list of possible energy measures for consideration has been developed, organizations can then utilize cost and value metrics developed by this Operational Practice to aid in prioritization and eventual selection of energy measures for implementation.
    a. Users are encouraged to target measures in Quadrant 3 of the scatterplots (high value / low cost) first, and then move to Quadrants 1 (low value / low cost) and/or Quadrant 4 (high value / high cost) depending on funding availability.
    b. Additional guidance and prioritized measures can be found in Table 8.1.
    c. After developing the list of applicable and prioritized measures, organizations *should* verify that these measures are applicable on a site by site basis through conversations with property managers, data collection, site audits or other means as necessary.

4. Develop Business Case – Once the organization has selected one or more energy measures for implementation, they *should* utilize the guidance in Section 6.5 to building a business case for implementation. The business case *should* include the projected energy efficiency and cost savings, non-energy benefits (e.g. sustainability benefits, water consumption reduction, maintenance cost reduction, energy resilience), and opportunities for project financing (e.g. utility incentives, alternative financing).
5. Implementation – If energy measures are approved for implementation, organizations must then research and select technology vendors who can achieve this work, and contract with them and other necessary parties (finance, installers) to implement the measure on-site. Post implementation, organizations are encouraged to monitor and verify savings that the energy measures create, and use that for internal and external messaging (e.g. sustainability reporting). Furthermore, organizations are encouraged to provide cost and savings data as a case study to this Operational Practice to aid in future improvements (see Section 1.5).

Appendix A – Energy Measures by Facility Type

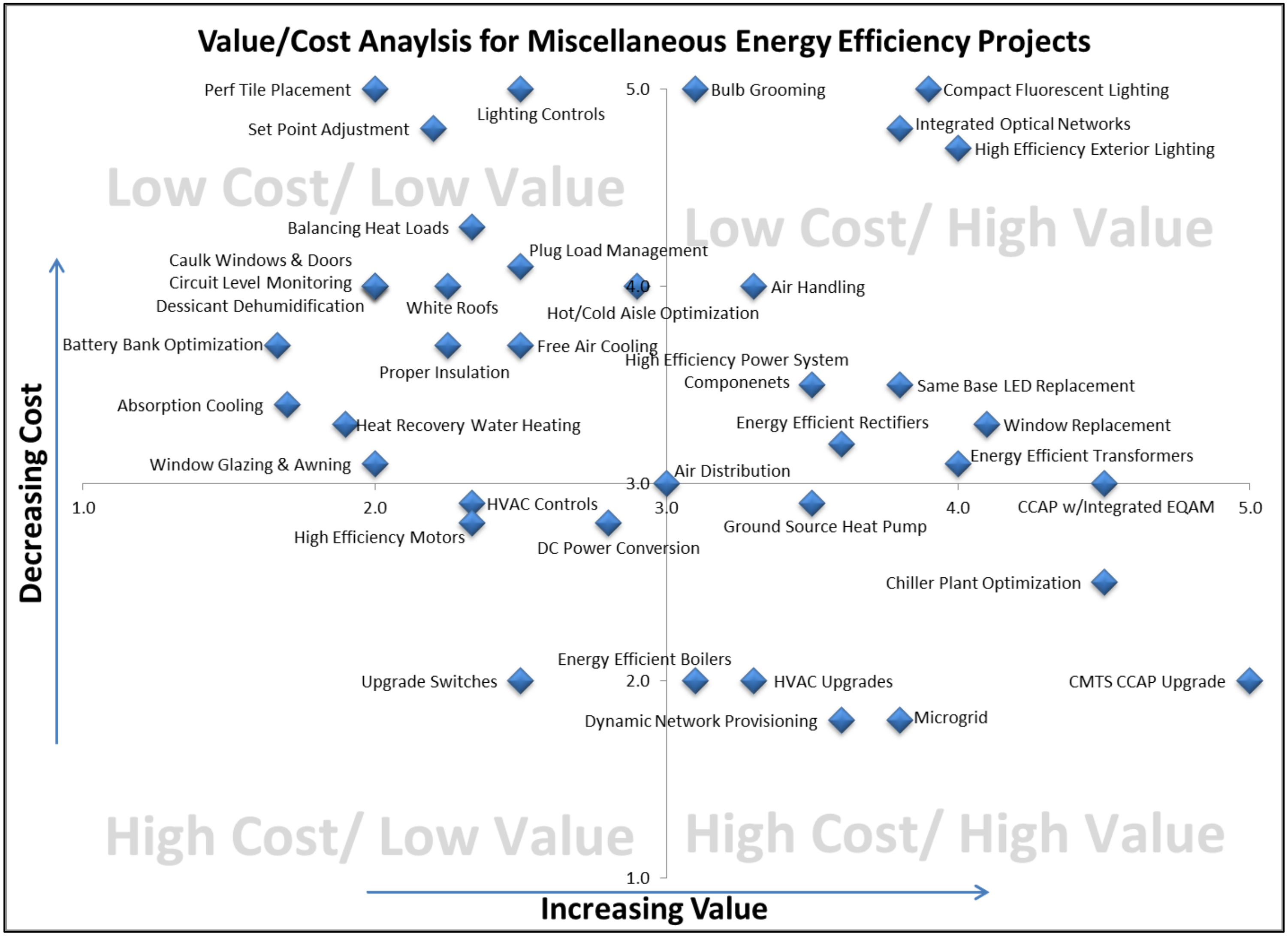

Figure 9 – Cost/Value Analysis of Energy Efficiency Measures for Critical Facilities

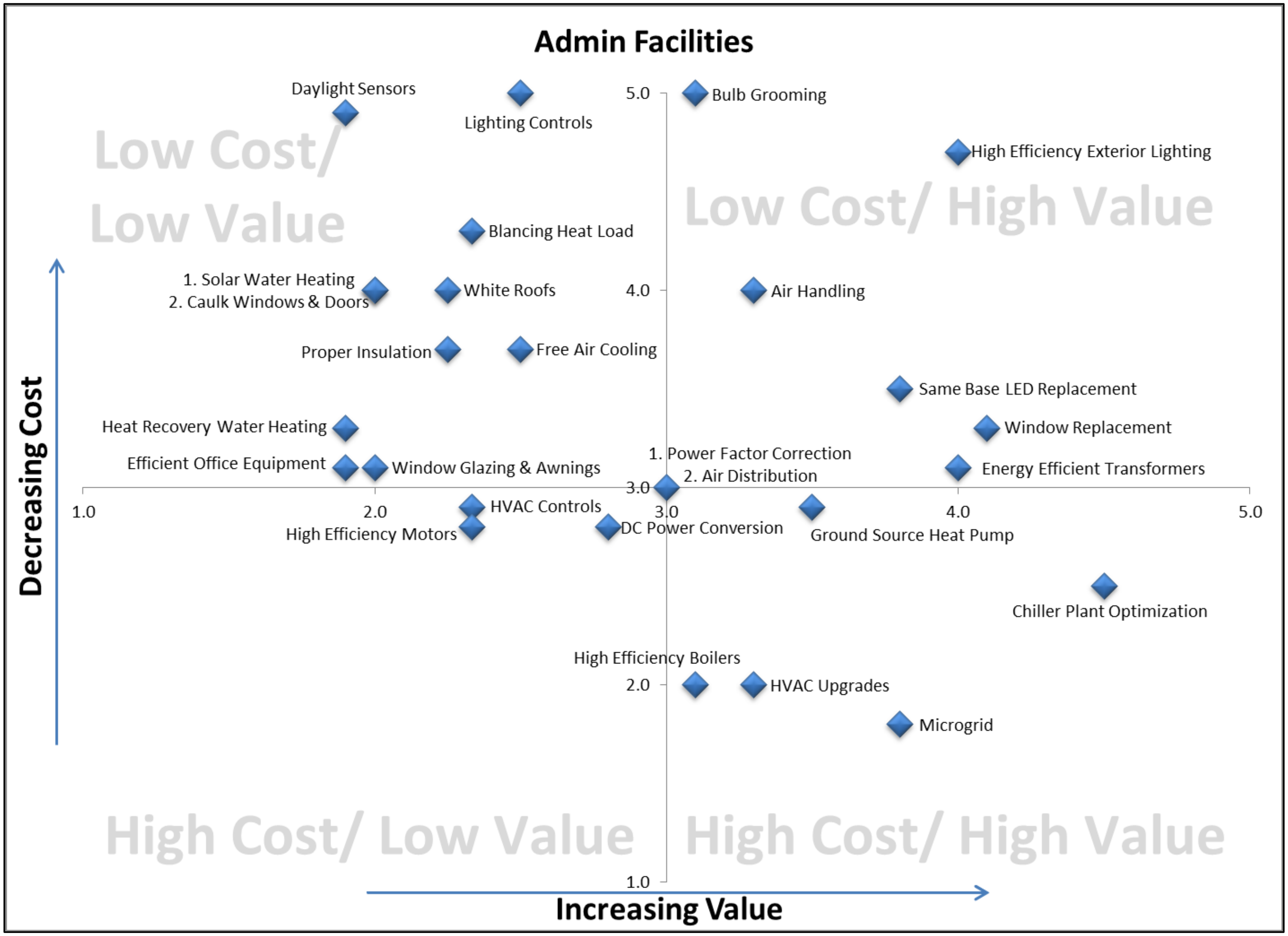

Figure 10 – Cost/Value Analysis of Energy Efficiency Measures for Administrative Facilities

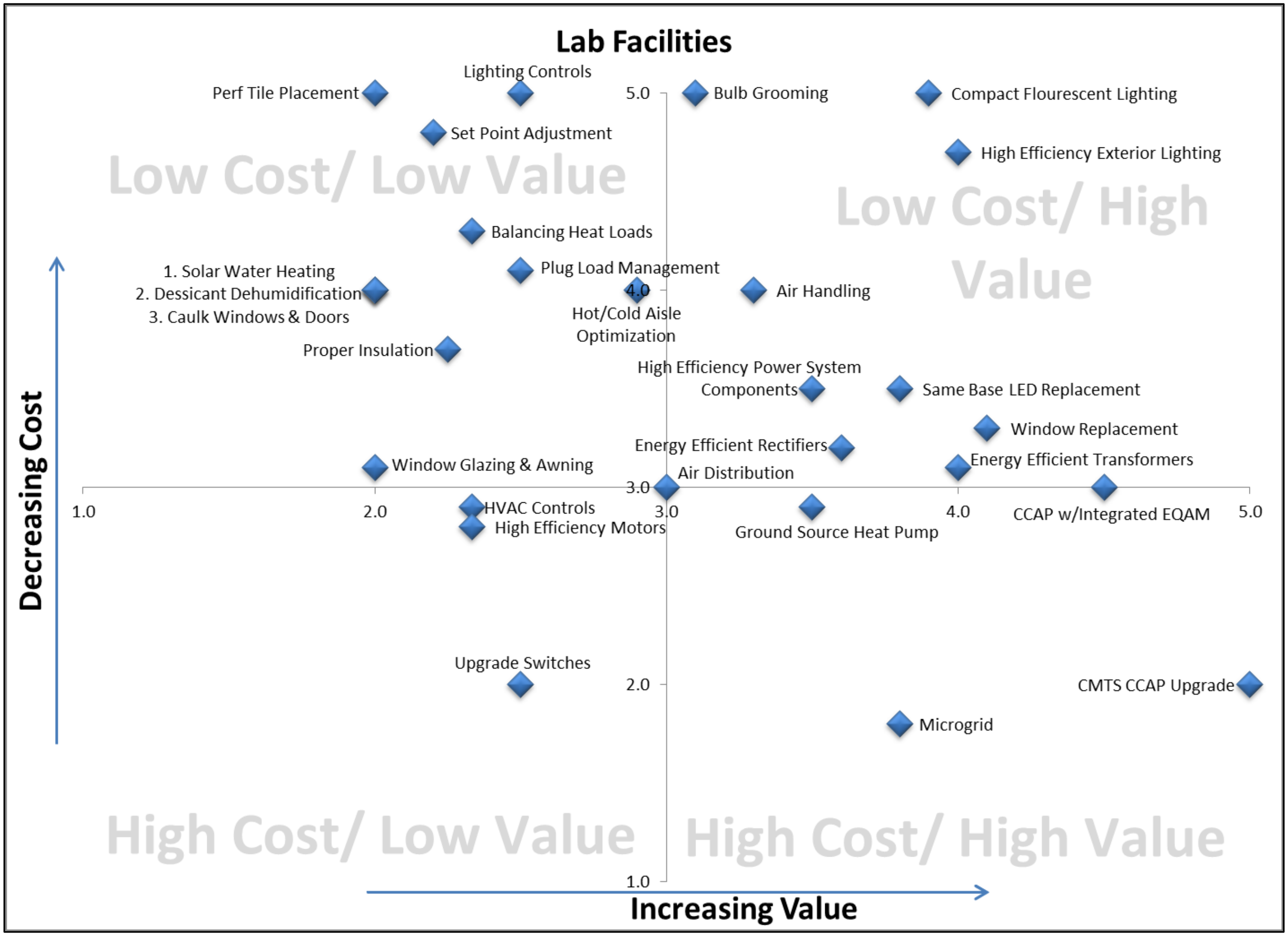

Figure 11 – Cost/Value Analysis of Energy Efficiency Measures for Laboratory Facilities

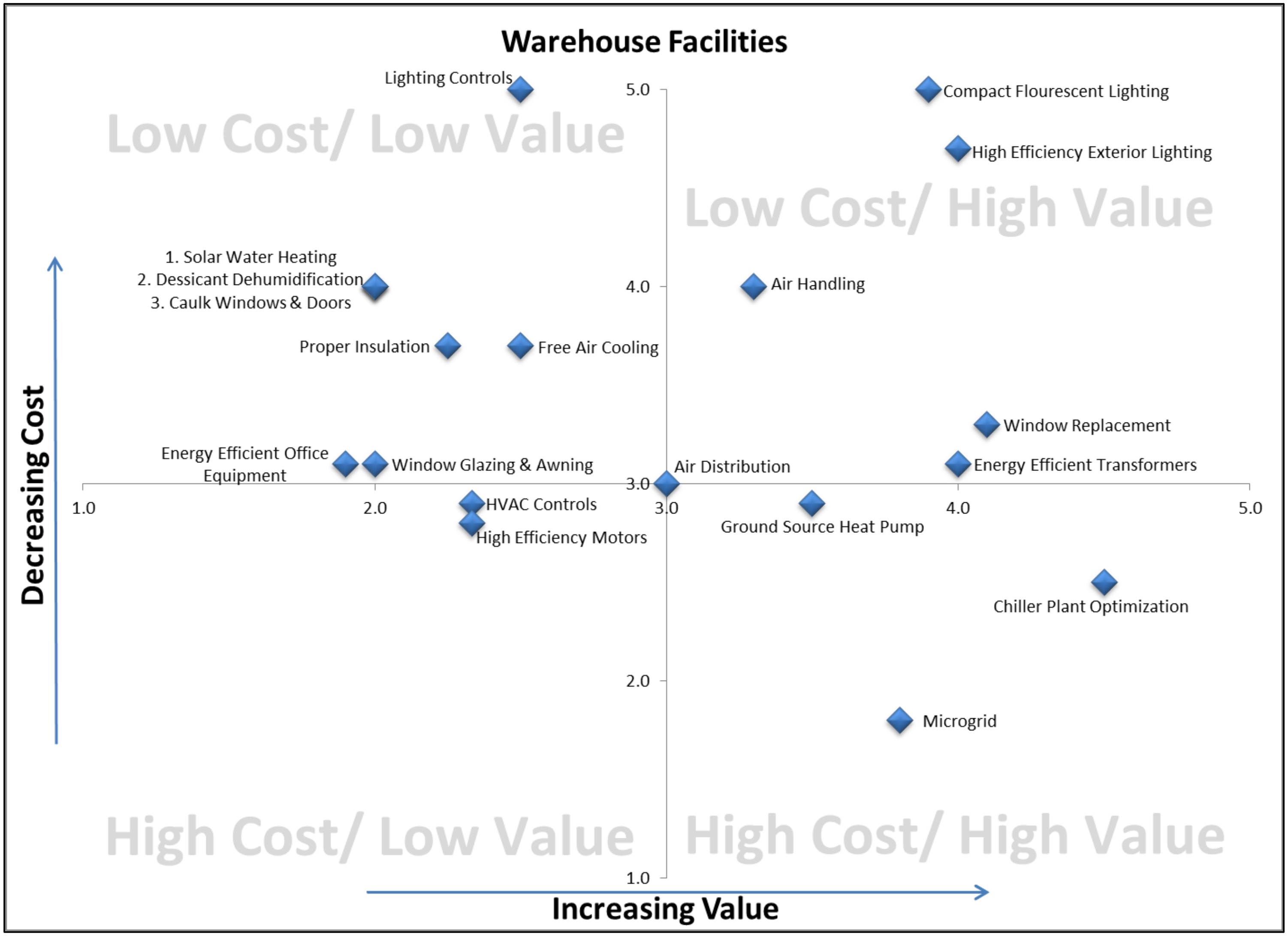

Figure 12 – Cost/Value Analysis of Energy Efficiency Measures for Warehouse Facilities

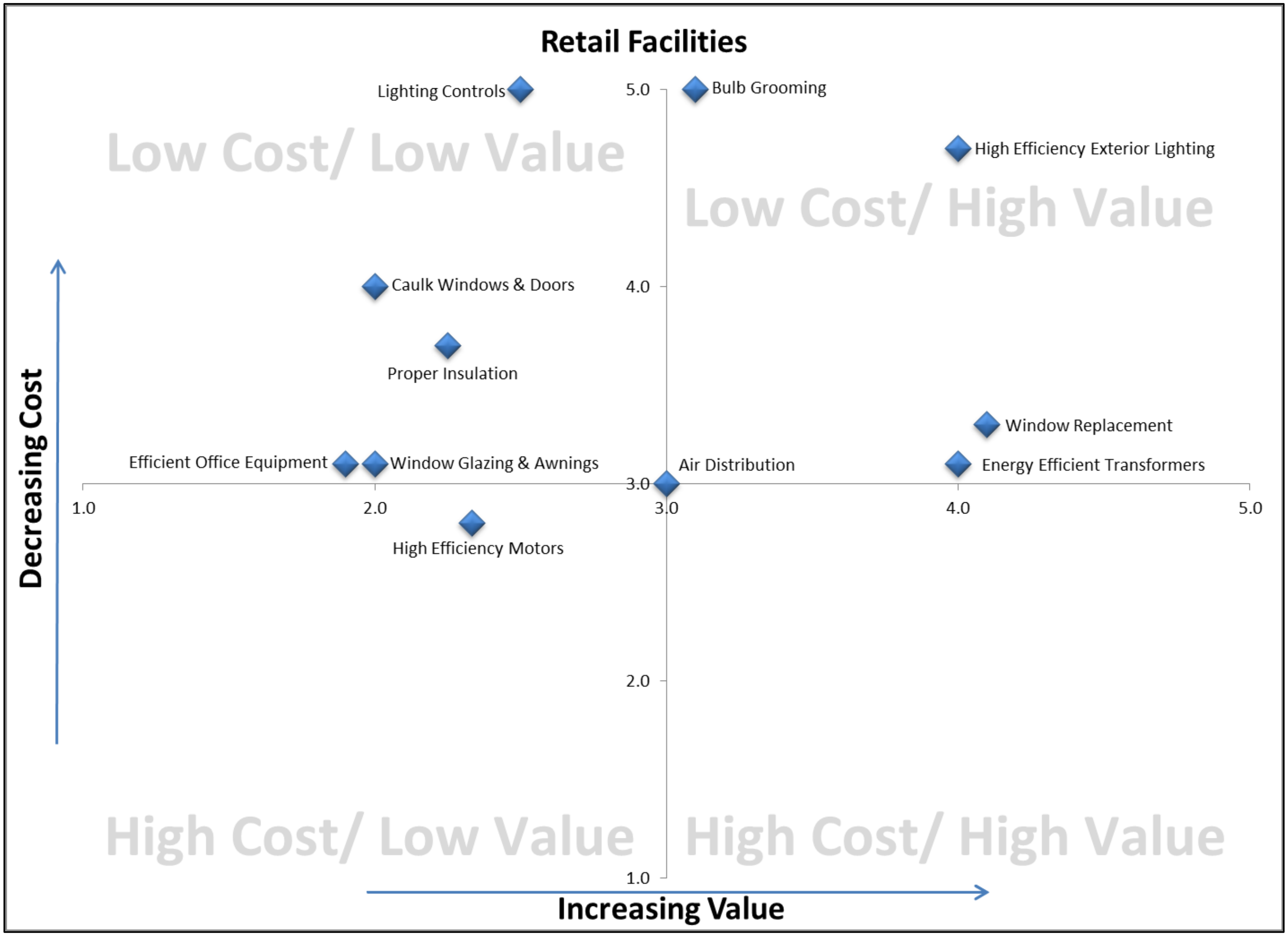

Figure 13 – Cost/Value Analysis of Energy Efficiency Measures for Retail Facilities

Appendix B – Case Studies and References for Energy Measures

The following table provides more details on specific energy measures obtained from case studies and feedback from Operational Practice users.

Table 12 – Case Studies and References by Energy Measure

Energy Measure	Feedback/Case Study	Description / Changes to Value &Cost

Miscellaneous – CMTS CCAP Upgrade	SCTE Expo 2013 – CCAP Case Study: Enabling Converged Video + Data thru Space & Power Savings	Modified measure based on 2013 SCTE publication on CCAP and case study information from ARRIS.
		
		Separated the measure into two:
		• (CMTS) converged cable access platform (CCAP) Upgrade
		  o Full CCAP upgrade from the older version, including adding equipment.
		  o Added value & cost for CCAP Upgrade at 5.0, 2.0 based on data from ARRIS case study (mid-high cost and 30-60% savings).
		• converged cable access platform (CCAP) with integrated EQAM
		  o Software upgrades enabling integration of EQAM into the CCAP allowing external EQAM to be removed. Assumes CMTS/CCAP equipment already installed
		  o Added value & cost at 4.5, 3.0 based on data from ARRIS case study (lower initial cost since system equipment present, 20-30% savings).

HVAC – Ground and Air Sourced Heat Pump	Southern California Edison 2009 – Air Source Heat Pump for Preheating of Emergency Diesel Backup Generators	Added air source heat pump application to energy measure based on case study from Southern California Edison. This technology uses an efficient air source heat pump to provide required heat energy for emergency diesel backup generators as opposed to inefficient resistance heaters. The technology is most applicable to large generators (over 500 horsepower). No modifications were made to the value & cost metrics for the energy measure (still reflect only Ground Source Heat Pumps). Case study suggests that the value & cost of this air source heat pump application would be approximately 5.0,4.0.