EXPRO National Manual of Assets and Facilities Management
Volume 17, Chapter 2

Energy Management Procedure

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1.0 PURPOSE

This document will enable the Entity to establish its own approach to achieving consistent and reliable Facility operations, sustaining profitability, and inculcating an environmentally sustainable culture.

When incorporated successfully into the Entity's FM Procedures, the guidance contained within the Energy Management Standard will facilitate the set-up of Entity-specific performance targets associated with Energy Management – parameters may include, for example, power and water consumption, Energy efficiency, resource utilization, and carbon emissions.

2.0 SCOPE

The Energy Management Standard outlines the importance of establishing an Energy Conservation Policy and describes how to implement the Policy through a Strategy developed around an Energy Management Information System (EMIS). The EMIS shall be developed in conjunction with an Energy Management Program (EMP). EMIS and EMP-related content is primarily for the attention of decision-makers within the Entity. However, in order for both to be established and successfully delivered, all members of staff within the organization should be aware of and work toward their successful implementation and continuous improvement.

In addition to covering the strategic-level requirements associated with implementation of an EMIS, the Standard also approaches the subject of Energy Management in sufficient technical detail to enable: Energy Auditing, Energy Baselining, Energy Data Analytics, Measurement & Verification (M&V), Monitoring-Based Commissioning (MBCx), and Reporting. Specialist technical content contained herein is intended for use by the Entity's Operational staff who are Subject Matter Experts (SMEs) within the Energy Management field.

3.0 DEFINITIONS

Term	Definition
AEE	Association of Energy Engineers
AHU	Air Handling Unit
AMR	Automated Meter Reading
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
BBT	Building Base Temperature
BEM	Building Energy Model
BMS/BAS	Building Management System/ Building Automation System
Btu	British thermal unit
CDD	Cooling Degree Days
CDM	Clean Development Mechanism
CEA	Certified Energy Auditor
CEM	Certified Energy Manager
CEng	Chartered Engineer
CFR	Current Facility Requirements
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CIBSE	Chartered Institution of Building Services Engineers
CMVP	Certified Measurement and Verification Professional
CSO	Current Sequence of Operations
CUSUM	Cumulative Sum Method of Energy Data Analytics
DDC	Direct Digital Control
DER	Distributed Energy Resources
DHW	Domestic Hot Water

EAC	Energy Accounting Center
EAMS	Enterprise Asset Management Systems
ECI	Energy Cost Index
ECRA	Electricity and Cogeneration Regulatory Authority
EIS	Energy Information System
EMIS	Energy Management Information System
EMP	Energy Management Program
Energy	Work done by units of Power and Water (or other, as applicable) over time
EMWG	Energy Management Working Group
EnPI	Energy Performance Indicator
ESCO	Energy Services Company
ESM	Energy Saving Measure
ESP	Energy Saving Project
ESPC	Energy Savings Performance Contracting
EUI	Energy Use Intensity
EVO	Efficiency Valuation Organization
FDD	Fault Detection and Diagnosis
FM	Facilities Management
GACA	General Authority for Civil Aviation
GDD	Growing Degree Days
GHG	Greenhouse Gas
HDD	Heating Degree Days
HWR	Hot Water Return
HWS	Hot Water Supply
HR	Human Resources
HVAC	Heating, Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IBMS	Integrated Building Management Systems
ICT	Information and Communication Technologies
IEQ	Indoor Environmental Quality
IET	Institute of Engineering and Technology
IGA	Investment Grade Audit
IoT	Internet of Things
IPMVP	International Performance, Measurement and Verification Protocol
IRR	Internal Rate of Return
IT	Information Technology
KACST	King Abdulaziz City for Science and Technology
KPI	Key Performance Indicator
KSA	Kingdom of Saudi Arabia
LC	Low Cost
LCCA	Life-Cycle Cost Analysis
LEED	Leadership in Energy and Environmental Design
M&V	Measurement and Verification
MAP	Monitoring Action Plan
MBCx	Monitoring-Based Commissioning
MEWA	Ministry of Environment, Water and Agriculture
MoF	Ministry of Finance
MoH	Ministry of Health
MoMRA	Ministry of Municipal and Rural Affairs
MoT	Ministry of Transportation
Mostadam D+C	D+C is applicable to the Design and Construction of new buildings

Mostadam O+E	Mostadam O+E is applicable to the buildings that have achieved Mostadam D+C certification and existing/older buildings, including those that are undergoing minor renovation, refurbishment and/or extension
NC	No Cost
NMA&FM	National Manual of Assets & Facilities Management
NPV	Net Present Value
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PBP	Payback Period
PIF	Public Investment Fund
PPE	Personal Protective Equipment
PV	Photo Voltaic
RCJY	Royal Commission for Jubail and Yanbu
RCM	Reliability Centered Maintenance
RER	Renewable Energy Resources
ROI	Return on Investment
RROR	Real Rate of Return
RTU	Rooftop Unit
SWCC	Saline Water Conversion Corporation
SASO	Saudi Standards, Metrology And Quality Organization
SBC	Saudi Building Code
SABIC	Saudi Basic Industries Corporation
SEC	Saudi Electricity Company
SEEC	Saudi Energy Efficiency Center
SENS	Saudi Environmental Society
SHW	Service Hot Water
SLD	Single Line Diagram
SLT	Senior Leadership Team
SMART	Specific, Measurable, Achievable, Realistic, and Time-bound
SME	Subject Matter Expert
SROI	Social Return on Investment
UN	United Nations
VAV	Variable Air Volume
VFD	Variable Frequency Drive

Table 1: Definitions

4.0 REFERENCES

- ASHRAE Guideline 0-2019: The Commissioning Process
- ANSI/ASHRAE/ACCA Standard 211-2018: Standard for Commercial Building Energy Audits
- ASHRAE Guideline 1.2-2019: Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies
- ASHRAE Guideline 1.4-2019: Preparing Systems Manuals for Facilities
- ASHRAE Guideline 14-2014: Measurement of Energy, Demand and Water Savings
- ANSI/ASHRAE/IES 100-2018: Energy Efficiency in Existing Buildings
- ISO 50001: 2018: Energy Management
- ISBN 13: 978-0-87258-902-5: ASHE/FGI Health Facility Commissioning Handbook: Optimizing Building System Performance in New and Existing Health Care Facilities
- ASHRAE Advanced Energy Design Guides: 50% Design Guide (above ANSI/ASHRAE/IES Standard 90.1:2004)
- US DOE Building Technologies Office, National Renewable Energy Laboratory – Advanced Energy Retrofit Guide: Healthcare, Offices, Schools

- US DOE, Better Buildings Energy Management Information Systems (EMIS) Toolkit: A Primer on Organizational Use of Energy Management Information Systems (EMIS), Lawrence Berkley National Laboratory, November 2015
- US DOE Contract DE-AC05-76RL01830 – August 2011: Metering Best Practices, A Guide to Achieving Utility Resource Efficiency, Release 2.0
- ISO 14001:2018: Environmental Management
- EVO 10000 – 1:2016: EVO IPMVP Core Concepts
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- ISBN 1-890956-96-1 – 2017: Building Commissioning Handbook – Building Commissioning Association
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- Canadian Industry Program for Energy Conservation: Energy Management Information Systems – Achieving Improved Energy Efficiency, a Guidebook for Managers, Engineers, and Operational Staff
- Expro Projects White Book, Volume 6, Chapter 7: Improving Energy and Water Consumption in Existing and New Buildings Document No. EPM-KE0-GL-000004 Rev 002
- SMS-EnMS-001: Energy Planning and Review, Version 2.0, February 2019 – by Serco
- SMS-EnMS-003: Energy Monitoring Measurement and Analysis, Version 2.0, January 2019 – by Serco
- SMS-EnMS-004: Energy Performance Indicators and Energy Baseline, Version 2.0, January 2019 – by Serco
- SMS-EnMS-005: Plant Operation and Maintenance, Version 2.0, January 2019 – by Serco

5.0 RESPONSIBILITIES

Each Entity shall establish an Energy Management Team. This function can either reside within an existing function (Engineering Standards Department) or be established as a standalone function. Wherever the Energy Management Team finds a home within the Entity, its powers must be maximized such that there are no obstacles in having the function achieve its aims. Table 2 (below) describes the typical Role which specific Stakeholders play as part of an EMP.

Role	Description
Senior Leadership Team (SLT)	• Provide active support and sponsorship for establishing the Energy Management Program (EMP) • Ensure 100% Policy compliance throughout the organization • Ensure Processes and Procedures are reformed to overcome obstacles to enabling the Strategy • Monitor and target progress through Reporting Procedures • Support the Energy Management Working Group (EMWG) in acquiring necessary resources and information
Energy Management Working Group	• Act as an interface between the Senior Management and the Energy Management Team • Lead the establishment, delivery, review, and development of the EMP • Continually assess performance parameters and troubleshoot performance concerns • Feedback to Senior Management regarding important Energy Management issues
Energy Manager	Can be the Facilities Manager, but must hold Certified Energy Manager qualification with relevant years of experience for the size of the Energy Management Program. Leads the Energy Management

	Team and chairs the Energy Management Working Group. Shall be capable of: • Energy Data Analytics (Utility Cost Accounting, Carbon Accounting, Benchmarking) • Establishing a Business Case (IRR Calculation, Cashflow Analysis, Simple Payback, ROI) • Performance Monitoring and Reporting (IPMVP, ESM Tracker, Energy Audit Reports, Annual Reports) • Target Setting (Objectives, Energy Performance Indicators, Drivers)
Energy Management Team	• Collate and analyze all data required to achieve the aims of the EMP • Collaborate with stakeholders across the organization to instill sustainability culture • Support in the establishment of Energy Budgets • Lead in the establishment of life-cycle costing, indices, and discounted cashflow-based assessments • Lead the EMWG to deliver its remit • Lead in the establishment of Energy Conservation Policy and Strategy • Lead in the delivery of the EMP • Lead in the establishment of Energy Baseline, execution of Energy Audits, and establishment of Business Cases for Energy Saving Projects (ESPs) • Manage the delivery of ESPs • Provide presentations and Workshops to all departments within the organization on all relevant matters related to the EMP • Identify products and services which will benefit the EMP, and ensure their procurement and integration into Entity Systems and Processes
Finance Team	• Support the Energy Management Team by providing relevant financial information (i.e. utility billing data, tenant payments) • Involve the Energy Management Team in decision-making and the development of Energy Budgets • Provide guidance, assistance, and support regarding internal and external funding mechanisms for successful execution of ESPs • Provide SME advice to the Energy Management Team in the calculation of life-cycle costing, indices, and discounted cashflow-based assessments
Procurement Team	• Ensure Energy Efficiency requirements and specifications are built into procurement criteria, promoting sustainably produced and recycled products • Together with the Energy Management Team, establish a Procurement Policy and associated Guideline to enable integration of Energy Efficiency into Procurement practices • Collaborate with the Energy Management Team to encourage Service Providers and Suppliers in maximizing Energy-Efficient products and services • Collaborate with the Energy Management Team to pre-qualify new Service Providers and Suppliers • Maximize inclusion of Energy Performance Criteria across all contracts
Information Technology (IT) Team	• Support implementation of Energy Management Software • Establish relevant communication channels and protocols for implementation of the EMP across different stakeholder groups within the organization (i.e. SharePoint, Yammer, One Drive, Shared Folders, Microsoft Teams) • Collaborate with the Energy Management Team for installation, configuration, and commissioning of field communication devices.

	Enable successful integration within existing Building Management and Automation Systems • Collaborate with the Energy Management Team regarding implications of IT and Communications Infrastructure on Energy Demand
Human Resources (HR) Team	• Provide a summary of the EMP as part of induction training for all new staff and describe staff responsibilities as part of the Program • Build sustainability culture requirements into the Employment Contract • Support the Energy Management Team in organizing awareness raising campaigns • Develop Job Specifications for relevant positions in collaboration with the Energy Management Team • Recruit, train, and retain staff who are qualified and competent to successfully deliver components of the EMP
Engineering Team	• Monitor and report (as required) Energy use during out-of-hours on behalf of the Energy Management Team (i.e. identifying Energy losses and areas of improvement, and recording analogue meter readings)
Assets Team	• Provide asset tagging data and other outputs from the Enterprise Asset Management System

Table 2: Responsibilities

6.0 PROCESS

The process which describes Energy Management is outlined in

(below).

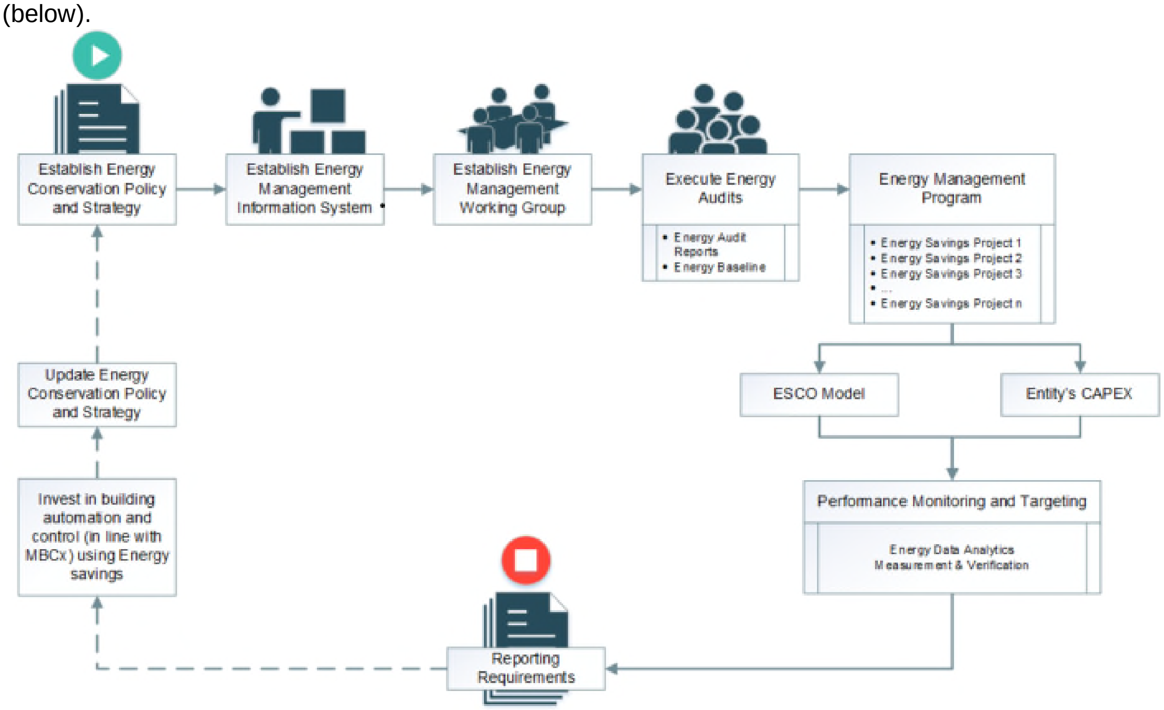

Figure 1: Energy Management Process

6.1 Establishing an Energy Conservation Policy and Strategy

A Policy Statement should be in place for Entities to help demonstrate their commitment to the conservation of Energy. Typically, each Entity should have a Policy for Sustainability & Environment and a separate Policy for Conservation of Energy. The Policy Statement should follow guidance laid out in Volume 17, Sustainability Procedure (EOM-ZNO-PR-000002) and Volume 5, Procedure Development (EOM-ZO0-PR-000008). A Template for the **Energy Conservation Policy** is contained within Attachment 1.

The best way to enact an Energy Conservation Policy is to start by defining a Strategy featuring components which will enable compliance with the Policy. Against each component of the Strategy, the Entity can assign Roles and Responsibilities, and track progress. The Energy Conservation Strategy should cover the following areas:

- **Risks and Opportunities:** Define short-term and long-term barriers to implementing the EMP; define goals, and detail how goals will be met
- **Management:** Identify personnel responsible for implementing the Energy Conservation Strategy and define their roles
- **Resources:** Identify internal and external resources (equipment, products, personnel, services) required to deliver the EMP
- **Financials:** Identify the budget and financial objectives, investment criteria, and lifecycle costing
- **Reporting and monitoring:** Specify metrics to be monitored, reporting mechanisms, and timescales

The Energy Conservation Strategy should be regularly reviewed (e.g. 2 to 4 times per year as required) to account for changing business priorities. A Template for the **Energy Conservation Strategy** is contained within Attachment 2.

6.2 Establishing an EMIS

An EMIS is a performance management system which enables individuals and organizations to plan, make decisions, and take effective actions to manage Energy use and costs. An EMIS drives Energy performance improvements at all organization levels by converting data held at Energy Accounting Centers (EACs) into Energy performance information by using performance equations that are compared with the organization's Energy targets as shown in Figure **Error! Reference source not found.** (below).

Figure 2: EMIS Components

The EMIS is a continuous cycle of communication optimized performance, continuous improvement, and integration, supported by metering and inputs, data capture and integration, data analysis and reporting, and people and procedures. EACs sit at the core of the EMIS and drive all of the activities.

An EMIS integrates Energy management process into normal operating procedures. It allows the Entity to track, analyze, and forecast Energy usage. Component parts of the EMIS are described in ISO50001.

Figure 3: Components of ISO 50001

Apart from EACs, all aspects of Figure **Error! Reference source not found.** (above) are covered throughout other sections of the Chapter. EACs are system boundaries wherein Energy is measured and reported. Although EACs are not compulsory, the establishment of EACs may be useful for Entities developing a centralized Energy Management Team, with multiple facilities under its scope distributed throughout various locations within the country (i.e. multi-site scenario). In this instance, each EAC shall have an EAC Manager who reports to the centralized Energy Manager. Figure **Error! Reference source not found.** (below) describes the structure for implementation of EACs.

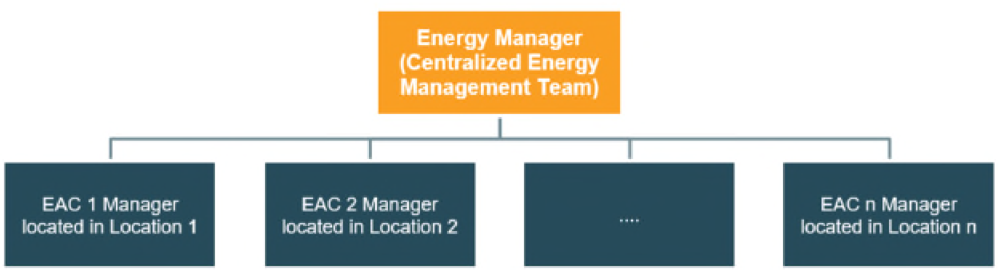

Figure 4: Energy Accounting Center Structure

In the absence of the aforementioned multi-site scenario, the EMT shall drive all of the activities required for successful delivery of the EMP since there will be, effectively, only one EAC.

There are three Phases to developing an EMIS (EMIS Audit, EMIS Implementation Plan, and Continuous Energy Performance Improvement) as shown in Figure Table 3 (below):

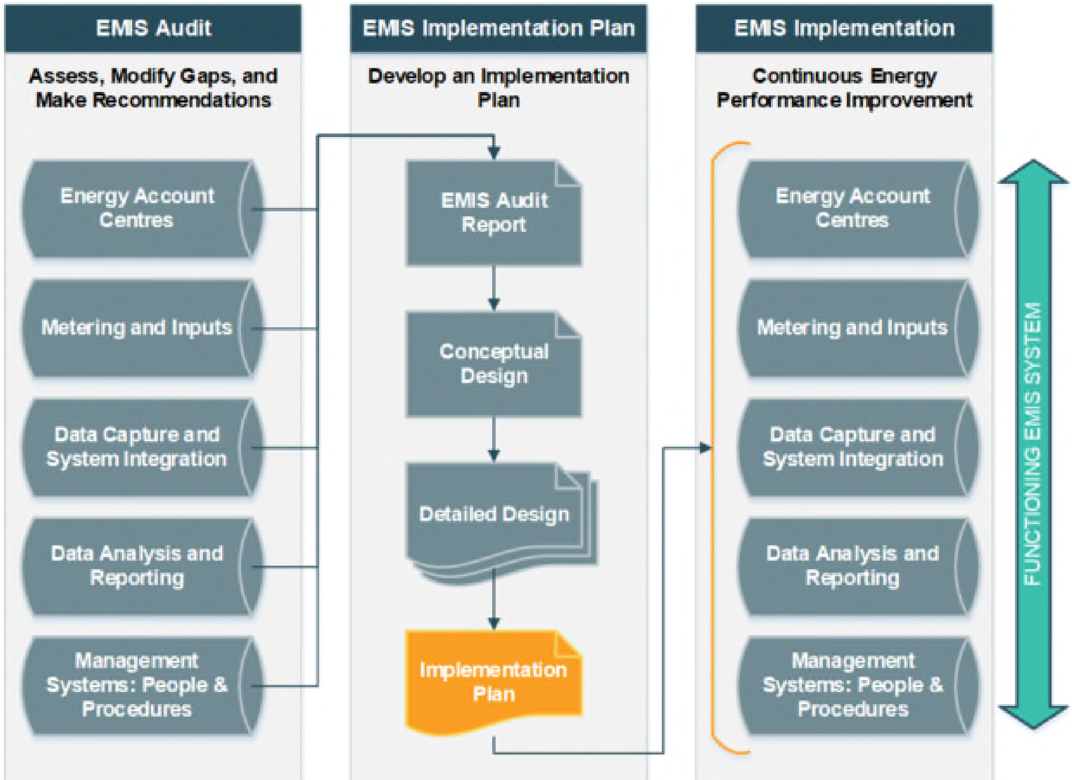

Figure 5: EMIS Development

An EMIS can be implemented without the need for software; however best practice dictates that the EMIS is integrated into existing organization systems and processes. This will reduce the need for multiple uncontrolled spreadsheets and tools created offline using MS Excel. The Entity should consult its existing software service provider regarding EMIS development, or consult Original Equipment Manufacturers (OEMs), Energy Services Companies (ESCOs), or firms such as OSIsoft and SAP.

6.3 Establishing an Energy Management Program

The most effective way to establish an EMIS is to create an EMP. The EMP comprises several ESPs with each contributing toward the success of the EMP. Each ESP is comprised of one or more Energy Saving Measures (ESMs). The criteria for what constitutes a project shall be determined by the Entity based on internal Commercial Governance.

6.3.1 Benefits

There are several potential benefits to implementing an EMP within each Entity. The list of potential benefits offered herein includes but is not limited to the following:

- Results in improved operational efficiencies and decreased Energy intensity
- Offers ability to establish and analyze Energy data for evidence-based decision making
- Acts as a vehicle for organizational and cultural change
- Drives organizational integration, removing “silos” and bureaucracy
- Reduces environmental impacts of business operations
- Instills operational excellence within resource management, accounting, budgeting, and reporting activities
- Offers a tangible demonstration of Corporate Social Responsibility, enhancing the Entity’s brand among customers, suppliers, and stakeholders
- Demonstrates a sustained effort toward meeting UN Sustainable Development Goals

- Supports carbon accounting and reduction, and compliant Sustainability Reporting
- Gives entities the opportunity to compete with private-sector counterparts
- Savings achieved as a result of an EMP could reach up to 30% against the baseline and will likely result in higher operating margin, thereby freeing up capital for re-investment into business growth, or staff training
- Improves transparency across business operations
- Improves staff productivity and well-being due to optimized Facility systems
- Results in a business case for the installation of renewable Energy generation
- Offers a mechanism by which to achieve certifications and awards (e.g. LEED, ISO50001)
- Raises organizational awareness and helps to foster a sustainability culture
- Increases likelihood of positively influencing staff behavior outside of the organization
- Enables Specific, Measurable, Achievable, Realistic, and Time-bound (SMART) Key Performance Indicators (KPIs)
- Supports the development of an Energy Conservation Policy and Strategy and provides opportunity for testing effectiveness and implementing continuous improvement
- Mandates highest standards to suppliers and service providers
- Improves overall employee engagement results
- Improves ability to manage Energy-related risks and exploit opportunities
- Increases Entity resilience to market fluctuations (equipment and tariffs)
- Mandates the implementation of latest Standards and best-practice
- Mandates the establishment of Energy-efficient specifications for equipment
- Improves understanding and recording of Entity assets, leading to intelligent evidence-based decision making
- Offers ability to issue evidence-based corporate communications and marketing
- Provides a basis for highlighting areas of improvement, incentivizing performance, and celebrating success
- Realization of non-Energy (indirect) benefits such as greater productivity and lower maintenance needs
- Fosters a culture which engages and empowers employees to identify and address Energy-saving opportunities
- Help organizations be better prepared for government or utility-sponsored Energy efficiency programs, carbon or Energy taxes, and international climate agreements
- Attracts international recognition and investment due to international compliance

6.3.2 Defining Success

Defining success is an Entity-specific exercise to be undertaken when establishing the EMP. Suggested definitions of success include but are not limited to the following:

- ESMs achieve forecasted savings
- KPIs are achieved
- Trending of Energy Performance Indicators (EnPIs) achieves forecasts
- Staff are engaged within the organization
- The organizations' profile is raised as a result of the EMP
- Building Certifications are achieved
- Staff are up-skilled as a result of delivering the EMP

Performance can be monitored and targeted by using KPIs as described in Section 0.

6.3.3 Success Factors

Factors which are identified as having the biggest impact on success shall also be determined by the Entity when setting up its own EMP. Examples of Success Factors are as follows:

- **Decentralization of responsibilities:** Best practice dictates that decentralization of responsibilities on the basis that "Energy Management is everyone's responsibility" is the most effective way in which to implement an EMP, with the Energy Management Team acting as the centralized focal point for all Energy data

- **Technology:** Maximizing the use of technology to capture and analyze data substantially increases the likelihood of a successful Program. Technology components of an EMIS such as Enterprise Asset Management Systems (EAMS), Smart Metering Systems, and web-based ESM Trackers are all good examples of technology which facilitate the EMP. Technologies such as Internet of Things (IoT)-enabled Building Management Systems (BMS) enable successful implementation of ESMs. Furthermore, real-time predictive analytics provide insight into operational anomalies uncovering several No Cost (NC) and Low Cost (LC) ESMs capable of delivering significant Energy savings

- **Data-driven processes:** Use of technology must be coupled with data-driven processes to ensure that the use of technology is maximized, and that digital software is used as it was intended

6.4 Establishing an Energy Management Working Group (EMWG)

Establishing an EMWG is a critical part of delivering a successful EMP. The EMWG has the following key responsibilities:

- Act as an interface between the Senior Management and the Energy Management Team.
- Lead the establishment, delivery, review, and development of the EMP.
- Continually assess performance parameters and troubleshoot performance concerns.
- Feedback to Senior Management regarding important Energy Management issues.

The EMWG is also responsible for:

- Leading the organization in raising awareness of the EMP and instilling sustainability culture.
- Building Business Cases for ESPs to establish budgeting requirements.
- Establishing Energy Management Leadership Awards.
- Recording Case Studies for the purposes of highlighting success and benchmarking activities
- Establishing the EMIS (defined in Section 3.0).
- Providing support and resources to other Departments responsible for delivering Projects with an Energy Saving component.
- Offering M&V Guidance to the organization (Data Quality, Energy Accounting).
- Establishing or refining Specifications and defining Standards (from an Energy Efficiency perspective) against which all Projects shall be delivered and EnMS Training and Skills.
- Setting Energy Conservation Policy and Strategy.
- Leading in the application of certification (i.e. LEED, ISO50001, Mostadam).
- Launching Pilot Projects.

Representatives from each of the following Teams shall be appointed to the EMWG:

- SLT
- Facilities Management (FM) Team
- Energy Management Team
- Finance Team
- Procurement Team
- Information Technology (IT) Team
- Human Resources (HR) Team
- Engineering Team
- Assets Team

The representative from the Energy Management Team shall be the Energy Manager. The Energy Manager is responsible for leading the Energy Management Team, setting the Agenda of the EMWG, and leading the discussion. Establishment of the EMWG and decision regarding who shall comprise the Membership is an Entity-specific matter and shall also be the responsibility of the Entity's appointed Energy Manager.

Full responsibilities for each EMWG Member are described within Table Table 2 contained within Section 5.0 Responsibilities.

6.4.1 Energy Review and Baselining

Energy Review is a critical component of implementing a successful EMP. The Energy Review has 5 key activities as follows:

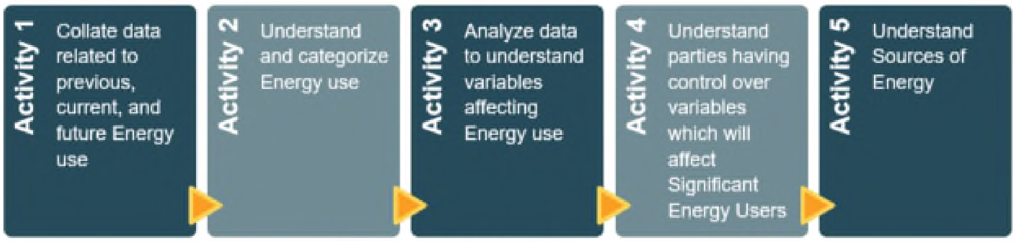

Figure 6: Energy Review Activities

1. Collate data related to previous, current, and future Energy use

A suggested list of relevant documents and information which shall be collated and reviewed are as follows:

- Layout Collate drawings buildings.
- Design information (equipment and plant specifications).
- Staff numbers per department.
- Utility invoices.
- Automated Meter Reading (AMR) Data.
- Metering/sub-metering information and architecture.
- Outcomes/reports of network studies/Consultancy commissions.
- Details and outcomes of current/previous initiatives.
- Contact details for all stakeholders.
- Equipment Lists.
- Load Schedules.
- Departmental organization charts.
- Operating hours.
- Existing aftercare services, 3rd Party Contracts, and Warranties.
- Existing maintenance strategies being deployed.
- Asset register.

In the likely event that specific information is not available; there are measures which should be taken, for example:

- Carry out simple measurements using instrumentation (such as LUX measurement or use of multi-meters).
- Develop a simple Building Energy Model (BEM) – see Section 6.7.2.
- Carry out calculations based on clearly defined assumptions from experience or recognized standards (cost of Energy apportioned to lighting).
- Benchmarking against Facilities of a similar function and size.

During this activity, a historical Energy trend should be established. For example, power and water use over the previous 3 years, and up to the next 3 years, or a future period which aligns with other business targets and review periods/horizons.

2. Understand and categorize Energy use

This activity entails a Table-top Data Review focussing on data collated regarding previous, current, and future Energy use. The result of this activity shall be a list of systems which consume the greatest amount of Energy (Significant Energy Users), for example:

- Chillers – 45%
- HVAC – 20%
- Office equipment and IT Servers – 10%
- Lighting – 9%
- Conveyance Systems – 8%
- Others – 8%

Further detail such as system-wise breakdown against overall consumption can be added to the list if known, as shown above.

Activities 1 and 2 are associated with establishing an Energy Baseline. Further information regarding Energy Baseline is contained within Section 6.4.1.1.

3. Analyze data to understand variables affecting Energy use

This is an activity which requires a combination of Walkthrough Audits and Table-top Data Reviews. Walkthrough Audits are described within Section 6.5. Table-top Data Reviews shall focus on anomalies discovered during the previous activity. Walkthrough Audits and discussions with System Operators can be used as a means by which to investigate and explain anomalies. The result of this activity will be a list of variables which affect Significant Energy Users, for example:

- Site operating hours.
- Operational settings of plant.
- BMS and controls functionality.
- Plant condition.
- Maintenance strategy.
- Capital and operational budget availability.
- Commercial models.
- Contract terms.
- Climatic fluctuations.
- Extreme weather episodes.
- Utility costs.
- Employee.
- Building user behavior.

4. Understand parties having control over variables which will affect Significant Energy Users

Several variables affecting Significant Energy Users are a direct result of human action. The purpose of this activity is to identify the parties which are impacting Energy use and begin engagement with them to establish Workshops, training, and Awareness Sessions tailored to their Operations.

Examples of parties which can influence and directly affect Energy use include:

- Operators
- Maintenance Team
- Contractors
- Building users

Some variables which affect Significant Energy Users, such as weather, cannot be controlled. These variables will be either controlled through engineering, or through Adjustments to the Baseline (See Section 6.7.2).

5. Understand Sources of Energy

For some facilities, it may be important to review Sources of Energy. For example, the Energy Conservation Policy may state that:

"…the Entity shall increase the penetration of Renewable Energy"

The Energy Conservation Strategy may therefore feature a statement such as:

"Diversification of Energy Sources shall be achieved through increasing the penetration of Renewable Energy Resources, reducing the dependence on grid-supplied Power, and whole replacement of diesel with biofuels, or part thereof."

If diversification of Energy Sources is part of the Strategy, then the Entity should understand quantities of existing Sources of Energy, for example:

- Grid-supplied Electricity
- Solar PV
- Solar Heaters
- Natural Gas
- Liquid Propane Gas
- Diesel

As with Energy use data, a historical trend should be established for Energy sources. Understanding the historical and existing Energy mix will enable the Entity to set future targets for Energy sources.

Desktop based activities undertaken during the Energy Review are the same activities which are required as part of Level 0 and Level 1 Energy audits.

6.4.1.1 Establishing an Energy Baseline

An Energy Baseline follows Energy Review. The Energy Baseline is the reference against which all savings shall be measured. It enables fair comparison of Energy performance before and after ESMs are implemented such that the effect can be fairly monitored during subsequent years (i.e. Reporting Period). Establishing an Energy Baseline involves data analysis techniques such as Regression Analysis. This enables examination of relationships between two or more variables (such as how a record-high hot month affects Energy use, and how the effect can be normalized to make for a fair comparison during the Reporting Period). Further information is contained within Section 6.5.

A Baseline Year shall be set by each Entity. The Baseline Year shall typically be set as the latest complete Gregorian Calendar year for which a complete set of data is held. It shall be reviewed annually, or whenever there has been a significant change that may affect the Baseline (whichever comes first). Reviews should take place no more frequently than on an annual basis, and using M&V techniques outlined in Section 6.7.

6.5 Energy Auditing

An Energy Audit is an inspection methodology that involves of surveying whole Facilities, or part thereof, and analyzing Energy flows to determine ESMs which, if feasible, will not negatively impact comfort.

A core component of Energy Auditing, apart from physical condition verification of building assets and equipment, is employing Data Analytics to reveal operational insights regarding the performance of the Facility and how it may be improved.

A list of variables affecting Energy consumption within a Facility is provided in Section 6.4.1. Other primary influencing factors include:

- Local weather conditions
- Building envelope characteristics
- Type of activities being performed within the premises

- Occupancy rate
- Facility equipment specifications
- System conditions and Operating regimes

Below are examples of systems that may be included in an Energy Audit of a Facility:

- Building Envelope (including infiltration, leakage, and stack effect pathways)
- Lighting (Exterior and Interior)
- HVAC (i.e. cooling, heating, air distribution and ventilation, exhaust systems)
- Building Automation Systems
- Hot, chilled, condenser, and domestic water pumping systems
- Steam systems
- Refrigeration (except for food processing refrigeration)
- Onsite power generation systems including renewable Energy systems
- Uninterruptible power supplies, power distribution units, and critical power systems
- Data centers and information technology infrastructure
- Conveyance systems (escalators, elevators, baggage handling, travellators)
- Plug loads (appliances, devices)
- Laundry equipment
- Kitchen equipment
- Pools, saunas, and spas

The type of Energy Audit required to be carried out depends on several factors, including:

- Function, type, size, and configuration of systems
- Level and magnitude of projected Energy savings and cost reduction targets
- Required level of certainty associated with envisaged sav

Energy Auditing is broadly defined by three progressive levels. Each level contains a higher level of detail, and therefore a higher level of certainty that forecasted savings will match actual savings. The activities involved within each Energy Audit are outlined within Table 3 (below):

Process	Level 1	Level 2	Level 3
Conduct Preliminary Energy-use Analysis (review documentation)	•	•	•
Conduct Walkthrough Audit	•	•	•
Identify LC/NC recommendations	•	•	•
Identify capital improvements	•	•	•
Review M&E design, condition, and FM practices		•	•
Measure key parameters		•	•
Analyze capital measurements (savings, costs, and transactions)		•	•
Meet with owner/operators to review recommendations		•	•
Conduct additional testing/monitoring			•
Perform detailed system modelling			•
Provide schematic layouts for recommendations			•

Table 3: Energy Audit Activities

Outputs of Energy Audits are outlined within Table 4 (below):

Outcomes	Level 1	Level 2	Level 3
Estimated Savings from Utility Rate Charge	•	•	•
Summarize Utility Data	•	•	•
Estimate savings if Energy Use Intensity (EUI) met target	•	•	•
Estimate LC/NC savings	•	•	•
Calculate detailed end-use breakdown		•	•
Estimate capital project costs and savings		•	•
Complete building description and equipment inventory		•	•
Document general description of considered measures		•	•
Recommend M&V method		•	•
Perform financial analysis of recommended ESMs		•	•
Write detailed description of recommended measures			•
Compile detailed ESM cost estimates			•

Table 4: Energy Audit Outcomes

6.5.1 Level 0 – Preliminary Activities

A Level 1 Energy Audit can only be successfully undertaken if the Auditor is familiar with the Facility by having carried out preliminary activities. Such activities are known as Virtual Energy Audit, Zero Energy Audit, or Level 0 Energy Audit. This encompasses a thorough historical data gathering exercise, an essential and formative step toward understanding the correlation between Facility operational requirements, building utility consumption, and its seasonal variation throughout the year. Several of these activities are carried out as part of an Energy Review.

6.5.2 Level 1 – Walkthrough Audit

A Level 1 Energy Audit should be the most regularly applied Audit to be undertaken by the Entity. It helps in:

- Defining the type and nature of Systems.
- Preliminarily analyzing the Energy consumption.
- Identifying the simplest and most cost-effective (LC and NC) ESMs.
- Continuous monitoring of Systems by Operational staff.
- Identifying areas of improvement and highlighting best-practice.
- Identifying inefficient equipment.
- Identifying human habits that require attention through Workshops, training, and Awareness Sessions.
- Identify maintenance or operational concerns.
- Identify Health, Safety, Security, and Environmental (HSSE) concerns.

On the basis that Energy costs can be reduced through simple actions that produce quick returns, LC and NC ESMs resulting from a Walkthrough Audit may include:

- Switching off lighting in unoccupied areas.
- Switching off HVAC in areas that are not under the control of the BMS.
- Closing windows.
- Turning off faucets that are not automated.
- Manually reducing the temperature of water heaters.
- Altering the timing of automated HVAC and lighting controlled through the BMS to timings that match occupancy and daylight requirements.

All LC and NC ESMs shall be captured in an ESM Tracker as described in Section 0. These will drive the need for checklists associated with daily Walkthrough Audits. Other regular checks which may feature as part of a daily Walkthrough Audit are as follows:

- **Out-of-hours meter readings** — Meter readings are recorded at the end of each working day, and at the start of the next working day, then at non-working days for a set time period to establish a trend. The difference in values determined through meter readings is the Energy used whilst the Facility is not in use. This difference should be accounted for.

- **Energy Saving Mode** — Some equipment (such as printers, photocopiers, and coffee machines) remains energized throughout the day and is used intermittently. If available, then Energy Saving Mode should be enabled. If Energy Saving Mode is not a function that is available on existing equipment, then a Feasibility Study can be done to determine the cost of replacing or retrofitting all such equipment

- **Workstations Equipment** — Check that workstation equipment (such as Visual Display Units, desktop lamps) is switched off when not in use

- **Temperature Control** — Check thermostat settings are correct and comparable with actual space temperature. Look out for signs of over-cooling through human behaviors (such as people wearing extra clothing to keep warm because the AC is too high during Summer)

As the pattern of Energy use varies throughout the day, it is beneficial to conduct a series of Walkthrough Audits at various times. For example:

- When Cleaning Staff are on duty
- During lunchtimes
- At non-operational times when little or no Energy should be consumed such as evenings and weekends
- At peak times, when it is considered that the Facility is envisaged to be consuming its highest quantum of Energy

Frequency of Walkthrough Audits should be planned as part of Standard Operating Procedures. Some checks shall be carried out daily, while others can be planned on a Weekly, Monthly, Quarterly, Bi-Annual, and Annual basis. Responsibility for executing Walkthrough Audits can be delegated to members of the FM Team, who are already carrying out checks throughout the Facility on a regular basis which coincides with the requirements of the Energy Management Team. However, Walkthrough Audits for a specific purpose (such as a pilot scheme or Business Case) shall not fall under the responsibility of Operations or Maintenance staff since such Audits are used to update the ESM Tracker.

A **Level 1 Energy Audit (Walkthrough Audit) Plan Template** is contained within Attachment 5.

6.5.3 Level 2 – Operational Data Analytics

A Level 2 Energy Audit builds upon findings of the Level 1 Energy Audit and evaluates Systems in more detail to propose a wide range of ESMs above and beyond LC and NC ESMs.

The approach to a Level 2 Audit differs depending on the Sector in which the Facility operates (i.e. Healthcare, Parks & Recreation, Schools & Universities, Roadways, Housing, Municipalities, and Offices). However, in all cases, more detailed data is required than what was required for successful completion of a Level 1 Audit. A Level 2 Audit requires detailed measurements, examination of Systems, and data analysis to be carried out by Energy Auditors.

Discovery of FM enhancing measures is a positive secondary benefit of a Level 2 Audit.

6.5.4 Level 3 – Investment Grade Audit

A Level 3 Audit is also known as an Investment Grade Audit (IGA). It is aimed at incorporating Capital intensive ESMs. A Level 3 Audit extensively builds upon results and findings from Operational Data Analysis carried out during a Level 2 Audit to determine with a high level of certainty, the savings which shall be realized by implementing proposed ESMs.

A Level 3 Audit involves extensive data collection through measurements carried out over longer time periods than that in a Level 2 Audit in order to:

- Accurately model ESMs.
- Determine how interactions between different Systems will affect forecasted savings.
- Increase the accuracy of forecasted savings.
- Determine the appropriate approach to M&V.
- Influence engineering activities, such as detailed design, specifications, and procurement of equipment.
- Determine accurate financial data through Life-Cycle Cost Analysis (LCCA) such as Capital cost, Return on Investment (ROI), Simple Payback Period (Simple PBP), Internal Rate of Return (IRR).
- Create a Project Risk Register by developing it throughout the project completion and into Warranty and Reporting Periods.

6.5.5 Qualifications and Prerequisites for Energy Auditors in KSA

There are two main authorities that have set out their requirements for Energy Auditors working in KSA. Requirements are described herein.

6.5.5.1 Saudi Energy Efficiency Center Requirements

According to the Energy Services Company Licensing Committee of Saudi Energy Efficiency Center (SEEC), KSA, ESCO licenses are classified as follows:

- Full License (minimum 1-year operating experience and evidence of Multi-project experience)
- Provisional License (with no documented Project experience)

ESCO Licenses are further categorized depending the type of work and the Sector in which Companies are engaged:

- **Audit Companies:** This license allows the firm to engage in Energy Auditing. In addition, companies with an Audit License can serve as an Independent Third-Party M&V Agent for Energy Savings Performance Contracts (ESPC) based upon SEEC's Energy Savings M&V User Guide for the KSA, Version #1, February 2017 (which uses the International Performance, Measurement, and Verification Protocol [IPMVP] as its foundation)

- **ESCO Companies:** This license permits the ESCO Licensee to perform either: Design and Engineering of ESMs, or Energy Efficiency Project Management. This license also encompasses the Audit License.

- **Industrial Energy Audit Companies:** These licensees cater to the Industrial clients and provide services that include either: Energy Data Review and Audits (Energy Audit for Industrial Plants) or Energy Design Review (Energy Efficiency Design Review for Industrial Plants)

Firms applying for a KSA ESCO License must have employees who are professionals with the following certifications:

- Certified Energy Manager (CEM) or Certified Energy Auditor (CEA) from the Association of Energy Engineers (AEE).
- Certified M&V Professional (CMVP) from Efficiency Valuation Organization (EVO) and AEE.

6.5.5.2 Mostadam

To qualify for KSA's Sustainability Rating Scheme – Mostadam, the company must employ competent professionals with at least two years of experience in undertaking Energy Audits and with at least one of the following credentials:

- An Associate Engineer registered under the Saudi Council of Engineers.

- A Professional Engineer member of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) or equivalent such as a Charted Engineer (CEng) Member of a relevant professional institute such as the Chartered Institution of Building Services Engineers (CIBSE), or the Institute of Engineering and Technology (IET)
- A CEA of the AEE; or
- A professional certified under another scheme that has received an approval by Sustainable Building Authorities in KSA.

Further information regarding SEEC and Mostadam is contained within Section 6.12, KSA Service Providers.

6.5.6 Procedure

As mentioned above, the depth of data collection and analysis may differ dependent on various factors such as function, type, size, and configuration of Systems; level and magnitude of projected Energy savings and cost reduction targets; and required level of certainty associated with envisaged savings. However, a common and systematic approach for executing Energy Audits shall be applied as illustrated in Figure **Error! Reference source not found.** (below):

Figure 7: Energy Auditing Procedure

6.5.6.1 Preparation

The data gathering exercise shall be undertaken by the FM staff responsible for supporting the Auditor in collecting Facility documentation and information for analysis. Reviewing FM records in conjunction with historical utility data will provide the Auditor with insight into potential operational bottlenecks plaguing the Facility as well as uncover NC or LC ESMs.

6.5.6.2 Execution

The audit process begins by analyzing the Energy flows within the building structure and its correlation with operational requirements with the Facility equipment. Data analysis is employed to ascertain and characterize the use and occupancy of the Facility, and to reveal operational anomalies and opportunities for ESM implementation.

6.5.6.3 Reporting

This phase focusses on documenting the Energy audit, highlighting the potential savings that may be realized following the implementation of identified ESMs, and the M&V methodology to be followed for savings verification post-implementation of ESMs. Guidance regarding contents of Energy Audit Reports for Levels 1 – 3 is contained within Section 6.10.2.

6.5.6.4 Post-audit Activities

Post-audit, Energy efficiency project management activities such as prioritizing, scheduling and planning the implementation of identified ESMs are undertaken. A Project Management documentation is developed and implemented at this stage. This can include Project Schedule, Risk Register, and Project Quality Plan. Energy Data Analytics is employed to continually monitor and assess the operational conditions to ascertain whether or not savings are being continuously achieved.

6.5.7 Instrumentation

Specific instrumentation is required in order to execute Energy Audits, specifically for Energy Audit Levels 2 and 3.

Instrument	Pictures
Power Analysis – To measure (logging) • Voltage • Current • Power • Power Factor	
Ultrasonic Btu meter – To measure • Chilled Water Flow • Chilled water temperature • Cooling load of chiller	
Air Quality logger – To measure • Space temperature • Humidity • CO2 ppm	
Air Conditioner Logger – To measure • Space temperature • Humidity	
Lux meter – To measure • Light Intensity	
Light/Occupancy Sensor – To measure • Light On/Off • Occupancy	
Thermal Imager – To Assess • Building envelope inspection • Energy losses in buildings • Hot spots in Electrical cabbies	
Vane Type Anemometer – To measure • Air Velocity	
Clamp meter – To measure (Instantaneous) • Voltage • Current • Power	
IR Thermometer – To measure (Instantaneous) • Surface Temperature	

Table 5: Instrumentation for Energy Audits

features a list of suggested instrumentation that is required for the execution of Energy Audits:

Instrument	Pictures
Power Analysis – To measure (logging) • Voltage • Current • Power • Power Factor	
Ultrasonic Btu meter – To measure • Chilled Water Flow • Chilled water temperature • Cooling load of chiller	
Air Quality logger – To measure • Space temperature • Humidity • CO2 ppm	
Air Conditioner Logger – To measure • Space temperature • Humidity	
Lux meter – To measure • Light Intensity	
Light/Occupancy Sensor – To measure • Light On/Off • Occupancy	
Thermal Imager – To Assess • Building envelope inspection • Energy losses in buildings • Hot spots in Electrical cabbies	
Vane Type Anemometer – To measure • Air Velocity	
Clamp meter – To measure (Instantaneous) • Voltage • Current • Power	
IR Thermometer – To measure (Instantaneous) • Surface Temperature	

Table 5: Instrumentation for Energy Audits

6.5.8 Establishing a Business Case

For each ESP, the Entity's EMT should produce a Business Case. This will help to justify investment in one ESP over another. The Business Case can conform to the **Energy Saving Project Business Case Template** provided within Attachment 6, or the Entity's own Business Case Template.

The Business Case shall consider the lifecycle FM costs of existing equipment, weighing it against operational benefits and savings accrued by implementing retrofit measures. As a minimum, the Business Case shall be derived from a Level 2 Energy Audit Report, but a Level 3 Energy Audit shall be required before an ESPC is in place. To write a successful Business Case, a basic level of Financial Modelling capability is required.

6.5.8.1 Financial Modelling

The IRR is a metric calculated through the use of iteration, and is used to estimate profitability of an investment (i.e. the “growth” a project is expected to generate). IRR does not consider aforementioned external factors; hence the calculation considers only "internal" factors. A higher forecasted IRR offers an attractive investment opportunity compared with ESPs with a low IRR.

To properly assess and compare multiple IRRs associated with several ESPs, other factors should be considered such as:

- Capex (labor, materials, and project management costs).
- Other Upfront Costs (fees for a Level 3 Energy Audit).
- Replacement Costs (costs of equipment required to maintain performance guarantees, if any).
- FM Costs (i.e. to maintain guaranteed performance).
- M&V Costs (i.e. equipment calibration certification, monitoring systems).
- Energy Cost Savings (SAR).

The best way to carry out the IRR assessment to support a Business Case is to create a Financial Model using Microsoft Excel as shown in the below example:

Items/Year	0	1	2	3	4	5	6	7	8	9	10
Capex	2,759,767										
Other Costs (DFS Fee)	224,550										
Replacement Costs	-	-	-	-	-	-	-	-	-	-	-
O&M Costs		68,994	72,335	75,837	79,510	83,359	87,395	91,627	96,063	100,714	105,590
M&V Costs		92,000	96,454	101,1124	106,022	111,155	116,537	122,179	128,094	134,296	140,799
Energy Cost Savings		925,882	925,882	925,882	925,882	925,882	925,882	925,882	925,882	925,882	925,882
Cashflows	-2,984,317	764,888	757,093	748,921	740,350	731,368	721,076	712,076	701,725	690,872	679,493
IRR	21.11%										
Simple Payback	3.97										

Table 6: IRR Calculation Example

Cashflows for each year are determined as follows:

$$Cashflow = (\text{Capex} + \text{Other Costs} + \text{Replacement Costs} + \text{O\&M Costs} + \text{M\&V Costs}) * -1 + \text{Energy cost savings (SAR)}$$

Equation 1: Cashflow Formula

In the model described in Table 6, the IRR for the lifecycle of the ESP (10 years) is determined through applying the MS Excel IRR formula as follows:

$$IRR\ (\%) = \text{IRR(Cashflow Column 1: Cashflow Column 10)} = 21.11\%$$

Equation 2: IRR Formula

Further information regarding IRR in Energy Data Analytics is provided within Section 0.

Another key component of the Business Case is the Simple PBP. It is the length of time required to recover the cost of an investment and is calculated as follows:

$$\text{Simple Payback Period (years)} = \frac{\text{Cost of initial investment (SAR)} + (\text{O\&M Costs} + \text{M\&V Costs to acheive Energy saving each year for desired PBP})(\text{SAR})}{\text{Energy cost savings per year (SAR)}} = 3.97$$

Equation 3: Simple Payback

The Entity shall set its own threshold for an acceptable Simple PBP; however, suggested acceptable Simple PBP for an ESP is between 3 and 5 years. The Simple PBP is calculated on the basis that tariffs and costs shall remain the same within the PBP. Should the Entity consider the impact of tariff, or cost changes, or indeed the impact of external factors such as currency exchange rate, interest rates (or Islamic Finance equivalent), or inflation, the Entity shall undertake a more detailed Financial Modelling executed by qualified and competent personnel.

For short PBPs, it may be also useful for the Entity to review the ROI. ROI is the measure of forecasted savings relative to the investment cost (Capex).

$$ROI\ (\%) = \frac{\text{SUM(total Energy cost savings per year (SAR)throughout project lifecycle)} - \text{SUM(O\&M Costs + M\&V Costs to acheive Energy saving each year)(SAR)}}{\text{Cost of initial investment (SAR)}} X\ 100$$

Equation 4: Return on Investment

A high ROI is a good indicator that the ESP is worth investing, whilst a negative ROI indicates a net loss. ROI for several ESPs can be compared to help determine which ESP is the most profitable.

The latest derivative of ROI developed by Economists is SROI (Social Return on Investment) which considers broader Environmental, Social, and Governance impacts of ESPs such as:

- Improvements in Air Quality.
- Positive impact on human behavior and well-being.
- Lower Carbon Footprint.
- Improved Entity profile.
- Improved education and skills.
- Higher share price.

Whilst ROI determines the total growth of the investment throughout the project lifecycle, IRR indicates the annual growth rate. For this reason, both ROI and IRR are worth reviewing dependent on the extent to which the Entity prioritizes cashflow.

The project lifecycle featured within the example shown in Table 6 is 10 years. As the project lifecycle increases, the accuracy of ROI decreases due to aforementioned external factors whose uncertainty increases over time. For this reason, ROI is suitable for short-term ESPs and IRR is more suited to long term ESPs.

Writing a Business Case and carrying out Financial Modelling will likely be outsourced by the Entity to potential ESCOs under the ESCO Model. Further information regarding the ESCO Model is contained within Section 6.11.

6.6 Energy Data Analytics

Advancement in Information and Communication Technologies (ICT) has driven Facilities Management (FM) monitoring and control beyond traditional BMS (which typically covered only HVAC and Lighting monitoring and control) into Integrated Building Management Systems (IBMS). An IBMS monitors and controls a network encapsulating all Systems (i.e. mechanical, electrical, IT, and security Systems) of a Facility, unifying them to share information and automatically react dependent on the behavior of neighboring Systems. Furthermore, the increased availability of appliances and equipment that can be wirelessly controlled through the Wi-Fi network has resulted in Facilities that can claim to operate an IoT-enabled BMS. The increased level of monitoring and control seen through new and integrated technologies has given rise to increased availability of data that can be subject to analytical tools and techniques (i.e. Energy Data Analytics). Increased knowledge of System behavior and the impact of human behavior on the Facility have uncovered substantial Energy efficiency opportunities.

6.6.1 Simple Reporting and Tracking Methods

Reporting and Tracking methods include approaches used to gauge financial, Energy, and carbon performance. They can be applied to specific building Systems; however, they are most commonly used at the site or portfolio level, except for IRR, which is often applied to specific ESMs. These methods can use utility billing information and may not require interval-meter data or sensor time series data. Reporting and Tracking methods are outlined as follows:

1. Simple Tracking
2. Utility Cost Accounting
3. Internal Rate of Return
4. Carbon Accounting
5. Longitudinal Benchmarking
6. Cross-Sectional Benchmarking

6.6.1.1 Simple Tracking

Simple Tracking is the most basic form of Energy Accounting. It is often the starting point for the other Tracking Methods and is the first step in measurement-based approaches to Energy Management. By tracking monthly or annual Energy use, changes in Energy use over time can be quantified leading to identification of increases and decreases in consumption and/or expenditures. Simple Tracking relies on Energy use totals and does not include normalization. Monthly or annual Energy use totals are recorded either at the Whole-building, System, or End-use level. Either utility billing data or interval meter data are employed to quantify Energy use totals. Examining them over time reveals irregularities or large increases or decreases in use that might indicate operational or efficiency problems. Figure **Error! Reference source not found.** provides an example of a typical graphical analysis which can be derived using the Simple Tracking Method.

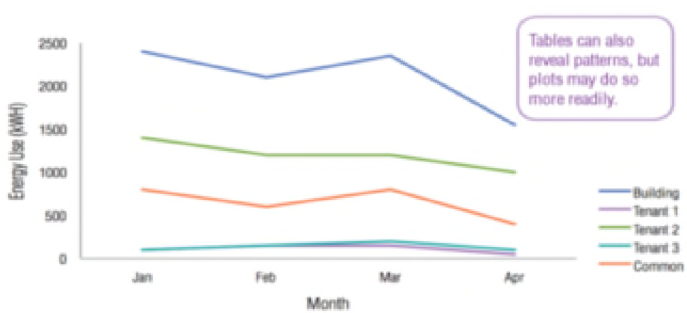

Figure 8: Simple Tracking of Energy Usage

6.6.1.2 Utility Cost Accounting

This method converts Energy consumption into billed costs, so information in budgets and financial projections can be utilized. Accounting may include demand charges and tariff specifics such as time-of-use rates. Utility Cost Accounting, used in addition to Simple Tracking offers a suitable overview of Energy-use. Utility Cost Accounting based on utility bills attributes Energy costs to the account holder; whereas, Utility Cost Accounting based on Sub-meters downstream of the Utility Meter can be used to pass Utility charges on to Tenants. Likewise, Sub-meter Cost Accounting provides a means of valuing operational and efficiency changes at System or equipment level.

Utility billing data for power, water, natural gas, and other 'fuels' are collated, and the Tariff Structure is identified (as shown in Figure **Error! Reference source not found.** – below). Power usage is frequently divided into component parts such as: Energy charge; Peak Demand charge; and supplemental charges which vary in complexity dependent on the Tariff Structure. Natural gas, other hydrocarbon fuels, chilled water, hot water, and steam carry Energy and Service Charges, and may be delivered and billed by either a Utility or a Private Distribution Company.

Energy costs attributable to Systems and equipment can be determined by multiplying Sub-metered Energy use by the Energy charges reflected on the bill for the upstream Utility Meter.

Utility Costs are allocated to sub metered loads using the "Charge Per Unit"

Energy			**Utility Costs**				
Utility Charges	Usage	Demand	Demand	Energy	Service	Total	**Charge per Unit**
Electric	23000	200	SAR5,000.00	SAR2,760.00	SAR20.00	SAR7,780.00	SAR0.34
Gas	1200	-		SAR2,880.00	SAR24.00	SAR2,904.00	SAR2.42

		Utility Costs			**Energy**	**Utility Costs**	
Electric Sub-Meter	Usage	Charge per unit	Total	**Gas Sub-meter**	Usage	Charge per unit	Total
Tenant 1	3670	SAR0.34	SAR1,241.42	Café	210	SAR2.42	SAR508.20
Data Center	1200	SAR0.34	SAR405.91				

Figure 9: Utility Cost Accounting

6.6.1.3 Internal Rate of Return (IRR)

IRR, as described in Section 6.4, is an investment decision-making method based on cashflow, which quantifies the financial benefit of ESMs. Utility Cost Accounting (as described above) provides fundamental input data used for IRR analysis. By applying a capital budgeting metric that accounts for the time value of money, IRR can be used in combination with Energy cost savings (SAR), to determine the economic benefit of ESMs.

IRR can be used to evaluate potential ESMs or confirm that savings forecasts have been achieved. It can be applied to the Energy cost savings associated with any ESP. In contrast to Simple PBP and ROI, IRR accounts for the time value of money, and for savings that accrue beyond the PBP as shown in Figure **Error! Reference source not found.** (below).

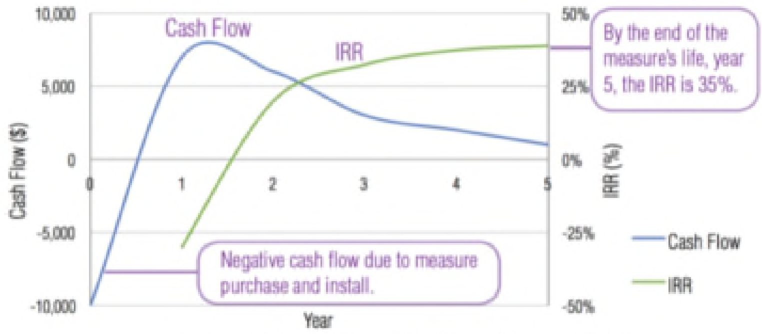

Figure 10: Internal Rate of Return (IRR)

6.6.1.4 Carbon Accounting

Carbon Accounting is used to quantify the greenhouse gas (GHG) emissions associated with a Facility's Energy consumption. GHGs associated with Facility Energy use include direct emissions from the fuel used to operate the Facility and indirect emissions used to generate purchased utilities, products, or services. Energy consumption can be converted into carbon emissions for Sustainability Reporting. Carbon is typically reported at the Facility level but may also be tracked at the System or equipment level.

For indirect emissions associated with generation, total metered Energy consumption associated with each fuel type (usually over an annual period) is collected. Purchased power, heat, steam, or other fuel is converted to GHG emissions by applying a conversion factor.

For direct emissions from on-site combustion, conversion factors depend on the fuel's: heating value; carbon content; carbon oxidation factor; carbon to CO_2 Ratio; and Global Warming Potential (GWP) to result in a graphical representation as shown in Figure 11 (below).

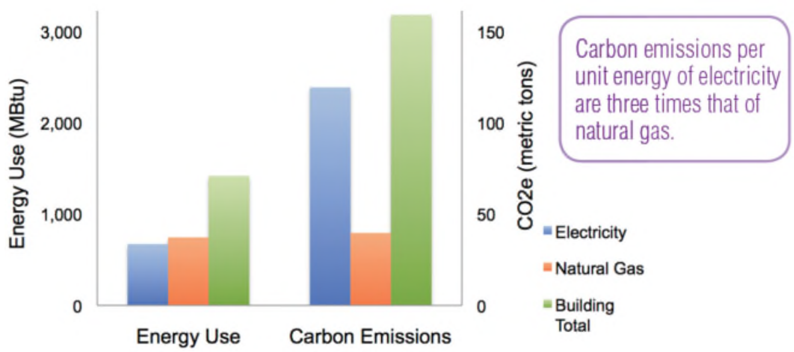

Figure 11: Carbon Accounting

6.6.1.5 Longitudinal Benchmarking

By comparing current Energy performance to past performance, Energy trends and opportunities for improvement can be identified. Longitudinal Benchmarking compares Energy usage in a fixed period for a building, System, or equipment to a Baseline period of the same length. It is used to:

- Determine if performance has deteriorated or improved
- Set goals for a building or System
- Monitor for unexpectedly high usage

Energy use in the Baseline period is characterized and expressed according a defined metric of choice, forming a benchmark. Then Energy performance relative to the Baseline period benchmark is tracked as shown in Figure 12 (below).

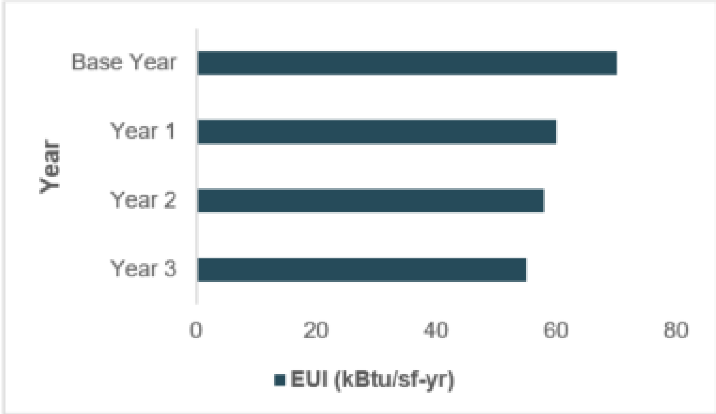

Figure 12: Longitudinal Benchmarking

Annual Whole-building benchmarking is most common with an EUI metric such as kilowatt-hours per square meter (kWh/m^2) being the standard metric. However, Longitudinal Benchmarking may also be conducted seasonally, for Systems and equipment.

6.6.1.6 Cross-sectional Benchmarking

While Longitudinal Benchmarking compares a Facility, System, or equipment Energy performance with itself over time, Cross-sectional Benchmarking compares a Facility's Energy performance to that of a comparable Facility or group of Facilities to determine whether the focus Facility is either: ahead of the pack; in the middle; or running behind its peers.

Cross-sectional Benchmarking is usually done at the Whole-building level, to assess a building's overall Energy performance, using an EUI metric such as kWh/m^2, or kWh/person.

Factors affecting Energy use such as: weather; operation hours; and other factors, are normalized for the purpose of comparison. One such normalization approach is to directly filter the peer group for Facilities with similar characteristics to the Facility being benchmarked. A more rigorous approach is to conduct Regression Analysis on the peer data set (as shown in Figure **Error! Reference source not found.** – below), which yields an equation that relates the performance metric to normalizing parameters.

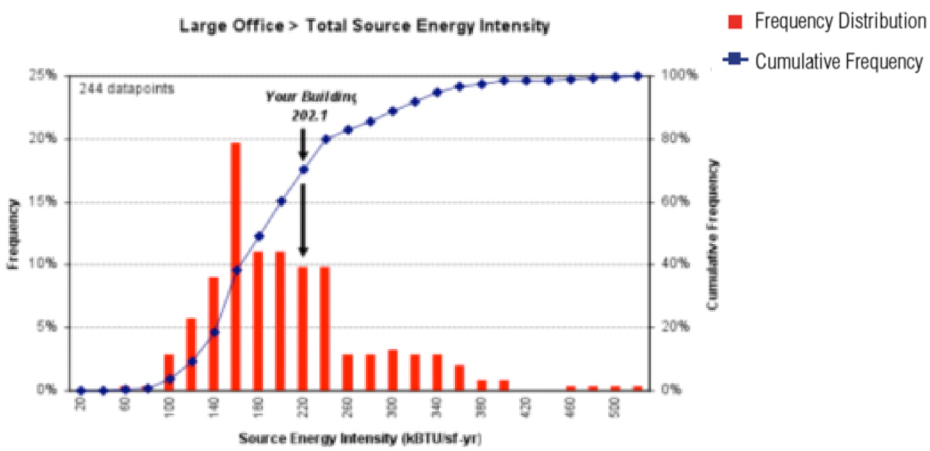

Figure 13: Cross-sectional Benchmarking

6.6.2 Fundamental and Advanced Methods of Data Analytics

Establishing a Data Analytics Framework represents the best approach to analyzing Facility Energy use data. The Framework offers flexibility such that Methods of Data Analytics used to fully understand Energy use, and make informed decisions based on the analysis, are applicable regardless of the size of the Facility or the Sector in which it operates. Fundamental Methods of Data Analytics described herein lay the foundation of Advanced Methods covered in the next Section.

The Data Analytics Framework shown in Figure **Error! Reference source not found.** (below) describes how collation and review of Energy use data (top of figure) through Monitoring and Tracking Methods mentioned in the previous Section lead to refinement of data through Fundamental Methods of Data Analytics.

Of the Fundamental Methods, Load Profiling and Peak Analysis are those which largely rely on inspection of time series data. Simple Baselines are then introduced to help characterize Energy performance, building upon the Simple Tracking approach that was presented in Reporting and Tracking Section (above). Energy Signatures and Model-based Baselines are then introduced, presenting the complexities of the real-time Energy monitoring and data interpretation.

Advanced Methods of Data Analytics include: Energy Savings Methods; Cumulative Sum Method; and Energy Anomaly Detection. These Advanced Methods help the Entity to understand, with a high level of certainty, key information, such as: contribution of Energy sources to overall Energy use; variables that affect Energy performance and the extent to which they impact Energy use; locations of Energy drains; and assets in which investment is required. Application of Advanced Methods of Data Analytics will ultimately lead to informed decision-making, better long-term financial performance, and more efficient operations.

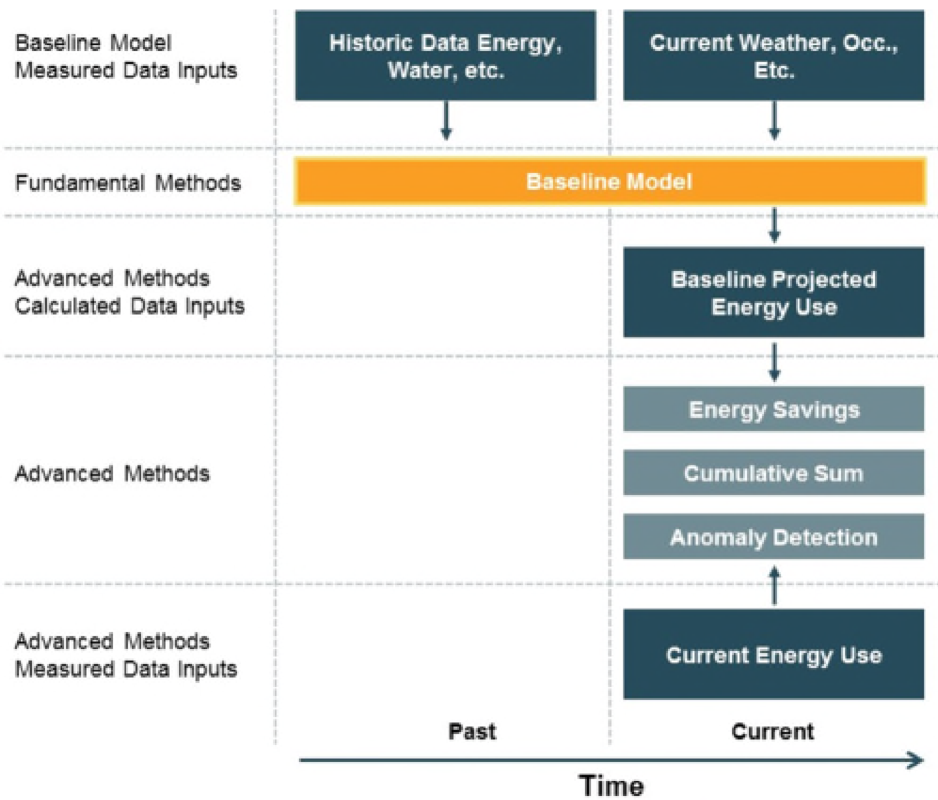

Figure 14: Energy Data Analytics Framework

6.6.2.1 Fundamental Methods of Data Analytics

Load Profiling

Load Profiling is used on a daily or weekly basis to understand the relationship between Energy Use (MW) and Time of Day (Hr). Abnormalities or changes in load profiles can indicate inefficiencies due to scheduling errors, unexpected or irregular equipment operation, high use during unoccupied hours, or untimely peaks. Figure **Error! Reference source not found.** below shows an example of the output realized through Load Profiling.

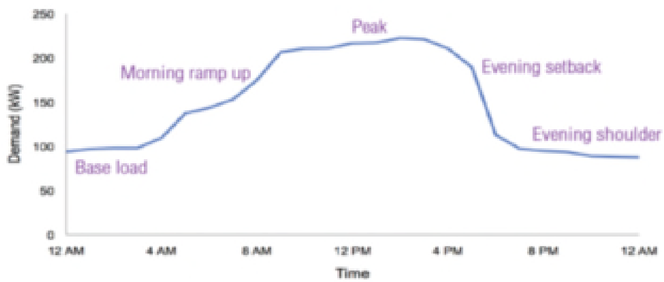

Figure 15: Load Profiling

Peak Load Analysis

Peak Load Analysis (as shown in Figure **Error! Reference source not found.** below) is similar to Load Profiling; however, it focuses on maximum demand rather than the entire range of measured loads. Peak Load Analysis is used for:

- Identifying potential reductions in utility demand charges
- Identifying potential improvements that are revealed in the relationship between minimum and maximum loads
- Assessing the sufficiency of system sizes during extreme weather

For the majority of applications, time series of Whole-building interval data with demand on the y-axis and time on the x-axis is plotted. The Peak Load either according to explicit utility definitions or simply as the maximum observed load is identified. Since peak load is strongly dependent on building size, the data can be normalized using EUI metrics (i.e. kWh/sf or kWh/m^2).

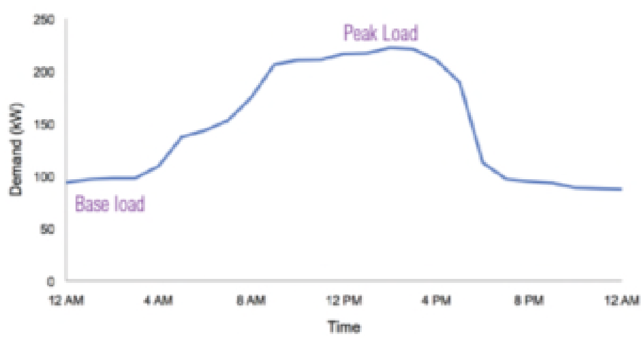

Figure 16: Peak Load Analysis

Simple Baselines

Simple Baselines are used to generate performance metrics for benchmarking and Energy savings estimates. They are used to characterize Energy performance according to key variables, thereby providing a marker from which better or worse performance can be assessed.

Energy use for a base period (often a year) is totaled, and the data is normalized according to factors that are known to affect Energy consumption. Floor area is frequently used in simple models of Whole-building Energy, plug loads, and lighting systems; whereas, heating degree days are commonly used for heating systems. Further examples are provided in

Energy Lead	Common Normalization Factors	Resulting Baseline
Whole-building electrical Energy	Floor area served	kWh/yr
Whole-building cooling system Energy	Cooling degree days	kBtu/CDD/yr
Plug load electric use	Number of occupants	kWh/occ./yr
Lightning electric use	Floor area served, operating hours, number of occupants	kWh/yr

Common formulations and metrics for simple baselines-the most appropriate model depends on the particular investigation and data availability.

Table 7: Normalization Factors for Simple Baselines

(below).

Degree-days fall under 3 categories: Heating Degree Days (HDD); Cooling Degree Days (CDD); and Growing Degree Days (GDD). The majority of Facilities within KSA are concerned with CDD. CDD are those days in which the outside air temperature was so hot that it meant that the HVAC System required operation to cool the Facility. CDD are dependent on the Building Base Temperature (BBT). BBT is the outside air temperature above which the Facility requires cooling.

This definition of CDD (determined by BBT) indicates the importance of well-insulated building fabric. If a building is well insulated, then the outside air temperature may be, for example, 30ºC while indoor temperature may be 24ºC. In this instance, the BBT would be set higher than if the building employed poor quality insulation. In summary:

- Building insulation is high performance, BBT is higher, HVAC operates less often, CDD value is lower, and Energy consumption is less, whilst conversely
- Building insulation is low performance, BBT is lower, HVAC operates more often, CDD value is higher, and Energy consumption is higher

Simple Baselines are much less robust than Model-based Baselines.

Energy Lead	Common Normalization Factors	Resulting Baseline
Whole-building electrical Energy	Floor area served	kWh/yr
Whole-building cooling system Energy	Cooling degree days	kBtu/CDD/yr
Plug load electric use	Number of occupants	kWh/occ./yr
Lightning electric use	Floor area served, operating hours, number of occupants	kWh/yr

Common formulations and metrics for simple baselines-the most appropriate model depends on the particular investigation and data availability.

Table 7: Normalization Factors for Simple Baselines

Model-based Baselines

Model-based baselines provide a mathematical characterization of Energy use based on measured historic data, such as weather conditions and metered Energy use. Model-based baselines are not used independently, but as the fundamental underlying component of advanced analyses such as Anomaly Detection, Cumulative Sums, and quantification of Energy savings.

Most commonly, model-based baselines use Linear Regression resulting in an equation to define a Dependent Variable (such as a load at a given time) based on the value of Independent Variables. Independent Variables are those that drive Energy use, for example: day of week, time of day, outside air temperature, relative humidity, or solar irradiance. The number and type of Independent Variables that are required to accurately represent the load depends on the particular system and load being modeled and the Baseline time interval (daily, hourly, and half-hourly). Examples of common Independent Variables are provided in Table 8 (below).

Load	Common Independent Variables
Whole-building electric	Outside air temperature, time of week, operating hours, principle building activity.
Whole-building gas/heating system	Outside air temperature, time of week, operating hours, principle building activity.
Heating/Cooling system	Outside air temperature, time of week, operating hours, principle building activity, relative humidity, wet bulb.
Plug loads	Time of week, number of occupants, area served, equipment type.
Lightning system	Time of week, building schedule, area served, operating hours, solar availability.
PV system	Time of day, Outside air temperature, wind speed, solar availability, relative humidity.

Table 8: Independent Variables for Model-based Baselines

Energy Signature

An Energy Signature plots Energy against outdoor air temperature for a certain period of time. It is used to monitor and maintain the performance of temperature-dependent loads such as whole-building gas and power use, or heating and cooling Systems.

Energy data is normalized against time or building floor area, while temperature metrics such as degree-days (as described above) are used instead of outside air temperature.

When applied at the heating/cooling system level, Energy Signatures allow simplified investigations of HVAC performance, and are therefore related to Heating and Cooling Efficiency.

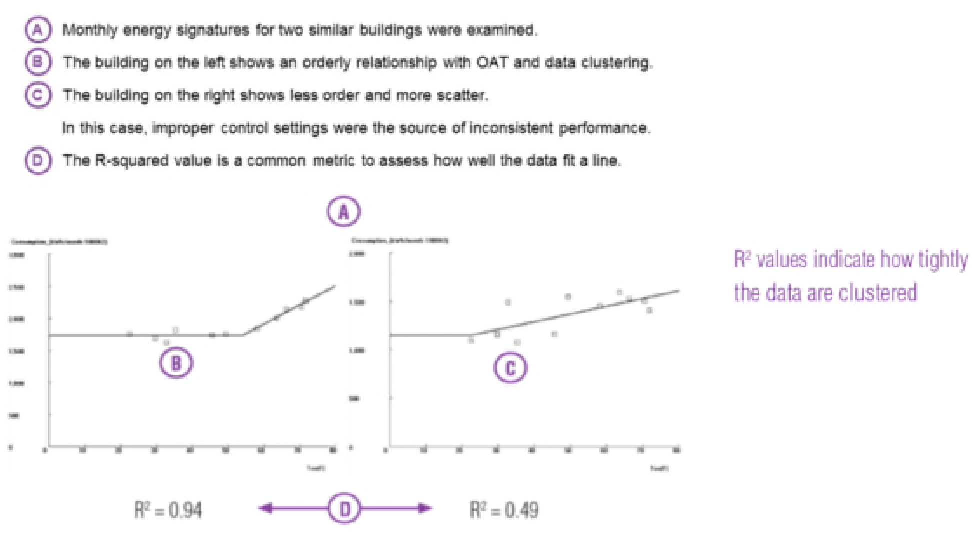

Figure 17: Energy Signatures

6.6.2.2 Advanced Methods

Energy Savings Method

The Energy Savings Method allows Entities to quantify and verify Energy-savings performance of ESMs. Energy Savings are the difference between the projected and metered load, after ESMs have been implemented.

In contrast to previously presented Methods of Data Analytics that can be used to estimate Energy savings, this approach makes use of Baseline Models. The Energy Savings Method is commensurate with IPMVP (as discussed in Section 6.7) in that metered Energy use is collected before and after (known as the Reporting Period) ESMs have been implemented.

The Baseline Model established before ESMs have been implemented is established with Independent Variables in mind. It is then projected into the Reporting Period, to quantify the Energy use that would have resulted had no ESMs been implemented. Finally, actual metered Energy use is subtracted from Baseline projected Energy use to quantify Energy savings, as shown in Figure **Error! Reference source not found.** (below).

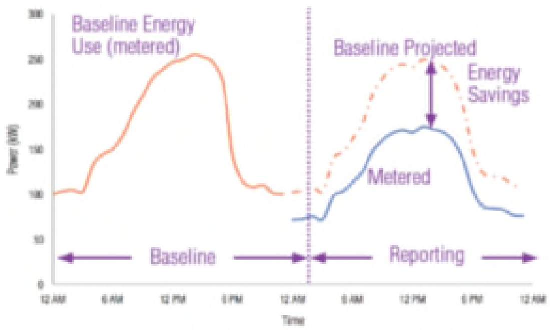

Figure 18: Energy Savings Method

Cumulative Sum Method

The Cumulative Sum (CUSUM) Method is used to quantify total accrued Energy savings over time and to detect Energy performance relative to changes in Facility operations (i.e. different processes undertaken within Entity buildings, more employees, higher loads, building extensions) CUSUM requires a Baseline Model, and is applicable to all Facility types and all building Systems.

Actual metered Energy use is subtracted from Baseline projected Energy use to quantify Energy savings. In this Method, those differences are aggregated over time to determine the cumulative sum of difference relative to the Baseline. Figure **Error! Reference source not found.** (below) shows the CUMSUM Method in action.

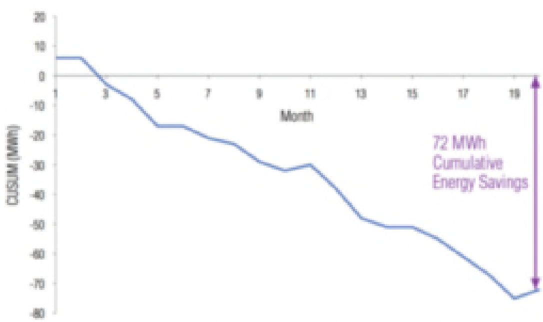

Figure 19: CUSUM (Cumulative Sum)

Energy Anomaly Detection

Energy Anomaly Detection is used to automatically identify abnormal Energy consumption; it may be paired with alarms that are set to activate if thresholds are breached. It can be used as part of Monitoring-Based Commissioning routines and is applicable to all Facility types and all building Systems. Abnormal Energy use can be isolated to a specific system or zone based on a combination of FM staff knowledge of the Facility and supplementary data such: as sub metered loads; equipment schedules and set points; and outside air temperature. Metered Energy use is compared with Energy use predicted by the Baseline Model. If metered use surpasses the forecast of the Baseline Model by a certain threshold value, this constitutes an Energy Anomaly as shown in Figure **Error! Reference source not found.** (below).

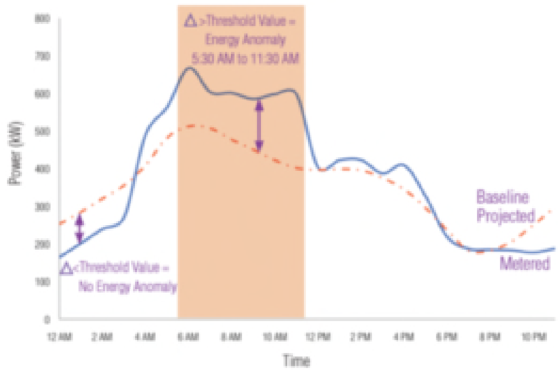

Figure 20: Energy Anomaly Detection

6.7 Measurement and Verification

Measurement and Verification is used to measure and verify, in a defined, disciplined, rigorous, and transparent way, Energy savings resulting from implementation of the ESMs that have been planned and designed to improve Energy performance of a specific Facility or group of Facilities. M&V is critical to a successful ESP since it offers assurance to a high level of accuracy to project owners that the ESP is achieving Energy and cost savings. The IPMVP formulated by Efficiency Valuation Organization (EVO) is at the forefront of M&V implementation in ESPs.

6.7.1 Core Principles

IPMVP Core Principles as extracted from SEEC's Energy Savings Measurement & Verification (M&V) User Guide for the Kingdom of Saudi Arabia, Version #1, February 2017 (Figure **Error! Reference source not found.** – below) provide the basis for assessing adherence to the M&V Process:

Accurate *M&V* reports should be as accurate as the *M&V* budget will allow. *M&V* costs should normally be small relative to the monetary value of the *savings* being evaluated. *M&V* expenditures should also be consistent with the financial implications of over-or under-reporting of a project's performance. Accuracy tradeoffs should be accompanied by increases conservativeness in any estimates and judgements.

Complete The reporting of *energy savings* should considered all effects of a project. *M&V* activities should use measurements to quantify the significant effects, while estimating all others.

Conservative Where judgements are made about uncertain quantities, *M&V* procedures should be designed to under-estimate *savings*.

Consistent The reporting of a project's *energy* effectiveness should be consistent between:

- different types of *energy* efficiency projects;
- different *energy* management professionals for any one project;
- different periods of time for the same project; and
- *energy* efficiency projects and new *energy* supply projects.

'Consistent' does not mean 'identical', since it is recognized that any empirically derived report involves judgements which may not be made identically by all reporters. By identifying key areas of judgement, IPMVP helps to avoid inconsistencies arising from lack of consideration of important dimensions.

Relevant The determination of *savings* should measure the performance parameters of concern, or least well known, while other less critical or predictable parameters may be estimated.

Transparent All *M&V* activities should be clearly and fully disclosed. Full disclosure should include presentation of all of the elements defined in Chapters 5 and 6 for the contents of an *M&V Plan* and a *savings* report, respectively.

Figure 21: IPMVP Core Principles

6.7.2 IPMVP Protocol Framework and M&V Options

The philosophy adopted by IPMVP is that Energy savings cannot be directly measured since savings represent the absence of Energy use. Therefore, savings are determined by comparing Energy use before and after implementation of an ESM, making suitable adjustments for changes in conditions.

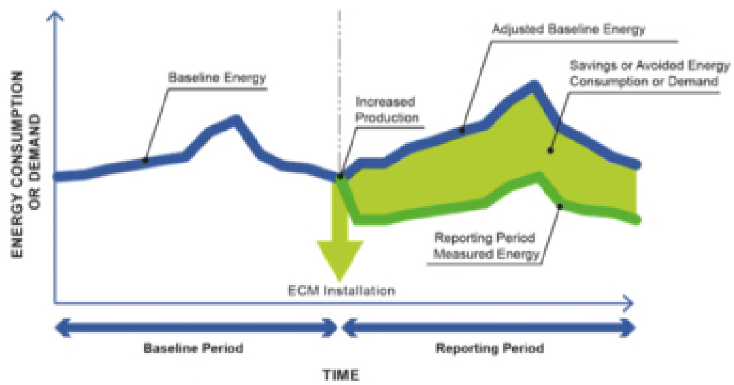

Figure 22: IPMVP Framework

The comparison of before and after Energy consumption or demand should be made on a consistent basis, using the following general M&V equation:

Savings = (Baseline Period Energy – Reporting Period Energy) ± Adjustments

Equation 5: Energy Savings Formula

IPMVP has developed four Options to address the range of retrofit situations that may be observed in ESPC projects. These are referred to as:

- Option A: Retrofit Isolation – Key Parameter Measurement
- Option B: Retrofit Isolation – All Parameter Measurement
- Option C: Whole Building or Facility Level
- Option D: Calibrated Simulation

M&V Option	How Savings are Calculated
Option A: Based on Measured Equipment Performance, Measured or Stipulated Operational Factors, and annual Verification of "Potential to Perform"	Engineering Calculations
Option B: Based on Periodic or Continuous Measurements Taken Throughout the Term of The Contract at the Device or System Level.	Engineering Calculations Using Measured Data
Option C: Based on Whole-building or Facility Level weather and / or Other Factors.	Analysis of Utility Meter Data
Option D: Based on Computer Simulation of Building or Process Simulation is Calibrated with Measured Data	Comparing Different Models

Table 9: IPMVP Options and Savings Calculations

Option A: Retrofit Isolation – Key Parameter Measurement

- Option A is the simplest option and involves the lowest cost. Generally, Energy performance parameters are measured (before and after), and Energy usage parameters may be estimated
- This option is used where the "potential to perform" needs to be verified but accurate savings estimation is not necessary. This approach requires agreement between the host Facility and the ESCO on the parameters to be measured and estimated

Option B: Retrofit Isolation – All Parameter Measurement

- Under Option B, some or all parameters are measured periodically or continuously. This option is applicable when accurate savings estimation is necessary and long-term performance needs to be tracked. This option reduces the uncertainty in savings estimates, particularly when load patterns and savings from the retrofit are variable. It may require metering and therefore entails more effort and cost.
- Key features of this option are that more accurate savings estimates are obtained (than Option A) and the option facilitates improved FM and ongoing commissioning

Option C: Whole Building or Facility Level

- Option C considers Energy use and cost of the entire Facility, not of specific equipment. It requires the use of utility meters, Whole-Facility meters, or sub meters to assess Energy performance of a whole Facility
- The measurement boundary encompasses either the whole Facility or a major section thereof and includes loads that are not subject to ESMs. This option determines the collective savings of all ESMs applied to the section of the Facility that is metered. In addition, since Whole-Facility meters are used, savings reported under Option C include positive or negative effects of any non-project changes made in the Facility. It may therefore require Baseline adjustments to reveal what changes resulted from ESMs. The key feature of this option is that savings are reported for an entire Facility and include any interactions among multiple measures that may be implemented

Option D: Calibrated Simulation

- Option D involves the use of computer simulation software to calculate Energy use for a Facility before ESM implementation, and after ESM implementation. The BEM must be "calibrated" so that it accurately represents actual Energy use. Option D may be used to assess the performance of all ESMs, similar to Option C. However, Option D also allows the estimation of savings attributable to each ESM, as calculated within the BEM
- Option D is very flexible but requires significant effort. It is applicable in situations such as: new-builds; design and installation of Energy management and control systems; major building-use changes; and significant building envelope modifications. The use of specialized software to establish the BEM is a specialist activity, requiring specific skills and experience. Examples of suitable software include: eQuest; EnergyPlus; TRACE 700; Carrier HAP; IES VE; Design Builder; and TRNSYS

6.7.3 IPMVP Adherent M&V Plan

An M&V Plan is a critical part of the M&V Process; it defines which of the M&V Options shall be selected for which System subject to an ESM, and how each M&V Option shall be applied. The M&V Plan, therefore, defines how savings will be calculated and specifies actions that will be carried out before and after equipment installation. A project-specific M&V Plan shall be produced for each ESP and shall include the following:

- Overview of proposed Energy and cost savings for the entire ESP (i.e. including all ESMs)
- For each ESM:
    - Details of Baseline conditions and data collected
    - Documentation of all assumptions and sources of data
    - Details of engineering analysis performed
    - Details of proposed Energy and cost savings and how they will be calculated/measured (i.e. M&V Option)
    - Details of any FM or other cost savings claimed and how they will be calculated/measured
    - Details of post-installation verification activities, including inspections, measurements, analysis, and project acceptance procedures
    - Details of anticipated routine adjustments to Baseline or Reporting Period
    - Content and format of all required M&V Reports (post-installation and periodic M&V)
- Schedule of all M&V activities (using software such as Primavera or MS Project)
- Witnessing and approval requirements

- Utility rates

An **M&V Plan Template** is contained within Attachment 4.

6.7.4 Operational Verification

Operational Verification consists of a set of activities that help to ensure that the ESM is installed, commissioned, and performing its intended function. Operational Verification serves as a low-cost initial step for assessing savings potential or verifying performance over time and should be included in the M&V Plan and precede other post-installation saving verification activities. Operational Verification is not necessarily the responsibility of the person performing the M&V activities but should be verified and documented as part of an M&V effort.

The selection of the best approach to Operational Verification depends on the ESM's characteristics, the level of uncertainty involved, and the magnitude of the savings at risk. Data collected during Operational Verification may be used during actual M&V.

During an independent review of reported savings, in addition to field verification of the installation, the reviewer shall conduct activities needed to observe that the ESM is based on sound scientific principles. Approaches to Operational Verification are outlined in Table 10 (below).

Operational Verification Approach	Typical EEM Application	Activities
Visual inspection	ESM will perform as anticipated when properly installed: direct measurement of ESM performance is not possible	View and verify physical installation of ESM
Sample Spot Measurements	Achieved ESM performance can vary from published data based on installations details or component load	Measure single or multiply key Energy-use parameters for a representative sample of the ESMs installations
Short-Team performance testing	ESM performance may vary depending on actual load controls or interoperability of components	Test for functionality and control measure key Energy use parameters may involve conducting tests designed to capture the component operating cover its full range or performance data collection over sufficient period of time to characterize operation
Date trending and Control-logic review	ESM performance may vary depending on actual load and is being monitored and controlled through BAS or can be monitored through independent meters	Set up trends and review data or control logic. Measurement period may last for a few days to a few weeks depending on the period needed to capture the full range of performance

Table 10: Operational Verification Approaches

6.8 Performance Monitoring and Targeting

Following a thorough Energy Review and Baselining, the Entity shall identify, prioritize, and record opportunities to improve Energy performance. When trending of Energy data has been completed though Energy Review and Baselining activities, targets can be set without detailed Energy Audits having taken place.

Although targets can be later refined based on detailed Energy Audits, they should first be set for the entire organization, and should propagate from SLT to Operational staff levels. Each member of staff should be held accountable and measured on their contribution to achieving the Strategy.

Following Energy Auditing, targets shall be set against the Baseline Year and shall be reflected within the Energy Conservation Policy. Statements resembling the following examples should feature in the Energy Conservation Policy:

"…reduction of Power consumption by 20% by 2022 against the 2019 Baseline."

"…reduction of Water consumption by 12% by 2022 against the 2019 Baseline."

"…reduction by 30% of Energy from non-renewable Energy Sources by 2025 against the 2019 Baseline."

Targets shall be monitored through KPIs. KPIs are a quantifiable measure of performance that can be monitored, targeted, and trended. KPIs shall be used to evaluate the success of the Energy Conservation Strategy in meeting the targets set out in the associated Policy.

6.8.1 Key Performance Indicators (KPIs)

EnPIs are a form of KPI specifically associated with ESMs. EnPIs are not binary, singular achievements, such as achievement of Certifications (i.e. LEED, Mostadam, ISO 50001) but rather the trend of improvements associated with key metrics (the measure of variables in relation to one another). Regression Analysis carried out during Baselining results in useful metrics that can be used as EnPIs. In Table 11 (below) are examples of how EnPIs can be applied to the Entity.

#	Objective	EnPI	Target	Drivers
1	*Provide a reliable, self-sufficient Power Network*	• Capacity/Demand Ratio (%) • Generation Cost (SAR/MWh) • System Losses (%) • Number of outages per annum • Billing/Collection Ratio (%) • Network Operational Costs (SAR/MWh) • Carbon (kg CO_2) • Power use vs. patronage (kWh/ No. of building users) • Energy Use per floor area (kWh/ m^2) • Energy Use per Facility	• Net-zero annual Energy consumption from non-renewable, conventional power sources • 100% LED Lighting • 100% availability of Power	• Sustainable Development Goal No. 7 • Ministry of Energy, NTP Strategic Objective No. 8
2	*Provide a reliable and sustainable Water Network*	• Total Consumption (L/person or L/household) • System loses (%) • Cost of Production (SAR/L) • Volume of water deposited to sewer (L) • Network Operation Costs (SAR/L) • Carbon (kg CO_2)	• Zero potable water for non-potable use	• Sustainable Development Goal No. 6 • Sustainable Development Goal No. 15 • MEWA, NTP Strategic Objective No. 4, 8, 10, 11, 15
3	*Maximize the reach of the District Cooling network*	• Co-efficient of Performance (% based on kWh/TR) • Carbon (kg CO_2) • Ratio of cooling from DC Network vs. Other types of cooling (%)	• Zero post-construction phase retrofits of split or package AC units	• Sustainable Development Goal No. 7 • Sustainable Development Goal No. 6 • Sustainable Development Goal No. 15

				• MEWA, NTP Strategic Objective No. 4, 8, 10, 11, 15

Table 11: Applying EnPIs within an Organization

Other KPIs not directly related to ESMs can also be used by the Entity to measure success. A list of benefits associated with implementing an Energy Management Program is outlined in Table 12 (below) against the ways in which these benefits can be measured (i.e. KPIs).

Benefits of the EMP	Key Performance Indicators
• Greater staff engagement within the organization. • Improves transparency across business operations. • Improves staff productivity and well-being because of optimized workplace lighting and HVAC. • Raises organizational awareness and helps to foster a sustainability culture. • Increases likelihood of positively influencing staff behavior outside of the organization. • Acts as a vehicle for organizational and cultural change. • Improves overall employee engagement results.	Staff engagement figures determined through annual Employee Satisfaction Survey, for example: • Number of staff claiming to switch off the light when they leave a room vs. the number of reports of lights being left switched on when rooms are unoccupied as determined by Walkthrough Audits. • Number of staff claiming to place all waste in the correct receptacle.
• The organizations' profile is raised as a result of the Energy Management Program. • Offers a tangible demonstration of Corporate Social Responsibility, enhancing the Entity's brand among customers, suppliers, and stakeholders. • Offers ability to issue evidence-based Corporate Communications and Marketing.	• Number of customers. • Number of followers on Social Media. • Number of non-compliance incidents featured within annual External Auditor Report. • Number of likes per Social Media post.
• Staff are up-skilled as a result of delivering the EMP.	• Number of qualifications and Professional Certifications held by staff as part Employee Database.
• Improved operational efficiencies.	• Annual spend on utilities as a portion of overall budget.
• Offers ability to establish and analyze Energy data for evidence-based decision making.	• Number of Projects against which budget is approved.
• Reduces environmental impacts of business operations.	• Measured variables such as air quality, or calculated variables such as CO_2.
• Instills operational excellence within resource management, accounting, budgeting, and Reporting activities.	• Number of non-compliance incidents featured within annual External Auditor Report.
• Supports carbon accounting and reduction, and compliant Sustainability Reporting.	• Calculated CO_2 levels. • Number of non-compliance incidents featured within annual External Auditor Report.
• More cash available for business growth, or staff training.	• Size of training budget year-on-year as a portion of overall budget.
• Improves understanding and recording of Entity assets, leading to intelligent evidence-based decision making.	• Number of assets tagged through the Enterprise Asset Management System. • Level of monitoring and control of assets determined through Asset Management Maturity Assessment.

• Provides a basis for highlighting areas of improvement, incentivizing performance, and celebrating success.	• Numbers of staff meeting and exceeding KPIs during Professional Development Reviews.
• Realization of non-Energy (indirect) benefits such as greater productivity and lower maintenance needs.	• Number of non-communicable analogue meters installed as a portion of overall installed meters.
• Fosters a culture which engages and empowers employees to identify and address Energy-saving opportunities.	• Number of suggestions received by Staff associated with Energy-saving opportunities.

Table 12: Measuring KPIs

6.8.2 Tracking Performance

For Entities without the budget to install EMIS software or upgrade metering, a manual approach to tracking performance shall be required. ESMs which, as a result of Energy Auditing, are considered to be viable opportunities shall be captured using an ESM Tracker. The ESM Tracker shall be presented in a tabular format with the following fields as a minimum:

- Entity Sponsor.
- Location of ESM.
- Name of ESM.
- Category of ESM (i.e. lighting, HVAC, and building envelope).
- Status (i.e. Level 1, Level 2, Level 3, Implementation, Reporting Period).
- Additional Notes.
- Estimated Cost (SAR).
- Power: Estimated Saving (kWh/year).
- Power: Estimated Saving (SAR/year).
- Water: Estimated Saving (m^2/year).
- Water: Estimated Saving (SAR/year).
- Estimated Payback (years).
- Estimated CO_2 Saving ($tCO_{2\ equivalent}$).
- Planned Completion Date.
- M&V Option (A, B, C, or D).
- Other Benefits.
- Value of other benefits (SAR/year).

In addition to plotting opportunities before ESM implementation, the ESM Tracker will also capture progress and performance during ESM implementation, and Reporting Period. This holistic reporting tool shall, therefore, also feature the following fields for each ESM:

- Actual Cost (SAR).
- Actual Saving (kWh/year).
- Actual Saving (m^2/year).
- Actual Saving (SAR).
- Actual CO_2 Saving ($tCO_{2\ equivalent}$).
- Other benefits: (Reduction in HVAC load [kWh/year]).
- Actual Payback (Years).
- Actual completion date.

Based on the aforementioned fields, graphs shall be derived and Reporting requirements shall be met. The ESM Tracker represents the minimum approach to Energy Management for Entities with limited budget and limited intelligent infrastructure (i.e. non-digital or non-communicable meters and limited/no BMS functionality).

Outputs of the ESM Tracker (i.e. Performance Reports) are only as accurate as the data that is input to the ESM Tracker. The ESM Tracker shall, therefore, be subject to continuous improvement through constant refinement and scrutiny. Examples of sources of inputs to the ESM Tracker are as follows:

- Metering data (Water, Gas, Power).
- Fuel oil supplies (i.e. transport fuel, diesel, and propane).
- BMS data.
- Energy Audit Reports.
- Energy Baselines.

All Entities shall implement an EMIS, and all Entities shall establish an EMP. As part of continuous improvement, Entities shall work toward fully automated buildings, with appropriate monitoring and control such that building operations can be optimized, and Energy savings can be maximized.

Entities that have enhanced operations and increased maturity toward Energy Management can begin to implement Monitoring-Based Commissioning (MBCx).

6.9 Monitoring-Based Commissioning

Building commissioning is a field that aims to optimize building performance specific to building usage requirements. The following are the main types of building commissioning:

New building commissioning (Cx): A quality assurance Process begins at the design stage and continues through construction, post-occupancy, and during the initial operating period. It typically ends at the end of the Warranty Period. Cx ensures that the new building operates as intended and that its staff is prepared to operate and maintain its Systems and equipment.

Retro-commissioning (RCx): A Process for improving an existing building's performance by identifying and implementing various LC O&M improvements. It involves investigating a building's Systems and equipment to improve performance or restore it back to the intended levels. It is particularly useful in addressing issues that originated during design or construction and developed since that time. It should include a Re-Cx Plan as part of the deliverables such that the building can be periodically returned to its intended performance levels established through RCx.

Re-commissioning (Re-Cx): Seeks to ensure the Energy savings and operational improvements last over time through a re-validation Process. Re-Cx should be carried out either:

- Every five years.
- When there has been a substantial change to building purpose.
- When the Facility has been significantly extended.
- When equipment Maintenance strategy or schedules have materially changed.
- When experiencing consistent and frequently occurring operational problems whose root cause cannot be determined or addressed by any other means. Re-Cx is typically less expensive than RCx since data collection and analysis should already be available from RCx activities.

Monitoring-Based Commissioning (MBCx): An ongoing commissioning Process that focuses on monitoring and analyzing large amounts of data on a continuous basis. MBCx uses RCx techniques but requires installation of monitoring equipment to collect data and analyze Energy performance over time. Monitoring equipment is permanently left in place, and staff review data to ensure optimized performance and verify Energy savings. Staff should be trained practitioners in MBCx tools in order to perform the work. MBCx requirements can be aligned with a Reliability Centered Maintenance (RCM) Strategy (particularly applicable to Industrial Sector) as required.

Whilst Cx pertains to new build requirements, RCx, Re-Cx, and MBCx pertain to existing buildings. Both RCx and Re-Cx can be recommended as ESMs and form part of an ESP. However, MBCx represents the highest level of maturity in terms of building commissioning and is therefore the focus of this Section.

Selected benefits of MBCx are as follows:

- Facilitates collection of building data.
- Enables data analysis through automated Fault Detection and Diagnosis (FDD) or EIMS to identify issues and opportunities.

- Offers a Process for implementing improvements based on the Energy Analytics and verifying savings.

The MBCx Process is captured in Figure **Error! Reference source not found.** (below):

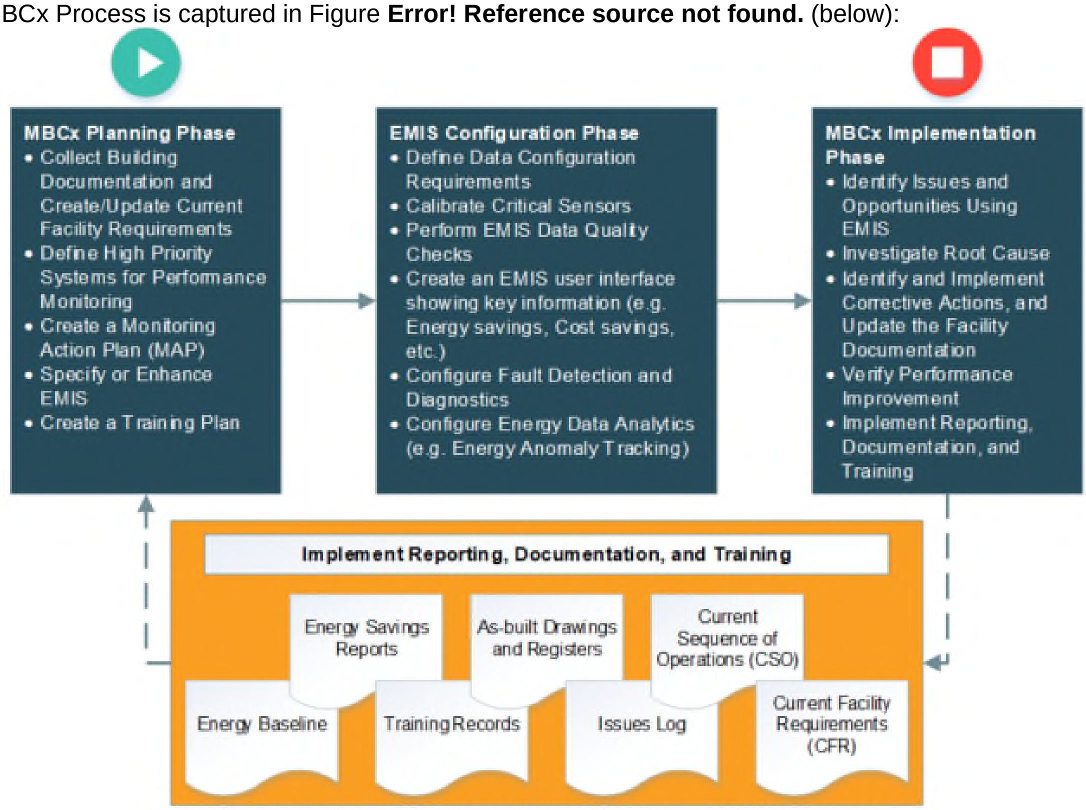

Figure 23: Monitoring-based Commissioning (MBCx) Process

6.9.1 MBCx Planning Phase

The Planning Phase establishes the technical plan (Monitoring Action Plan) and scope for how MBCx will be implemented. Technical monitoring activities are defined in a Monitoring Action Plan (MAP). Metrics, views, and analytics contained within the MAP should be made available through the EMIS. A Monitoring Action Plan Template is provided within Attachment 3.

1. Collect Building Documentation and Create/Update Current Facility Requirements

Normal operating ranges for each monitored System are documented in the Current Facility Requirements (CFR) document. The CFR includes information such as: indoor temperature and humidity requirements in occupied and unoccupied mode; building operating hours; requirements for special use areas and other key operational parameters.

The CFR is used to inform the development of the MAP. Whilst the CFR features normal operating parameters that inform the MAP, the Current Sequence of Operations (CSO) document also guides the development of the MAP based on faults that are identified when Systems deviate from normal operating sequences.

2. Define High Priority Systems for Performance Monitoring

Defining high priority systems for performance monitoring within the MBCx Plan narrows the focus of monitoring to the most critical Systems: those that have the greatest impact on Facility operations and Energy use. Therefore, it is also important to track the performance of ESMs implemented prior to the establishment of the MBCx Plan.

3. Create a Monitoring Action Plan

The MAP defines the analysis that will occur during the MBCx Process. It acts as a quick reference guide for Operators on what will be tracked in order to keep building Systems such as HVAC and lighting optimized over time. The MAP will include KPIs and targets that will be tracked in the EMIS.

4. Specify or Enhance EMIS

Once the MAP is completed, an existing EMIS may need to be updated to meet its needs. In the case of a newly specified EMIS, the Specification should include reference to the MAP. When specifying and selecting an appropriate EMIS to meet the requirements of the MAP, the Entity should consider who is expected to use the system, and how it will be used. The EMIS will be used by staff to perform the following MBCx activities:

- **Identify issues and opportunities:** For a quick summary view at a portfolio level, color-coded anomaly conditions and automated analysis within the EMIS will be used to identify and prioritize areas for improvement. Graphs (load profiles) may also be created for manual/visual review of Energy performance.
- **Root cause analysis and investigation:** After System performance issues have been detected (through the BMS), results of Energy Data Analytics will be reviewed within the EMIS, and combined with field observation to pinpoint a specific resolution.
- **Identify and implement corrective actions:** Issues should be resolved using the EMIS as a support tool to feed issues into the Entity's Work Order System.
- **Reporting:** The EMIS will be utilized in reporting results of MBCx and M&V efforts on a regular basis by tracking Energy performance.

5. Create a Training Plan

An MBCx Training Plan will be created, defining training for new and existing staff. Topics covered in the Training Plan will include the following as a minimum:

- CFR and CSO.
- Sensor calibration.
- Troubleshooting (for instance, data quality issues or system performance).
- EMIS capabilities and navigation.
- Using the MAP.

The Training Plan will include timing, location, and other relevant details (i.e. learning outcomes, examination requirements, and certification) of planned training courses.

6.9.2 EMIS Configuration Phase

This Section offers guidance on establishing reliable and accurate data streams for a new or previously installed EMIS to support an MBCx Program. The EMIS Configuration Process goes beyond simply installing hardware and software; the EMIS must be commissioned to ensure that the correct data is accurately and reliably being gathered. Steps for configuring and commissioning the EMIS include the following:

1. Define Data Configuration Requirements

The Entity should select data types to be monitored using the EMIS to support the MBCx Program. In addition to configuring the ongoing data stream, historical data shall also be imported as far as possible. Data point tagging shall follow the Entity's Tagging Procedure.

2. Calibrate Critical Sensors

Meters and sensors shall be calibrated in line with OEM recommendations. Measured values shall be crosschecked against monthly billing data to ensure consistency. Examples of temperature transducers that should be calibrated are those which measure:

- Outside air temperature.
- Air Handling Unit (AHU) supply air temperature, return air temperature, and mixed air temperature.
- Chilled Water Supply (CHWS) and Return (CHWR) temperatures.
- Hot Water Supply (HWS) and Return (HWR) temperatures.

3. Perform EMIS Data Quality Checks

EMIS data being used for the MBCx Program shall be quality-checked, with particular attention to the following:

- Data values falling outside the range of an installed meter or sensor.
- Meters installed incorrectly.
- Insufficient data capture (low memory, incorrect sample rate, data gaps due to power outage and no cache memory at meter).
- Data point tagging not complying with the Entity's Tagging Procedure.
- Sum total of sub meters does not add up to total of upstream meters.
- Results that are not intuitive (such as imported weather data not representative of local climate).

4. Create an EMIS user interface showing key information (Energy savings, Cost savings)

Following data quality checks, EMIS dashboards shall be configured to support Reporting requirements. EMIS dashboards shall feature a high degree of flexibility to satisfy needs of all users and stakeholders. The following basic features shall be included within the EMIS user interface as a minimum:

- Facility name and location.
- Graph and summary table display indicating KPIs.
- Energy Accounting Center (i.e. multi-site) View (if applicable).
- Easy navigation from main landing page to specific Facilities, meters, and graphs.
- Summary of alarms/alerts.
- Savings summary data showing progress toward the savings target.

5. Configure Fault Detection and Diagnostics

Following the import of BMS data points to the FDD tool (built into the EMIS), and data storage and communications having been established as well as calibration of the FDD toll completed, FDD rules must be selected and implemented. Rules should initially be limited to certain fault types. The MAP should inform specific rules to be implemented, and fault thresholds tuned as part of the configuration process. The fault prioritization method shall also be set (cost impact, occupant impact).

6. Configure Energy Data Analytics (Energy Anomaly Tracking)

An EMIS can be used to:

- Measure Energy savings relative to a historical Baseline, and.
- Alert users when Energy use exceeds current expectations (tracking "anomalies").

Once meter data streams have been established, Energy savings tracking will be configured.

6.9.3 MBCx Implementation Phase

This Section outlines implementation of the MAP, which takes place following successful commissioning of the EMIS. The following steps define the MBCx Implementation Phase:

1. Identify Issues and Opportunities Using EMIS

The Entity should use EMIS to identify issues through a combination of FDD analytics, manual review of KPIs, and analysis of graphs and tables. The issues and opportunities identified should be compiled in an Issues Log.

2. Investigate Root Cause

Root cause of Energy Anomalies shall be determined by reviewing BMS trends, set points, controls programming, and through field investigation of equipment. Results will also be tracked in the Issues Log.

3. Identify and Implement Corrective Actions, and Update the Facility Documentation

Corrective actions for issues found through the MBCx Process shall be addressed as follows:

- Issues Log shall be presented at EMT/EMWG Meetings.
- Issues shall be prioritized based on severity and cost.
- Cost thresholds shall be agreed between EMWG and SLT for approval of Corrective Actions.
- Improvements shall be input to the Work Order System.

Corrective actions may include LC or NC actions, as well as those requiring commercial approval, for example: maintenance/repair covered under existing budgets (Opex), set-point modifications, and control sequence modification.

4. Verify Performance Improvement

ESMs shall be verified and FDD rules updated to detect degradation of the measure automatically through the EMIS. EMIS metering and analysis capabilities may be utilized to automatically quantify Energy and cost savings (Section 0 – Energy Data Analytics further guidance).

5. Implement Reporting, Documentation, and Training

To maximize benefits of the MBCx Process, the following documentation shall be regularly reviewed and updated by the EMT as required:

- CFR
- CSO
- MAP
- Issues Log
- As-built drawings/registers
- Training records
- Energy savings Reports
- Energy Baseline

6.10 Reporting

This Section describes Reporting requirements that should be considered by the Entity as part of delivering a successful EMP.

6.10.1 EMIS Output

Dependent on the software employed to monitor and track performance (i.e. MS Excel and EMIS software); Weekly and Monthly Summary Reports can be generated to provide an overview of consumption. Components such as percentage change from previous week are useful parameters to capture. Changes should be color coded to denote whether the change is positive or negative as shown in Figures 24 and 25 (below) which show increases in Energy Use denoted in red color, and Energy Savings denoted in green color.

Homepage > Enterprise > Basingstoke > Aquadrome > Weekly Summary Report

Weekly Summary Report

This item is built-in. This means it cannot be edited or deleted.

Scope

This report refers to the last complete week (from Monday to Sunday)

Electricity Consumption - From the Grid (Peak)

	Previous Period	Current Period	Change	% Change
Electricity Meter ImServ	5,976 KWh	801 KWh	-5,175 KWh	-86.6%
Total	**5,976 KWh**	**801 KWh**	**-5,175 KWh**	**-86.6%**

Electricity Consumption - From the Grid (Off Peak)

	Previous Period	Current Period	Change	% Change
Electricity Meter ImServ	3 KWh	1,704 KWh	1,702 KWh	68,060.0%
Total	**3 KWh**	**1,704 KWh**	**1,702 KWh**	**68,060.0%**

Electricity Consumption - From the Grid (Total)

	Previous Period	Current Period	Change	% Change
Electricity Meter ImServ	5,978 KWh	2,505 KWh	-3,474 KWh	-58.1%
Total	**5,978 KWh**	**2,505 KWh**	**-3,474 KWh**	**-58.1%**

Electricity Consumption - CHP

	Previous Period	Current Period	Change	% Change
CHP Electricity Meter (Usage)	38,394 KWh	19,848 KWh	-18,545 KWh	-48.3%
Total	**38,394 KWh**	**19,848 KWh**	**-18,545 KWh**	**-48.3%**

Figure 24: EMIS Dashboard – Weekly Report

A longer view is offered by Monthly Summary Reports which provide an overview of existing consumption against the same period in the previous year. The trend is best shown graphically for all performance parameters as in Figures 25, 26, 27, and 28 (below).

Electricity Consumption - Total

	Previous Period	Current Period	Change	% Change
Usage	199,214 KWh	142,006 KWh	-57,208 KWh	-28.7%
Total	**199,214 KWh**	**142,006 KWh**	**-57,208 KWh**	**-28.7%**

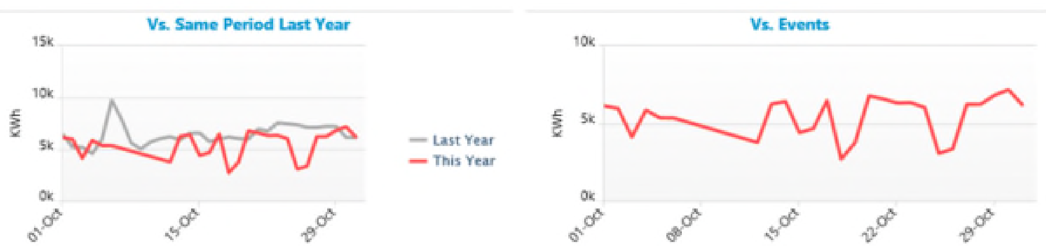

Figure 25: EMIS Dashboard – Monthly Report (Electricity)

Gas Consumption	Previous Period	Current Period	Change	% Change
Gas Meter 1	564,961 KWh	585,355 KWh	20,393 KWh	3.6%
Total	**564,961 KWh**	**585,355 KWh**	**20,393 KWh**	**3.6%**

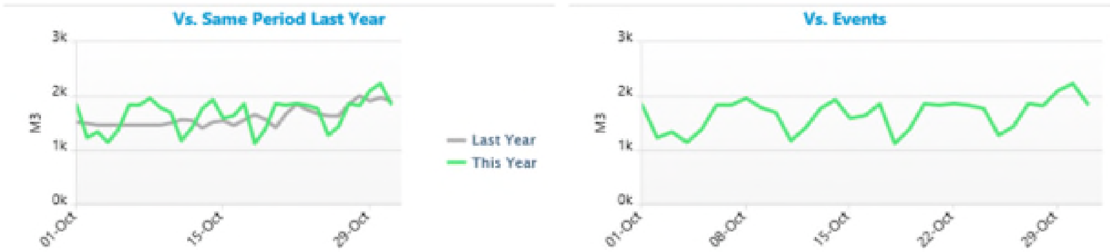

Figure 26: EMIS Dashboard – Monthly Report (Gas)

Water Consumption	Previous Period	Current Period	Change	% Change
Water Meter 1	1,650 M3	2,283 M3	634 M3	38.4%
Total	**1,650 M3**	**2,283 M3**	**634 M3**	**38.4%**

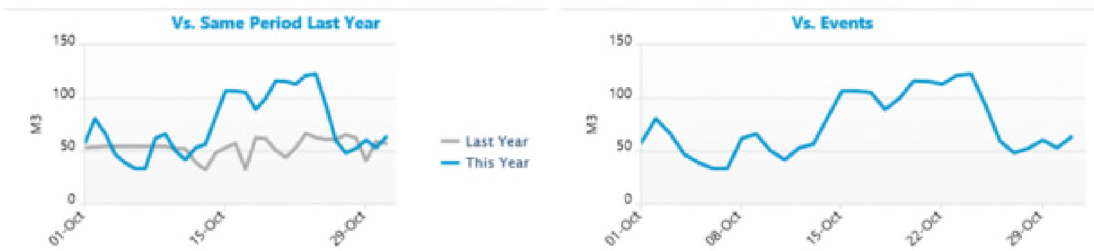

Figure 27: EMIS Dashboard – Monthly Report (Water)

Carbon Consumption	Previous Period	Current Period	Change	% Change
Carbon	129.635 tonnes	104.792 tonnes	-24.843 tonnes	-19.2%
Total	**129.635 tonnes**	**104.792 tonnes**	**-24.843 tonnes**	**-19.2%**

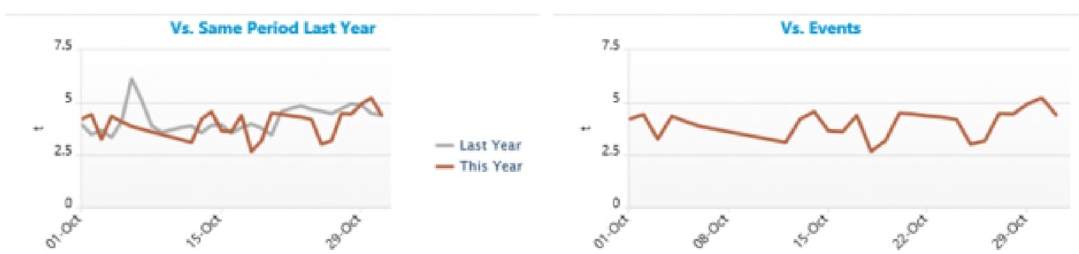

Figure 28: EMIS Dashboard – Monthly Report (Carbon)

6.10.2 Energy Audit Reports

Reporting elements for aforementioned levels of Energy Audit are as follows:

6.10.2.1 Level 1 Required Elements

Executive Summary

- Overall assessment of benchmarking and Energy performance.
- Potential savings and ROI.
- Recommended ESMs with estimated savings and ROI

Introduction

- Audit scope.
- Key dates and milestones set in consultation with FM.
- Contact information of the Auditor.

Facility Description

- Site Information
- Notable Conditions – Level 1 Audit Report highlights observed conditions affecting comfort or health of building occupants, Indoor Environmental Quality (IEQ) deficiencies, operational anomalies, historical heritage/preservation status, and improvement in O&M practices.

Historical Utility Data

- Monthly and Annual Utility Data – Monthly Utility Data for past 12 consecutive months (preferably 36 months) for the whole Facility including rate schedules and preliminary data analysis.
- Identification of irregularities in monthly Energy use patterns and suggestions about their possible causes.
- Annual EUI and Energy Cost Index (ECI) – EUI is indicative of Energy consumed per unit area per year while ECI provides an estimate of Energy consumption cost per unit area per year.

Benchmarking

- Benchmarking serves to provide a basis for comparing operational performance of the Facility building with its own historical performance or peer buildings of similar stature.
- Normalization of data is usually carried out to reflect the performance of the buildings on a common set of operating conditions.

Establish Target and Estimate Savings

- By comparing the EUI or ECI with that for the benchmark buildings, an improved EUI or ECI shall be identified and reported as a target.
- An estimate shall then be provided for annual Energy and cost savings that can be achieved if the target is met.
- The established target shall be chosen in consultation with all the concerned stakeholders.

Energy Saving Opportunities

- The LC and NC changes to the Facility or to O&M procedures, and estimates of the approximate level of Energy, Energy costs, and non-Energy cost savings that will result from those changes as well as their basis for being included shall be stated in the report.
- These changes and their estimated level (high, medium, or low) of annual savings shall be listed by Energy system type (lighting, HVAC and service hot water (SHW)/domestic hot water (DHW), plug/process loads, envelope), and may be documented as follows:
    - Recommended change and brief description of change.
    - Modified building systems.
    - Impact on occupant comfort (improved thermal comfort, indoor air quality [IAQ], lighting quality, and acoustics).
    - Estimated cost (high, medium, low).
    - Estimated level (high, medium, low) of annual savings.
    - Estimated level (high, medium, low) of ROI.
    - Priority (high, medium, low).

The Level 1 Energy Audit Report must also feature the following elements as a minimum:

- Date the building was designed/built and the Energy efficiency code applicable at that time. If this is not known, an estimate should be provided by the Competent Professional.

- Evidence of interviews that were conducted with a cross-section of building users to understand how the Facility operates and to note concerns, or commonly occurring issues.
- Results of building envelope covering the following as a minimum:
  - Air leaks around outlets, fixtures, doors and windows.
  - Location, age, condition, and efficiency of external HVAC equipment units (i.e. DX Units and Rooftop Units (RTUs).
  - Wall and roof insulation and framing type.
  - Quantity, and type of external lighting and control devices.
- Building orientation.
- Comparison between the installed building System specifications and the requirements of the latest Saudi Building Code (i.e. SBC 601 and 602, in relation to heat transfer coefficients and specific fan power).
- Results of interior visual inspection covering the following as a minimum:
  - Power consumption of electrical systems.
  - Electrical appliances' SASO rating (Saudi Arabian Standards Organization) or other Energy scheme rating (Energy Star).
  - Filters of internally installed HVAC units (i.e. split AC and Fan Coil Units).
  - Thermostat type and settings.
  - Quantity, and type of external lighting and control devices.
- Recommendations on ways to improve the building's Energy efficiency to save money with a simple PBP analysis including:
  - Initial costs.
  - Energy (in kWh) saved per year.
  - Annual financial savings.
  - Simple PBP.
  - Typical equipment life expectancy.

6.10.2.2 Level 2 Required Elements

Level 2 Reporting elements incorporate all Level 1 elements, and the following additional elements:

- Facility Description – The Facility description shall be expanded to include building information including building type and usage, conditioned/unconditioned gross floor area, owner vs. tenant Energy responsibilities, commissioning history, operating schedules and inventory, onsite power generation resources, building envelope conditions (roof, walls, floors, fenestration, overall enclosure tightness).
- Expanding upon HVAC System Types, Distribution System and Ventilation, Controls [Pneumatic or direct digital control (DDC)], Zone controls (core, perimeter, space types).
- BMS, Lighting (Exterior, Interior), Process and Plug Loads.
- Building Conveyance equipment, Historical Data Analysis, End-use Energy breakdown.
- Analysis and End-Use System Energy Consumption Reporting Methodology.
- ESM Summary – Expanding upon LC and NC ESMs, Capital Intensive ESMs, Distributed Energy Resources (DER) and Renewable Energy Resources (RER), ESM Cost Estimate Reporting, and ESM Economic Analysis Reporting.
- Quality Assurance Reviews.

6.10.2.3 Level 3 Required Elements

Level 3 Reporting elements incorporate all Level 2 elements, and the following additional elements:

- M&V Methodology – The proposed M&V methodology with appropriate justification and adherence to IPMVP shall be documented. Kindly refer to 6.7 Measurement and Verification section for further details
- LCCA – LCCA of each recommended ESM shall be conducted for a timeframe that spans, at a minimum, the life of the measure with the longest service life and shall include the following:
  - Initial costs.
  - Financing costs.
  - Annual Energy costs.
  - Escalation rates citing the source within the Energy audit report.

  - Discount rates citing the source within the Energy audit report.
  - Cash incentives.
  - Expected periodic replacements.
  - Estimated recurring non-Energy costs (maintenance), of each measure or set of measures. Such costs include annual maintenance and service labor costs, routine replacement of worn parts, or annual warranty fees from manufacturers.
- Risk Assessment – For the measures that receive Level 3 analysis, a Risk Assessment shall be conducted. The analysis shall have a minimum level of rigor as described below:
  - Identification of technical, operational, and fiscal parameters those are potentially most uncertain, sensitive, and critical to the installation, operation, and savings of each ESM in the project.
  - Determining realistic high and low levels for each of these parameters. This may be accomplished through further measurement, selection of a realistic range (for parameters such as equipment efficiency levels), or by examining historical data or industry projections for parameters such as Energy cost.
  - To assess the uncertainty and sensitivity of critical parameters, the Level 3 analysis shall be repeated, varying one or more critical parameters within the ranges defined in the preceding paragraph. Each critical parameter is assessed independently.
  - Examples of critical parameters include full and part-load equipment efficiencies and capacities, equipment availability, load variation, weather, financing costs, discount rate, Energy rates, and escalation assumptions.

6.11 The ESCO Model

ESMs are any activity, installation, or initiative that result in the reduction of power and water use, and operational efficiency increase. ESMs may require significant upfront investment or may be categorized as LC, or NC.

Examples of ESMs include:

- Installation and optimization of existing cooling equipment (such as adiabatic cooling, thermostats, pumps, Variable Frequency Drives [VFDs])
- Building envelope alterations (window shading, wall insulation, window double glazing)
- Installation of Energy efficient lighting and optimization of lighting management systems
- Optimization of building conveyance systems (travellators, escalators, elevators)
- BMS optimization

See Expro Projects White Book, Volume 6, Chapter 7 for more examples of ESMs and how they can benefit the Entity.

An ESCO delivers feasibility, design, implementation, and monitoring of ESMs. ESCO services may also include retrofitting, retro commissioning, and installation of on-site power generation equipment. An ESCO service which conforms to the definition of an ESM, and wherein savings resulting from the service can be measured, can be included as an ESM. Figure 29 (below) describes a typical ESCO Model:

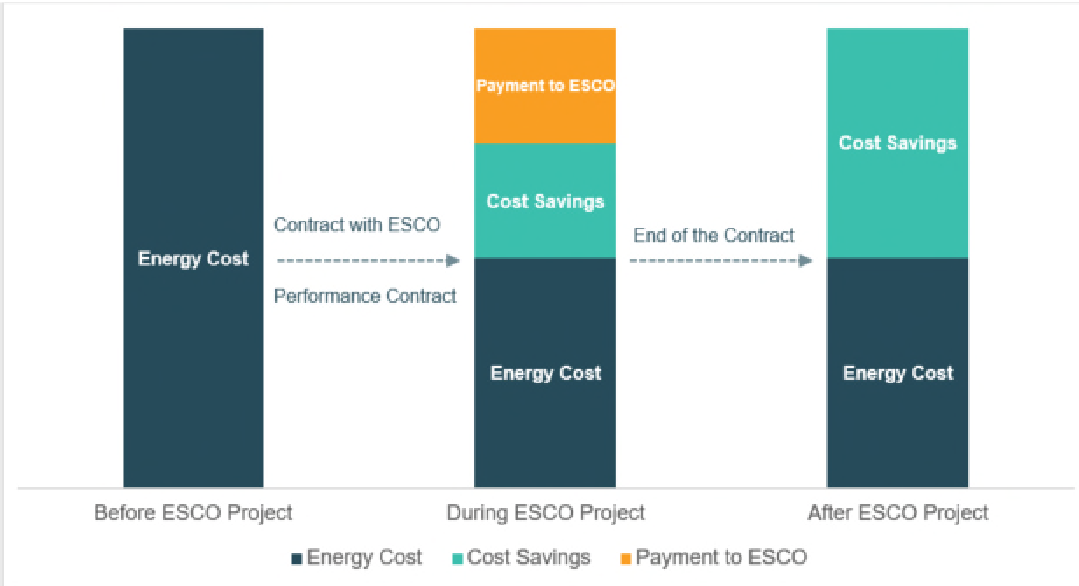

Figure 29: ESCO Performance Contracting Model (Source: World Resources Institute, Building Energy Efficiency)

ESCOs typically offer innovative techno-commercial solutions tied to Energy Savings Performance Contracting (ESPC). In KSA, there is also an organization (Tarshid) that finances retrofit projects, and sub-contracts to ESCOs, leaving ESCOs to focus solely on technical delivery while Tarshid focuses on finance. Tarshid is known as a "Super ESCO" and more information regarding Tarshid is contained within Section 6.12.2.

6.11.1 Energy Savings Performance Contracting

ESPC is a budget-neutral approach to incorporating ESMs. ESMs are self-financing in nature, in that: upfront investment is offset by cost savings generated during their lifecycle or part thereof. ESPC differs from other forms of Contracting since it features accurately forecasted savings arising from ESMs based upon internationally recognized M&V Protocols. Performance is measured against savings forecasts contained within the Contract.

Successful execution of ESPCs requires:

- The ability to prove Energy savings.
- O&M expertise to maintain ESM performance.
- Continuous monitoring, targeting, and improvement of ESMs and related systems.
- A solid understanding of operational demands.
- Complete control over anything which may affect ESM performance.

Benefits of using the ESCO Model and implementing ESPC are as follows:

- Aids in Facility modernization through equipment upgrades.
- Prolongs the lifecycle of the equipment.
- Improves the existing building FM practices.
- Improves performance monitoring.
- Maximizes data capture and analysis.
- Necessitates the need for evidence-based decision making.
- Demonstrates savings to occupants and prospective tenants, thus increasing asset value.

6.11.2 Financing Solutions

ESPC models are continuously being adapted in response to evolving business needs and innovative financing solutions; however, they largely fall under two categories: Shared Savings, and Guaranteed Savings. In both categories, power and water tariffs are typically fixed, or are varied under a predetermined escalation clause and schedule.

6.11.2.1 Shared Savings

Savings measured by the ESCO are mutually shared between the ESCO and the client in a predetermined ratio, for a predefined duration. Positive cashflow generated by savings is used to repay costs of implementing, operating, and maintaining the ESM. Financing of ESMs may be undertaken by either the ESCO, third-party, Client, or a combination thereof.

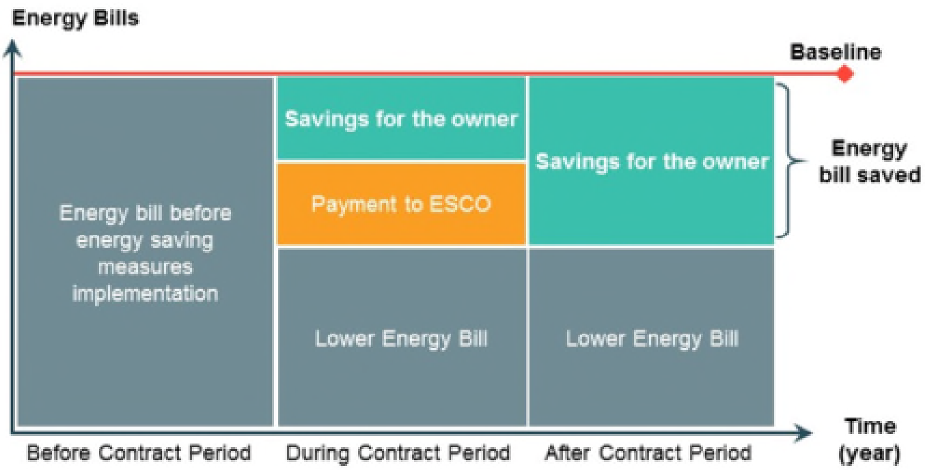

Figure 30: Shared Savings Mechanism between ESCO and Client (Facility Owner)

Figure 30 (above) shows how the split of savings between the Client and the ESCO varies against time.

A type of Shared Savings category known as the ‘First-out’ Model involves the ESCO securing 100% of savings achieved until it recovers the cost of the ESM, plus an agreed rate of return.

The ESCO can also add a clause to the contract which triggers a Variable Contract Term such that the ESPC duration can increase in case the value of savings is less than expected.

6.11.2.2 Guaranteed Savings

The ESCO guarantees power and water savings while the Client bears the total cost of the ESMs. The ESCO receives contractual payments during the pre-negotiated term as long as savings are achieved. Shortfall in savings is monetarily covered by the ESCO. Thus, the ESCO adopts majority of the risk.

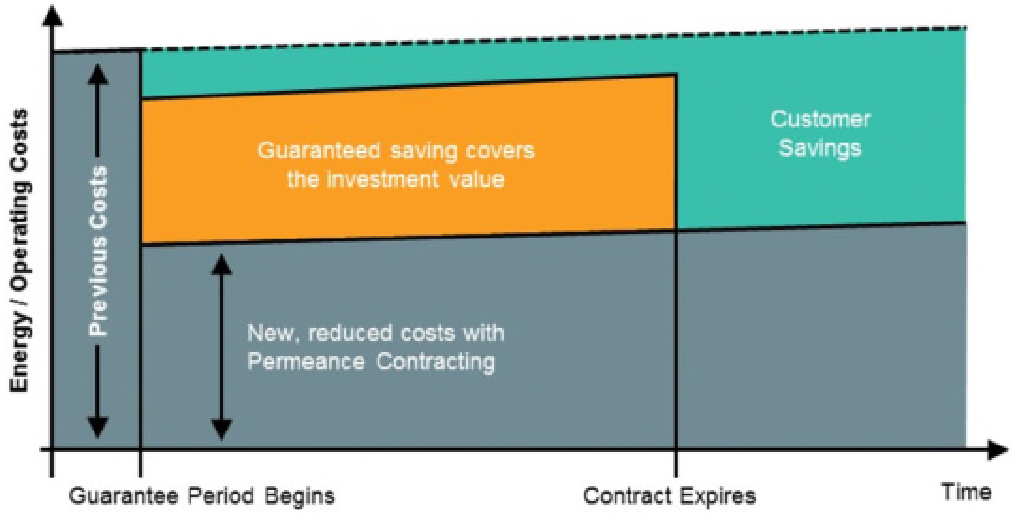

Figure 31: Guaranteed Savings Mechanism between ESCO and Client (Source: Codema)

A variation of the Guaranteed Savings category involves inclusion of performance levels, which may include mutually sharing the savings measured surplus to the minimum guaranteed savings in an agreed ratio for each of the performance levels.

6.12 KSA Service Providers

This Section describes Service Providers within KSA that have been established specifically to support Entities in saving Energy.

6.12.1 Saudi Energy Efficiency Center

The Saudi Energy Efficiency Centre is tasked with unifying and consolidating efforts between governmental and non-governmental organizations in rationalizing Energy use and improving Energy efficiency. The establishment of SEEC was born out of common challenges faced across KSA in reducing Energy consumption, such as:

- Low Energy prices.
- Low consumer awareness of the importance of Energy efficiency.
- Absence of Energy Efficiency Standards and Specifications.
- Poor inter-Entity collaboration regarding Energy efficiency.

In 2012, SEEC launched the Saudi Energy Efficiency Program (SEEP) as a vehicle by which to deliver its commitments. Through the Program, SEEC:

- Develops a national Energy efficiency plan for KSA.
- Develops Policies, Regulations, Standards, and Procedures that govern Energy efficiency and support its implementation.
- Promotes Energy efficiency awareness.
- Participates in the implementation of Energy efficiency pilot projects.
- Identifies KPIs and setting targets.
- Proposes Energy efficiency projects.
- Licenses and qualifies Energy efficiency service providers.
- Establishes rules for Energy efficiency tests.
- Provides technical advisory services in the field of Energy audits, and M&V.
- Develops the National Manual for Measurement and Verification in Energy Efficiency Services.
- Monitors compliance with Energy efficiency Standards.
- Delivers training programs, developing Energy efficiency curricula in the field of higher education.
- Organizes exhibitions, conferences, programs, and seminars in the field of Energy efficiency.

According to SEEC, there are 3 Sectors that consume more than 90% of the Energy in KSA and in which SEEC focuses its efforts. Based on 2012 figures, these Sectors and their corresponding Energy consumption are as follows:

- Buildings Sector: 29%
- Transport Sector: 21% (specifically associated with vehicle Energy use)
- Industry Sector: 41 – 44%

Through its Program, SEEC has implemented initiatives to rationalize Energy consumption in these Sectors. An Executive Committee manages implementation and enforcement of the SEEP, including national reporting.

The National Manual of Assets and Facilities Management (NMA&FM) applies to 6 Sectors (Healthcare, Parks & Recreation, Schools & Universities, Roadways, Housing, Municipalities, and Offices). The NMA&FM is best aligned to SEEC's Buildings Sector (Section 6.12.1.1).

6.12.1.1 Buildings Sector

Of 29% KSA Energy consumption apportioned to the Buildings Sector, approximately 65% is attributed to cooling. One contributing factor to the high cooling requirement within KSA buildings is that 70% of the buildings in the Kingdom are not thermally insulated. Thermal insulation alone can reduce power consumption by up to 30%. SEEC has, therefore, prioritized an initiative to thermally insulate KSA buildings and in doing so, has taken the following steps:

- Issuance of thermal insulation Standards.
- Mandated that thermal insulation of buildings is to be mandatory.
- Developed Standards for air conditioners to improve their Energy efficiency.
- Issued Standards for washing machines and refrigerators.
- Issued Standards for lighting.
- Update the SBC to reflect new building Energy requirements.

On October 3rd, 2016, the Saudi Council of Ministers issued a Royal Decree obliging government Entities to utilize district cooling technology, subject to the following criteria:

- That the development is classified as a new project.
- That the requirement for cooling demand requirement exceeds 15,000 tons.
- That sufficient treated water is available in the area where the project is located.

SEEC has been assigned in coordination with the Electricity and Cogeneration Regulatory Authority (ECRA) to review and update the above-mentioned conditions as necessary.

6.12.1.2 Certification and Training

SEEC delivers training programs in the field of Energy efficiency for SMEs across KSA. SEEC also offers internationally accredited courses in cooperation with partners such as AEE. A selection of courses offered by SEEC is as follows:

- Energy Conservation in Buildings.
- Energy Conservation in Light Factories.
- Energy Conservation in Heavy Factories.
- CEM
- CEA
- Certified Measurement and Verification Professional.

In cooperation with the Technical and Vocational Training Corporation, SEEC also delivers courses to university and college students.

6.12.1.3 ESCO Accreditation

SEEC is responsible for qualifying companies to work in the Energy services sector in KSA through accreditation and licensing mechanisms that contribute in enhancing the level of services provided by these companies. SEEC qualifies ESCOs interested in working with Tarshid, the National Energy Services Company.

6.12.2 National Energy Services Company (Tarshid)

Tarshid is the National Energy Services Company, recently established by KSA's sovereign wealth fund – the Public Investment Fund (PIF) – to support the development of a more Energy efficient Saudi Arabia. Tarshid is the result of a collaborative effort between the Ministry of Energy, the Ministry of Finance (MOF), and SEEC.

Tarshid aims to stimulate development of a thriving Energy efficiency industry in the Kingdom and serve the Kingdom's strategic sustainability goal of achieving significant Energy savings, without placing any burden on the government's budget. The company, therefore, has a mandate to develop, fund, and manage impactful Energy efficiency projects in government and commercial Sectors. It operates a Shared Savings Model.

Tarshid serves three focus areas:

1. Building Retrofits.
2. Street lighting Retrofits.
3. Renewable Energy.

6.12.3 Saudi Environmental Society

The Saudi Environmental Society (SENS) is a national, non-profit organization born out of the Ministry of Social Affairs. SENS is tasked with improving conditions for the residents of regions within KSA that suffer from environmental problems by offering sustainable development programs.

SENS provides training programs to multi-Sector government and private partners. The following is a selected list of training programs offered by SENS:

- Energy Management Systems – ISO 50001
- Energy and Water Auditing of buildings
- Leadership in Energy and Environmental Design (LEED)
- Renewable Energy and Photo Voltaic (PV) Solar
- Eco Systems
- Green Way finding Elements: Green Signage, Street Furniture, and Environmental Graphics Design
- Green Schools and Classes
- Green Offices
- Green Restaurants
- Environmental Action for Automotive Servicing and Repairs
- Environmental Management – ISO 14001
- Occupational Health and Safety
- Prevention and Firefighting
- Water and Wastewater
- Environmental Pollution

6.12.4 Clean Development Mechanism

The Clean Development Mechanism (CDM) (https://www.cdmdna.gov.sa/) offers support to Entities responsible for the achievement of a cleaner environment and sustainable development within KSA. It does this by helping Entities to:

- Participate and benefit from global and national mechanisms that contribute to emission avoidance and the achievement of the sustainable development goals of the Kingdom.
- Raise climate change education and awareness within KSA.

6.12.4.1 National Committee on Climate Change

CDM interfaces with the KSA National Committee on Climate Change. Chaired by the Minister of Energy and supported by a team of experts, technical, and administrative staff; membership of the Committee is currently composed of the following Entities.

- Ministry of Energy
- Ministry of Industry and Mineral Resources
- Ministry of Transportation (MoT)
- Ministry of Municipal and Rural Affairs (MoMRA)
- Ministry of Health (MoH)
- Ministry of Environment, Water and Agriculture (MEWA)
- Royal Commission for Jubail and Yanbu (RCJY)
- Saline Water Conversion Corporation (SWCC)
- Saudi Arabian Oil Company (Saudi Aramco)
- Saudi Basic Industries Corporation (SABIC)
- Saudi Electricity Company (SEC)
- King Abdulaziz City for Science and Technology (KACST)
- King Abdullah City for Atomic and Renewable Energy (KACARE)
- The Electricity and Cogeneration Regulatory Authority (ECRA)
- General Authority of Meteorology and Environmental Protection (GAMEP)
- Ma'aden
- Modon

6.12.4.2 Areas of Focus

1. Adaptation

Due to its arid nature, KSA is highly vulnerable to the adverse effects of climate change-induced extreme weather phenomena. Therefore, the Kingdom continues to invest in activities which enhance resilience and protect and renew its natural environment. Selected adaptation measures captured by CDM include:

- **Water and Wastewater Management:** Projects are in place, which will ensure the reduction, recycle, and reuse of water and wastewater within municipal, industrial, and commercial Sectors. These national projects will also reduce Energy consumption, reliance on desalinated water production, and unground leakage.

- **Urban Planning:** Mass transport systems are under development in urban areas such as Riyadh, Jeddah, and Dammam.

- **Marine Protection:** Coastal management strategies are in place, and are designed to reduce coastal erosion, increase the sinks for blue carbon, maintain related ecosystems, and address the threats that climate change poses to marine life. Projects that include the planting of mangrove seedlings and coral reef restoration along the northwestern coast are also underway.

- **Reduced Desertification:** Desertification management strategies are underway. These include actions that will promote the stabilization of sand movements around cities and roads, while increasing sinks for capacity through using green belts as barriers. Inland resource conservation activities and eco-system adaptation initiatives are also being implemented. The aim of these initiatives is to improve soil quality, water quality, pasture potential, and wildlife resources through a system of protected areas and reserves. The aim is to reduce land degradation and improve land management practices, particularly within agriculture and forestry industries.

2. Energy Efficiency

In addition to the work being led by SEEC and Tarshid, significant wider efforts in the field of Energy Efficiency are underway within KSA, as follows:

A Demand-side Management Program has been launched covering building, transport, and industrial Sectors.

- Buildings Sector
  - Regulation has been implemented for building insulation products with mandatory thermal insulation being a requirement for new buildings.
  - Minimum Energy efficiency ratios have been mandated for air conditioning units and white products (refrigerators, washing machines) whilst inefficient lighting products are being phased out within the lighting market.

- Transport Sector
  - Regulations regarding Energy efficiency of light duty vehicles are in force including, for example, fuel economy labelling.
  - Resistance Standards for Tires have also been established.

- Industrial Sector
  - Recognizing that industry represents 41 – 44% of total Energy consumption within KSA (out of which 80% of Energy consumed is in the petrochemicals, cement and steel sectors), new regulations were passed in 2014 mandating all plants to benchmark and set targets for EUI against international benchmarks.
  - Strict product control has also been implemented covering items such as: electrical appliances, tires, and electrical motors.

3. Renewable Energy

There is significant work underway within KSA regarding the use of Solar Energy, Wind Energy, and other sources of Renewable Energy such as Geothermal Energy as part of the Energy mix.

Solar Energy

The Energy Research Institute (ERI) at KACST has been conducting R&D activities in the field of solar Energy (i.e. photovoltaic, Solar thermal, solar water heating, solar water pumping and desalination, and solar hydrogen production).

Other Entities working within the field of Solar Power in KSA are:

- Solar and Photovoltaic Engineering Research Center at King Abdullah University of Science and Technology (KAUST).
- Center of Research Excellence in Renewable Energy at King Fahd University of Petroleum and Minerals (KFUPM).
- KACARE.
- General Authority for Civil Aviation (GACA).
- Saudi Electricity Company (SEC).

Wind Energy

The first Saudi Arabian Wind Energy Atlas was produced in 1987 by a research team from KACST and KFUPM based on the data collected from 20 meteorological stations during the period 1970-1982 (Al-Ansari et al, 1986).

In 2016, KACARE developed the renewable resource atlas of Saudi Arabia, which provides newly collected and historical Wind resource monitoring data and satellite-based modelled data for developers, researchers, government institutions, and policy-makers. KACARE has identified 40 sites throughout KSA which will serve as future Wind Farms and plans a First Round of 650MW with a Second Round of 1.05GW.

Other Renewable Energy Sources

According to "Harrat Khaybar" (Lashin et al., 2015), Geothermal resources within KSA comprise 3 categories:

- Low enthalpy resources represented by deep-seated aquifers that can be accessed only by deep oil wells.
- Medium enthalpy resources (hot springs) encountered along the western and southwestern coastal parts.
- High enthalpy resources (Harrats) that are represented mainly by lava fields with fumarolic activity.

Principal focus areas for future research in the field of Geothermal Energy include:

- Environmental assessment of Geothermal Energy systems.
- Determination of high potential locations for the development of Geothermal Systems.
- Assessment of technological challenges in the design, construction, and operation of Geothermal Energy Systems.
- Assessment of technologies to minimize cost and maximize efficiency of Geothermal Energy Systems.

4. Technology

KSA has realized the significance of emphasizing the investment on technology transfer and high technology know-how through research, development, and manufacturing processes to achieve its aspired socio-economic development objectives in a sustainable manner, particularly, the objective of diversifying the national economic base. A number of policies, initiatives, and laws have been constituted and implemented in the Kingdom to promote climate-friendly technology transfer and development as follows:

- National Policy for Science and Technology
- Centers of Research Excellence Initiative
- National Technology Incubator Policy Framework
- National trends to invest and to commercialize new technologies in strategic areas including Renewable Energy technologies
- National Intellectual Property Policy
- National system for protecting patents, layout designs, integrated circuits, plant varieties, and industrial designs

6.12.5 Mostadam

Mostadam is the KSA sustainability rating and certification system established to address the long-term sustainability of buildings in KSA. At present, Mostadam is only applicable to residential buildings; however, when tailored to Sectors outside of the Residential Sector, it shall be aligned with the NMA&FM. Further details are provided within Chapter 3 – Sustainability.

7.0 ATTACHMENTS

1. Attachment 1 – EOM-ZN0-TP-000006 – Energy Policy Template
2. Attachment 2 – EOM-ZN0-TP-000007 – Energy Conservation Strategy Template
3. Attachment 3 – EOM-ZN0-TP-000008 – Monitoring Action Plan Template
4. Attachment 4 – EOM-ZN0-TP-000009 – M&V Plan Template
5. Attachment 5 – EOM-ZN0-TP-000010 – Level 1 Energy Audit (Walkthrough Audit) Plan Template
6. Attachment 6 – EOM-ZN0-TP-000011 – Energy Saving Project Business Case Template

Attachment 1 – EOM-ZN0-TP-000006 – Energy Policy Template

Energy Policy Statement

We are committed to the conservation of Energy.

It is the policy of <Entity> to control Energy consumption, which will, in turn, minimize financial losses and improve cost-effectiveness, productivity, and working conditions. We will promote conservation of Energy throughout our organization and wider stakeholders. In order to continually improve our performance, we will:

- Implement and develop an Energy Management Program (EMP) aligned with ISO50001
- Maximize the use of ESMs throughout all our facilities, wherever it is cost effective
- Ensure that our staff are aware of the environmental impacts of their work activities and encourage them through awareness-raising and training to minimize those impacts
- Review our Procedures and Policies on a regular basis
- Measure and report on our performance
- Appoint an Energy Manager to lead Energy Management activities within the organization
- Buy fuels at the most economic cost without sacrificing Energy Performance or the Environment
- Use Energy as efficiently as is practicable
- Reduce pollution that our Energy consumption causes
- Reduce our dependence on fossil fuels, and consider feasibility of on-site Renewable Energy.

Signed

Date

Entity Leadership

Attachment 2 – EOM-ZN0-TP-000007 – Energy Conservation Strategy Template

Our Energy Management Program

This Energy Management Program (EMP) acts on our Policy which links Strategic Goals with Business Objectives.

Implementation

Our Energy Manager will develop an Annual Business Plan for Energy Management and produce an Annual Savings Report to inform the Plan. In collaboration with the Finance Manager, the Energy Manager will establish and prioritize funding requirements for the EMP.

Responsibilities

The Energy Manager will: coordinate all Energy Management efforts across the entire business; formulate and implement the Energy Conservation Policy; and Chair the Energy Management Working Group, reporting directly to the Senior Leadership Team (SLT). At the same time, all <insert name of entity> staff and building users are responsible for controlling Energy consumption.

Communications and Reporting

The Energy Manager will lead in the delivery of all Reporting activities, including Energy Audit Reports, Energy Baseline Reporting, and Energy Savings Reports. All internal stakeholders shall be briefed regarding Energy Performance monitoring and targeting, with specific information to be shared outside of <insert entity name>.

Recognition and Rewards

An Energy Rewards Program shall be established, which shall recognize and reward contributions toward success of the EMP.

Resources

The number of Energy management staff for the coming year will be <insert number> Full Time Equivalent (FTE). Annual funding Energy Management activities shall represent a minimum of <insert number>% of the annual Energy expenditure.

Review and Continuous Improvement

The EMP will be subject to periodic review and continuous improvement via annual internal audit conducted through the Energy Management Working Group.

Attachment 3 – EOM-ZN0-TP-000008 – Monitoring Action Plan Template

Meter-level KPIs		
Checkpoint/Metric	**EMIS View**	**What to look for**
Annual Energy use with normalizing factors such as gross floor area and CDD	Annual Energy Use Intensity (EUI) in kWh/m^2 or by fuel Energy Star portfolio manager benchmark score to gauge climate-normalized performance relative to peers	Rank portfolio and review outliers
Monthly Energy use with normalizing factors such as gross floor area and CDD	Monthly EUI in kWh/m^2 or by fuel	Compare to previous month or previous year of the same month
Daily electricity KPI: (Total bldg. kWh/day)/(Avg. daily outdoor air temperature)	Min/max/average/current daily reading	Establish Facility benchmarks after commissioning
Daily gas KPI: (Total therms/day)/(Avg. daily outdoor air temperature)	Min/max/average/current daily reading	Establish Facility benchmarks after commissioning
Meter-level Analytics		
Checkpoint	**EMIS View**	**What to look for**
Schedules	Use heat map and/or load profile graphs with filtering for weekday/weekend/holiday	Confirm that time-of-day schedules meet the current Facility requirements. Check weekends and holidays for scheduling improvement opportunities
Base load	Use heat map and/or load profile graphs with filtering for weekday/weekend/holiday	Compare to the peak load to assess the after-hour setback
Energy signature	Hourly Energy consumption vs. hourly outside air temperature (or daily Energy consumption vs. degree-days). Some EMIS automatically compare the Energy signature metrics to industry benchmarks	Weather-dependency of loads, balance point temperature at which heating or cooling starts, and base load. High heating Energy use in summer may be associated with simultaneous heating and cooling
Load shape	24-hour demand plot, min/max/avg. by day type	Start time, stop time, weekend, and holiday scheduling
Energy anomaly	Flag when Energy use is outside the modeled prediction (see Appendix D for modeling instruction)	Energy use outside of a defined threshold of performance (+/- 10% for instance)
Meter data	Flag when meter has failed. A time series graph may be used to visually identify a gap	Large or repetitive (i.e. at regular intervals) gaps in Energy data
Energy Savings/M&V	The cumulative annual Energy savings, or % change in Energy use	Model statistics are within the thresholds set
System-level Key Performance Indicators		

Attachment 4 – EOM-ZN0-TP-000009 – M&V Plan Template

Executive Summary/M&V Overview and Proposed Savings Calculations

1. Proposed Annual Savings Overview

ESM	Total Energy savings (kWh/yr.)	Power savings (kWh/yr.)	Natural gas savings (m^3/yr.)	Water savings (m^3/yr.)	Other Energy savings (kWh /yr.)	Total Energy and water cost savings – Year 1 (SAR/yr.)	Other Energy-related O&M cost savings – Year 1 (SAR/yr.)	Total cost savings – Year 1 (SAR/yr.)
ESM 1								
ESM 2								
Total savings								

Table 1: Proposed Annual Savings Overview

Include all applicable fuels/commodities for project (electric Energy, electric demand, natural gas, fuel oil, coal, water)

Table 2: Site Use and Savings Overview

	Total Energy (kWh/yr.)	Power (kWh/yr.)	Natural gas (m^3/yr.)	Water (m^3/yr.)	Other Energy (kWh/yr.)
Total proposed project savings					
Usage for entire site					
% Total site usage saved					
Project Area (m^2)					
Total site Area (m^2)					
% Total site area affected					

Table 2: Site Use and Savings Overview

Attachment 5 – EOM-ZN0-TP-000010 – Level 1 Energy Audit (Walkthrough Audit) Plan Template

Level 1 Energy Audit (Walkthrough Audit) Plan	
Date Issued	
Scope Description	The Energy Management Team is requested to provide a Walkthrough Energy Audit of <insert building name> and produce a Findings Report highlighting viable ESMs. Outcomes of this Report shall be inserted into the ESM Tracker and later form a Business Case upon which funding will be procured to initiate an ESP
Activities	• Carry out preliminary audit to understand building operations and identify ESMs, categorized as follows: o NC/LC behavioral and operational changes. o Further investigation. o Capital investment. • Carry out Walkthrough Audit capturing the following steps: o List number of areas covered within the Audit (include: room tags, room purpose/apparent use). o Estimate number of people and area per person. o Note lighting specifications/number of lights per room. o Note heavy plant/machinery specifications and observed operation requirements. o Note operational (plant/equipment/machinery) operational requirements and non-operational (toilets/ablution) requirements. o Note room temperatures. o Note behavioral norms (lights left on in areas not in use, plant power negligence). o Take photos. o Note safety concerns/mal-operation/non-operation of equipment. • Review layout drawings. • Review Single Line Diagrams (SLDs). • Identify technological opportunities. • Review historical/existing meter readings and highlight savings opportunities. • Review Tenant List (as applicable). • Prepare a Draft Findings Report. o Provide presentation to stakeholders, receive feedback, and build into Draft Report. o Receive comments on Draft and submit Final Report to Energy Manager.
Expected Outputs	• A presentation in .PPT format presented to stakeholders demonstrating findings. • A report in .DOC format provided in electronic form.
Est. Days Effort	10 days
Technical Lead	
Energy Manager	
Start Date	
End date	
Equipment/ Inputs Required	• Layout Drawings. • SLDs. • Tenant List. • Electricity and Water Bill. • Previous Audit findings (if available). • Info regarding planned expansion and upgrades. • Site escorts (as required). • Camera.

Attachment 6 – EOM-ZN0-TP-000011 – Energy Saving Project Business Case Template

ESM Project Business Case	
Title of Work	Install air barrier across <insert building name> building doors
Background	
The Energy Management Team (EMT) has a brief to identify, promote, and execute Energy Saving Measures (ESMs) in support of its objectives to reduce the overall Energy and water bills. The EMT has defined a strategy for its work built on internal business commercial drivers to create a 5-year-plan to reduce overall consumption, with greater focus on an annual plan to deliver short-term benefits, and enabling works for future or more complex ESMs.To this end, the EMT has created a central register of ESMs (ESM Tracker) which is made up of ESMs generated by all Entity departments, and by the EMT itself, through agreement by the Energy Management Working Group (EMWG). This work specifically is derived from cross-department agreement for the need of an Energy management system that reduces the Energy lost via door openings resulting in a reduction in building heating and cooling costs. A successful trial project was implemented in 2019 to demonstrate Energy savings and the proposal to roll out the technology throughout the Facility has been endorsed by the EMWG.	
Objectives	
The objectives are as follows: • Reduce Energy lost via door openings • Reduce costs through Energy savings • Reduce HVAC duty – reduce Energy and maintenance costs	
Financial Summary	
Cost Breakdown	The unit installed cost of an air barrier is SAR XXXX. The proposal is to install 33 air barriers across all external doors at a total cost of SAR XXXX.
Savings Breakdown	Based on metered data, Energy savings seen from the free trial were SAR XXXX. The forecasted savings associated with a full roll out are therefore SAR XXX.
Savings Calculation	
<insert savings calculation here>	
Other Benefits	
Expected benefits from installing the air barrier include: • An air barrier creates an effective seal on the doorway by re-circulating Facility air in a smooth laminar flow, preventing the penetration of outdoor air. • High efficiency motors – low running costs. • Re-circulates ambient air – improves Facility heating/cooling efficiency. • Reduce carbon footprint. • Reduction in the ingress of outside contaminants, dust, and flies contributing to an increase in product yield, protection of capital equipment, and a more comfortable environment.	
Description of Work	
<insert details of what the contractor proposes to do>	
Risks	
<insert details of risks to existing Facility operations>	