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ENERGY MANAGEMENT INFORMATION SYSTEMS

Planning Manual and Tool

CIPEC

Developed for Natural Resources Canada's Office of Energy Efficiency by Efficiency New Brunswick in collaboration with provincial and territorial governments.

Canada

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TABLE OF CONTENTS

INTRODUCTION

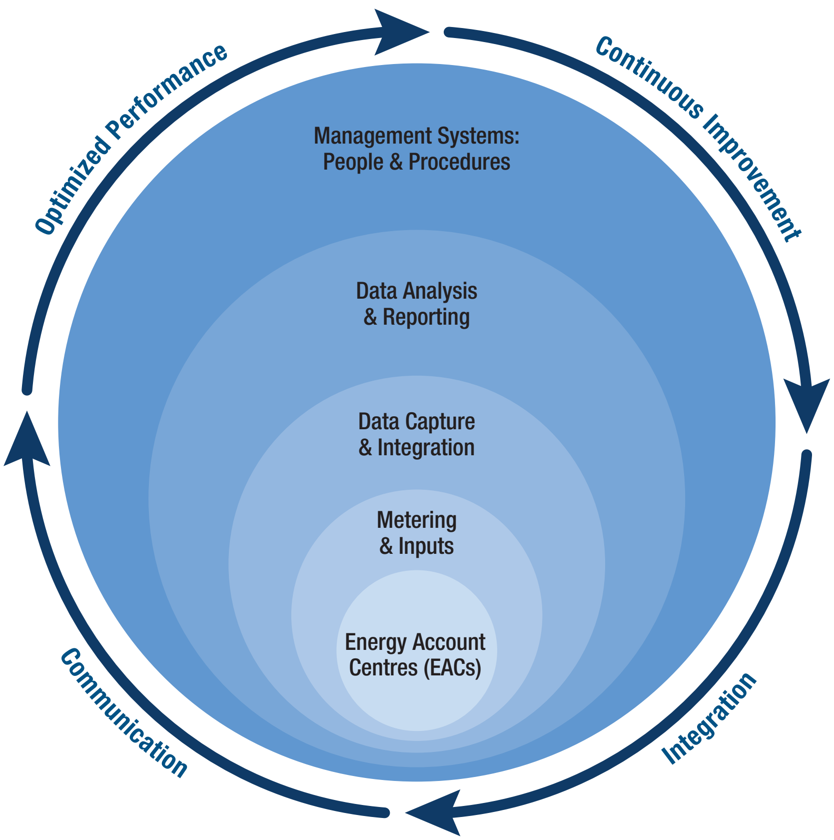
PART I - INTRODUCTION

1. Introduction

An Energy Management Information System (EMIS) provides relevant information that makes energy performance visible to various levels of an organization, enabling individuals and departments to plan, make decisions and take effective action to manage energy. It can lead to productivity improvements through the continuous monitoring of energy performance, and savings opportunities that, once implemented, are sustained over the long term. The performance information generated by an EMIS enables organizations to take actions that create financial value through the management and control of energy.

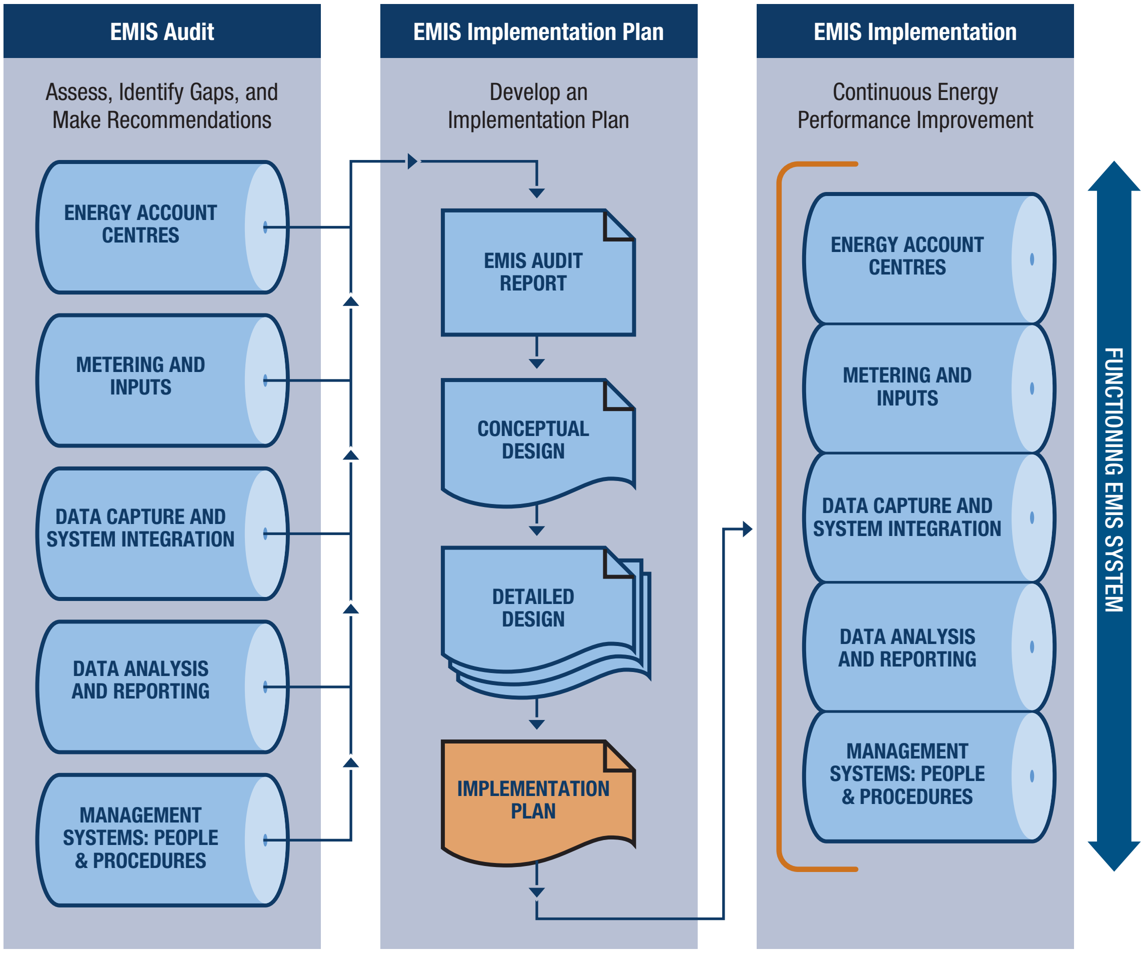
Figure 1-1 illustrates the elements of an EMIS and the various business processes that it can support within an organization. It shows that an effective EMIS requires communication, integration and a commitment to continuous improvement in order to result in optimized performance.

Figure 1-1 Operational Energy Management Information System (EMIS)



There are three phases to developing an EMIS: the Audit, Implementation Plan, and Implementation. Figure 1-2 shows the phases. This Manual is organized to provide guidance on: (a) How to conduct an EMIS Audit (see Part A of the Manual) and; (b) How to prepare an EMIS Implementation Plan (see Part B of the Manual). The Manual is intended to assist industries and their service providers to develop and design well conceived EMIS to increase the probability of implementing a successful EMIS that will be an important element of the overall energy management.

Figure 1-2 Phases of EMIS Development and Implementation



2. Objectives and Organization of EMIS – Planning Manual and Tool

The objectives of this EMIS Manual and Tool are:

- to enable companies to conduct EMIS audits and prepare EMIS implementation plans; and
- to provide companies with the tools to prepare a financial business case for EMIS implementation.

The target audience for the Manual and Tool is industrial organizations that are considering an EMIS or those who are already implementing aspects of an EMIS.

The Manual and Tool is made up of four parts:

PART A (EMIS Audit) – is theoretical and provides the methodology to be used by outside or in-house engineers and consultants to do a thorough EMIS Audit. An EMIS Audit should provide sufficient preliminary business case performance metrics to enable a company to decide whether or not to proceed to the EMIS implementation plan phase.

PART B (Implementation Plan) – is structured as an instructional guide to help industry do the work themselves. It provides guidance, tools and activities at each stage of EMIS implementation planning. For service providers and suppliers to industry who may be contracted to undertake an EMIS Implementation Plan, it provides a structured methodology for, and tools to support, the EMIS Implementation Plan process, as well as a consistent form for reporting outputs.

PART C (Appendices) – includes templates, guides and spreadsheets that will help the user develop an EMIS Audit, gather data and score their company, prepare a conceptual and detailed design, as well as a business and financial plan for implementation.

PART D (Reference document) – reproduces the *Energy Management Information Systems – Achieving Improved Energy Efficiency: A handbook for managers, engineers and operational staff*, published in 2003 by the Office of Energy Efficiency of Natural Resources Canada. It is a useful reference tool for those who want to understand the basics of an EMIS prior to conducting an EMIS Audit or preparing a business case and implementation plan.

3. Nomenclature

As with any subject, energy management has developed its own language, most of which appears in this Manual and Tool. For the reader new to the subject, the following is a list of definitions:

ENERGY MANAGEMENT SYSTEMS (EnMS)	A formal management system (such as the ISO Energy Management Systems Standard 50001), or to the collection of business systems and processes comprising operational and commercial control over an organization's energy use. EMIS is a component of this.
ENERGY MANAGEMENT INFORMATION SYSTEM (EMIS)	A performance management system that provides relevant information that makes energy performance visible to different levels of an organization, enabling individuals and departments to plan, make decisions and take effective action to manage energy.
ENERGY ACCOUNT CENTRE	The organizational level at which energy performance should be managed and, therefore, reflects both process and organizational responsibilities. Energy Account Centres may be process lines, unit operations such as furnaces or driers, or components such as air compressors or boilers.
METERING	The measurement of data required for the EMIS and includes: ▪ Energy consumption data derived from energy meters or "sub-meters"; and ▪ "Utility Driver" data, which are the factors influencing energy consumption, typically production, environmental factors and operational factors.
UTILITY DRIVERS	Includes production data, environmental and operational factors that affect energy consumption in an organization. Production data: In an industrial context, production refers to the physical outputs of the process, usually the finished goods. Within the context of energy management, it is sometimes also important to use data from intermediate stages of the production process (sometimes termed work-in-progress), especially when processes are complex (i.e., with multiple outputs) or of long duration. In commercial and public buildings "production" may refer to other data such as occupancy hours (i.e., the time the building is occupied). Environmental factors: These are conditions beyond the direct control of the organization that influence energy consumption (e.g., ambient temperatures, absolute and relative humidity). Operational factors: These are the operational conditions that are under the direct control of the organization and influence energy consumption; (e.g., set point temperatures and pressures).
SUB-METERS	Measures the energy input to an Energy Account Centre and may also be used to measure the utility drivers. They are termed sub-meters because they measure a part of the total utility supply to the site, which is captured by the utility meters for billing purposes.

DATA CAPTURE	The hardware, software and/or procedures used to collect metered data. This can range from walking around a plant noting meter readings on a piece of paper and then copying these readings into a spreadsheet to a fully integrated automatic meter reading system with data stored centrally in a "data historian."
DATA HISTORIAN	Where captured data is stored in a structured format to allow subsequent analysis. Data historians can range from spreadsheets to proprietary databases, such as InSQL or PI.
DATA ANALYSIS	The process by which energy consumption is compared with the utility drivers to arrive at some conclusion on energy performance. Data analysis may be summarized as the means of converting data into management information.
REPORTING	The means by which this information is presented in an easy-to-understand format. The reports generated may be tabular or graphical.
TARGETS	Includes three types of targets: "Strategic" Targets – generally corporate level top-down targets based on some business-driven need (e.g., reduce costs by 5%) also known as "Objectives." "Tactical" Targets – specific energy targets that are defined from a bottom-up perspective (e.g., "this machine should run at × kWh/linear feet of board"); sometimes called Key Performance Indicators ("KPI"). "Operational" Targets – recognize all the influences on energy performance and may be used for predictive and control models based on mathematical relationships developed through regression analysis. Example: Electricity (kWh) = 16543 + 2.97 × production (tonnes) - 154 * average temperature (°C). In this equation, the operational target is dependent on both production and average ambient temperature and includes a base load. If the production is 230 tonnes and the average temperature is 25°C, then the target electricity would be: = 16543 + (2.97 * 230) – (154 * 25) = 13376.1 kWh If the actual consumption in the period is 14,000 kWh, there should be an investigation to determine the root cause of the difference. For purposes of clarity, we will refer to "Objectives", "KPIs" and "Targets" throughout this document.
CUSUM	CUSUM stands for "CUmulative SUM of differences", where "differences" refer to the discrepancy between actual consuption and the consumption expected in light of an established pattern.

EMIS AUDIT	Assesses an organization's current management practices and how it reports and measures energy to develop a proposed EMIS scope and business case.
AUDIT REPORT	Consists of (a) an assessment of organizational and facility gaps with respect to the recommended EMIS; (b) a proposed scope for EMIS as well as (c) the business case for investing in EMIS, including estimated costs and energy savings.
BUSINESS CASE	Provides the projected financial return information about the proposed EMIS that can be used by company decision-makers to decide if the company will proceed to the EMIS implementation planning phase.
CONCEPTUAL DESIGN	Provides a business-level overview of the proposed EMIS system and develops work packages based on a review of the EMIS Audit Report recommendations. It is at this stage that sign-off from management and key decision makers on the design of the EMIS structure takes place.
DETAILED DESIGN	Builds on the conceptual design and creates detailed work packages for all EMIS systems (i.e., metering, data capture, data analysis etc). This can be used to specify work for external service providers and suppliers and to acquire bids.
EMIS IMPLEMENTATION PLAN	Presents accurate costs for implementation and details the scope of the project and the resources needed by the organization to manage an EMIS. It provides a schedule to implement and manage an EMIS, a schedule for implementation and a timeline to see benefits.
EMIS IMPLEMENTATION	Spans the procurement, installation and commissioning of the EMIS, as well as training of personnel up to and including the point at which industry has achieved a functioning EMIS. Final phase of an EMIS (not included in this Manual and Tool) undertaken upon completion of the EMIS Audit and Implementation Plan.

4. What is an EMIS?

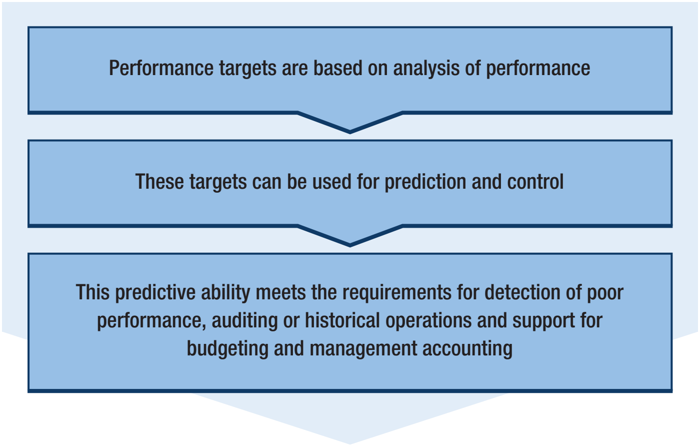
An EMIS provides relevant information that makes energy performance visible so that key individuals and departments within a business can take effective action to create financial value for the organization. In practice, this means that an EMIS should:

- Gather information on energy consumption;
- Gather information on the useful outputs derived from the consumption of energy (e.g., production, heating, lighting);
- Gather information on any other factors that may influence energy consumption (e.g., environmental factors such as ambient temperature and relative humidity, or operational factors such as building occupancy, packaging sizes);
- Contain analysis routines to allow for a comparison between energy consumption and utility drivers;
- Build and display energy performance reports.

With effective management systems in place, these performance reports can:

- Act as a stimulus for investigation and identification of the root causes of both good and poor performance;
- Promote operational best practices by eliminating the root causes of poor performance and promoting activities that lead to good performance;
- Provide the justification for energy saving projects by making visible the costs of current energy performance and providing a baseline against which savings projects can be compared; and
- Demonstrate the success or benefits of projects that have been implemented.

Figure 1-3 Targets in an EMIS

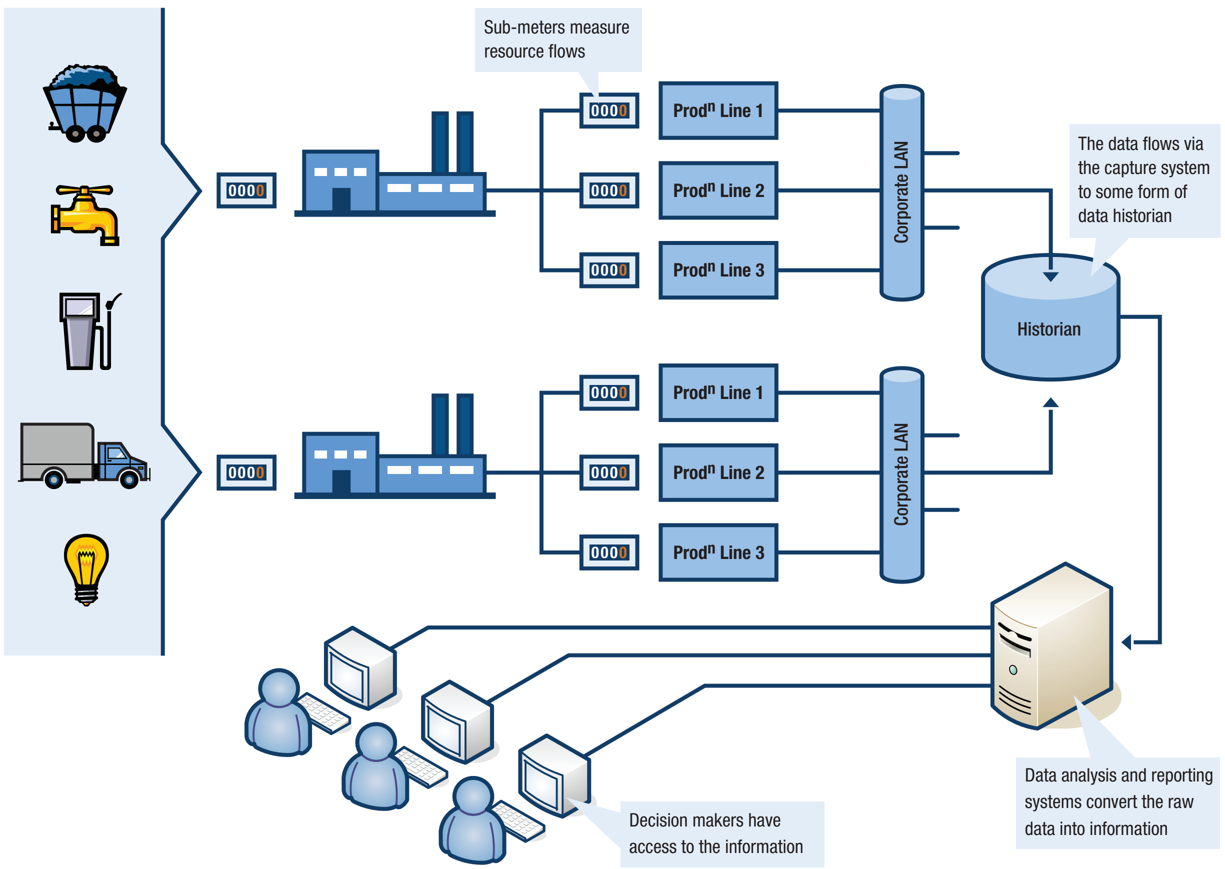


To deliver the results shown in Figure 1-3, an EMIS generally includes the following key components:

- Energy Account Centres (EACs) to manage the energy performance systems (e.g., may be process lines, unit operations such as furnaces or driers, or components such as air compressors or boilers).
- Energy meters and sensors for the key environmental factors that influence energy performance but over which operators have no control (e.g., temperature, relative humidity);
- Production meters and sensors for the operational factors;
- Data capture systems and data historians to store this data; and
- Data analysis and reporting systems.

An EMIS does not exist in isolation but is part of an organization's energy management system (EnMS). Any EMIS should be adequate to the purpose of the organization it serves, i.e., meet the requirements assigned to the EMIS by the organization and be appropriate to the current status and anticipated development of the organization's energy management system. This means that assessors cannot simply restrict themselves to the technical components of the EMIS (Figure 1-4) during the audit, but must also address the interaction between the EMIS and the EnMS.

Figure 1-4 Technical Components of an EMIS



5. What is the Scope of an EMIS?

Although an EMIS usually operates at a site level, in practice it can be implemented at many levels:

- Restricted to an area of energy use – this may be a good starting point for those organizations unfamiliar with the technique;
- Equipment or process – as an example, EMIS can be used to control air compressors by comparing the compressed air generated with the electricity used in generation with the compressed air generated during production;
- Department level;
- Cost centre;
- Energy Account Centre;
- Site-wide;
- Corporate – integrating the performance reporting from multiple sites into a corporate energy or environmental report.

6. Outcomes and Benefits of an EMIS

The savings potential attributable to the implementation of an EMIS depends on a number of different factors:

- The type of process the site is operating;
- The maturity of the organization in terms of its energy management systems and procedures;
- The abilities and motivation of the operational staff. There are many types of self-assessment tools available online to help evaluate this capacity.

Of the three, the people element is the most important. As a result, it can be difficult to define in advance the savings associated with implementing an EMIS.

It is useful at this stage to clarify how implementing an EMIS may lead to savings. There are a number of recognized outcomes of an EMIS:

- Reduced operational variability and embedding of operational best practices. This is determined by an operator's ability to recognize when the process is operating well or poorly. Savings are made by eliminating the root causes of poor performance and promoting activities that lead to good performance.
- An investigation into the causes of poor performance and the identification of energy conservation measures. Ideas for energy conservation measures may be developed as part of the process of understanding the root causes of poor performance.
- Benchmarking of similar processes across organizations. Why do the same production processes have different energy performance characteristics at different sites?

- At a strategic level, implementation of EMIS and energy management may also help to reduce the business risk facing an organization as a result of volatility in energy prices. By reducing both the amount of operational variability and encouraging investment in energy conservation measures, energy performance becomes more predictable. With predictable energy consumption, the organization is better able to negotiate energy supply agreements and more accurately forecast energy costs.

What savings can you expect?

Experience gained within the context of Efficiency New Brunswick's Large Industry Program suggests that, when properly implemented, an EMIS can save anywhere between 2 percent and 5 percent of an organization's energy consumption.

Natural Resources Canada's *Energy Management Systems Information* handbook notes that "as an initial approximation, 8 percent appears to be a reasonable estimate" [of the savings potential] (PART D).

Note: Savings can vary and may depend on size of Industry and/or energy profile.

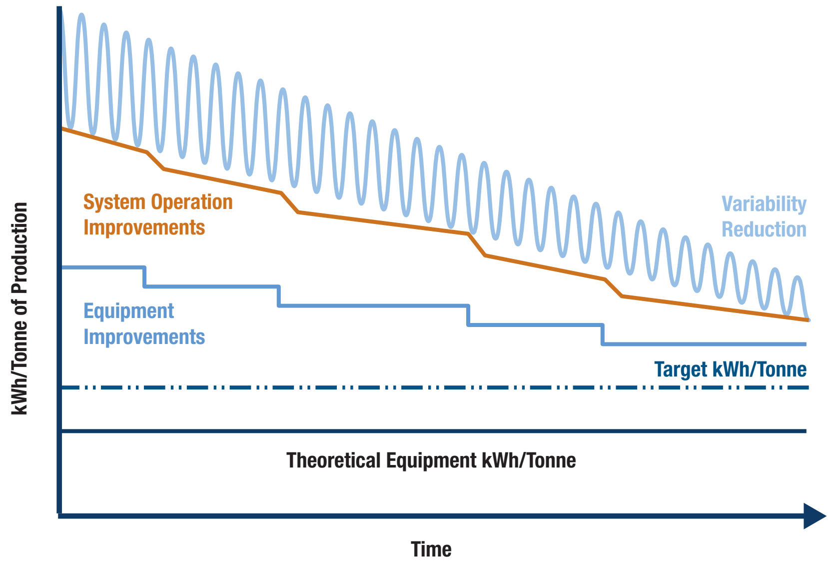
Energy Management, EMIS and Savings

There is extensive literature on establishing a systematic approach to the management of energy. There is no "one size fits all" approach to the issue. As the purpose of installing an EMIS is to provide information to people that enables energy improvement actions, the organizational context that drives those actions is paramount to EMIS success. In other words, an EMIS alone will not save money. An EMIS must be developed with careful consideration of the broader context of the structured management of energy. The material and tools are aimed at supporting this holistic concept of EMIS.

By placing an EMIS within a context of an energy management program with continuous improvement as one of its objectives, it can also lead to productivity improvements through the progressive elimination of wasted consumption (Figure 1-5). Using information gained about the behaviours that lead to reduced energy consumption, best practices are quickly identified and less efficient historic ways of working are challenged. Continuous monitoring of performance also means that when savings opportunities are implemented they are sustained in the long term and deviations from best performance can be quickly recognized and corrected.

More information in energy management planning is available at Natural Resources Canada's Dollars to $ense Energy Management Workshops (oee.nrcan.gc.ca/industrial/training-awareness/).

Figure 1-5 Savings from an EMIS



A

EMIS AUDIT

PART A - EMIS AUDIT

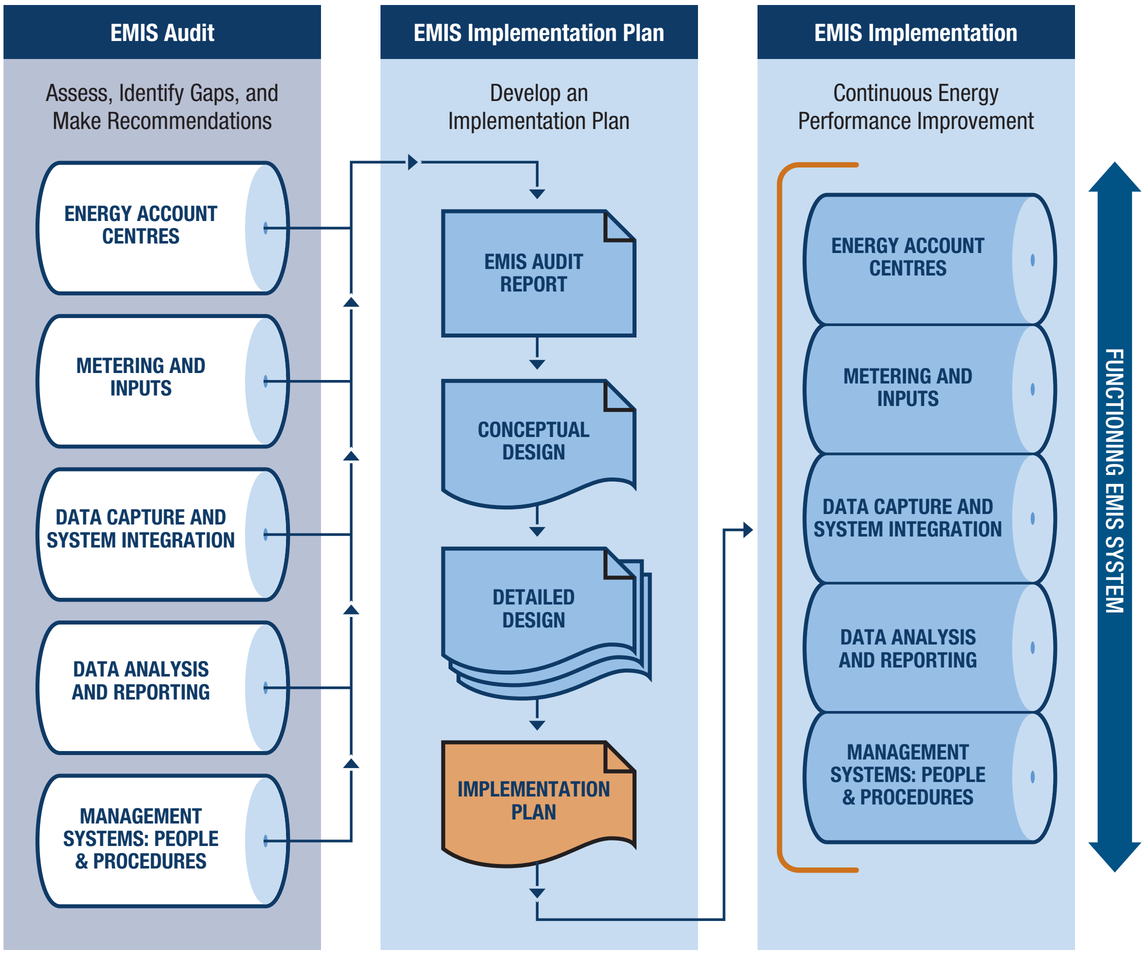
1. Introduction

The EMIS Audit is considered the first stage in planning an Energy Management Information System. The expectation is that approximate costs for each action will be identified and a business case and audit report developed, including all the recommendations, in order to be in a position to weigh the benefits and establish whether there is a financial case for EMIS implementation. The next step is to sell it to decision-makers within the organization. If the audit is successful, it will be followed by preparation of the implementation plan.

Part A covers the following:

- Choosing/Hiring the EMIS Auditor;
- Prior to the Audit: This section considers the activities of the auditor prior to the EMIS Audit. This will ensure that the time spent on-site is not wasted;
- EMIS Audit: This section (shown in Figure 2-1) provides instructions on how to carry out an audit and covers:
  - EMIS Purpose;
  - Management Systems and Procedures;
  - Definition of Energy Account Centres (EACs);
  - Metering and Data Capture;
  - Data Analysis and Reporting.
- Business Case: This section provides guidance on how to identify key findings of the EMIS Audit, report these findings to senior management and prepare a detailed Audit Report. It looks at:
  - Identifying Recommendations;
  - Estimating costs and savings of an EMIS implementation;
  - Reporting and Presenting the Business Case and developing the EMIS Audit Report.

Figure 2-1 First Phase of EMIS Implementation – EMIS Audit



2. Choosing/Hiring the EMIS Auditor

Unlike financial audits, which require an external auditor, organizations considering EMIS Audits have the preliminary decision of whether to undertake the work in-house, employ an external supplier, or use a hybrid approach wherein work is shared between an internal team and an outside advisor or advisors. The hybrid approach is the most likely to produce results; it combines both knowledge and experience with the process itself and the outside expertise of an EMIS auditor.

What are the skill sets required to undertake an EMIS Audit?

Table 2-1 provides a summary of the tasks included within the scope of an EMIS Audit. Ultimately it is up to the industrial organization to decide which tasks are best retained in-house and which should be outsourced.

Table 2-1 Tasks and Skills of an EMIS Auditor

Task	Key Skills	Comments
Defining the Purpose of EMIS	Facilitation skills	Using an outside advisor as facilitator will ensure that the definition includes all requirements and is not coloured by the organization's internal politics and power dynamics.
Management Systems and Procedures Assessment	Communication skills Familiarity with management systems	Better performed by an outside advisor who can bring knowledge and experience of other systems.
EAC Definition	Knowledge of process Knowledge of organizational responsibilities Knowledge of utility distribution systems	Best performed jointly where the organization provides the basic information about the site and the advisor provides knowledge on EAC design.
Metering and Data Capture Assessment	Knowledge of meter types Knowledge of data capture systems and standards Systems integration experience Knowledge of process to identify utility drivers	Could be undertaken in-house. Specific support on meter types and installation constraints may be found outside.
Data Analysis and Reporting Assessment	Experience with statistical data analysis Experience with business information systems and specific EMIS software	Should be provided by an outside advisor who has hands-on experience with EMIS and thus can bring knowledge of the most effective types of performance reporting.
Developing the Business Case	Financial analysis and modelling	Could be done externally, provided that all relevant costs can be identified.
Presenting the Findings	Presentation skills – both written and oral	The EMIS Audit will be of little value if recommendations are neither understood nor accepted.

Matters to Consider

- When the decision is taken to outsource some or all of the tasks, the following are key matters to consider: Be clear on what the scope of the audit should be – At what level is an EMIS to be implemented? As described earlier, there are a range of possible scopes for the implementation. Equally, recognize what skills and time are available in-house and what specific skills you need to source from outside. If you already have metering and data capture expertise in-house, look for an auditor who can add specific knowledge about analysis and reporting.
- Don't dismiss candidates without specific sector experience – You may struggle to identify EMIS auditors who have as much industry or sector-specific knowledge as your own staff. The most highly performing audit teams will include key experts from your own organization and an outside EMIS auditor who has complementary knowledge on metering, data capture, analysis and reporting, and integration of an EMIS within existing management systems.
- Look for EMIS or energy management experience – Anyone can learn sufficient terminology to speak EMIS auditing. Look for someone who asks relevant questions and listens more than they talk. These are the signs of a professional. But don't rely on words alone. Review what your prospective EMIS auditor has done, preferably for organizations of a similar scale and complexity. Check out the auditor's level of experience. An auditor in high demand will likely perform several audits a year, and focus solely on auditing. Check references too. A good auditor should have at least two or three outstanding testimonials from people who are willing to put their names on the line. Call references (if possible) rather than e-mailing, to ask about the auditor's attention to detail, etc.
- Look for strong communications skills – An auditor may have all the skills and experience in the world but if they are unable to communicate clearly the changes required and likely costs and benefits, the EMIS Audit will leave you none the wiser. You are likely going to be working closely with this person, anywhere from a few days to several weeks, depending on your company size and the audit scope. You also want to find someone likely to be flexible and responsive to your needs. Look for someone who is a good communicator, able to speak in your business language at your level. The auditor should be able to link the changes needed for EMIS implementation to the overall business objectives of your organization. Otherwise, your audit could be limited and serve more as a generic checklist.
- If you want to see what type of audit report you're going to get, ask to see some of your potential auditor's past work. To maintain confidentiality, they may need to sanitize the report, removing names, numbers, addresses, etc., before they give it to you. (If you get a report containing another organization's confidential information, you should strongly consider the fact that the potential auditor is not handling confidential information responsibly). Seek clear, concise documentation on what was audited, what was found, and the recommendations.

Hiring an EMIS Auditor

There are three main stages involved in hiring an EMIS auditor:

- Stage 1 – Identifying a shortlist of potential auditors;
- Stage 2 – Getting good quality proposals from them;
- Stage 3 – Evaluating the proposals consistently.

Since EMIS is an innovative technology, there is a limited range of potential service providers. Consult your provincial engineering association or visit Natural Resources Canada's Energy Management Services Directory at oee.nrcan.gc.ca/providers/index.cfm.

Once potential auditors have been identified, you should solicit bids from them. The most reliable method is to initiate a Request for Proposals (RFP). The RFP should be clearly written, set out the scope of the EMIS Audit and the specific inputs sought from the EMIS auditor, and contain sufficient information to allow them to prepare bids on a common basis. The RFP will, by necessity, include some commercially confidential information. For this reason you may wish to contact the potential auditors and obtain signed Confidentiality Agreements from them prior to the RFP.

The RFP should include the following information at a minimum:

- Site location and address;
- The intended scope of the EMIS Audit – Will it relate to the whole site or just part of it?
- What services you wish to contract – How much of the EMIS Audit scope will be outsourced?
- Industrial classification and types of products manufactured – This should be enough to inform the auditor on the complexity of the production processes;
- What are the existing utility systems and their capacities – (e.g., compressed air, boilers and steam generation, combined heat and power, refrigeration and cooling)?
- Minimum 12 months of monthly energy consumption data – This could be a summary of the invoiced amounts. Given the importance of demand charges in the overall costs structure, in addition to consumption, you should also provide the maximum or chargeable demand. This is to provide the auditor with an appreciation of the scale of the operations;
- Minimum of 12 months of monthly production data, allocated by product. Again, this is to inform the auditor of the scale and complexity of the operations;
- General administrative information –
    - Site contacts for technical issues and commercial issues;
    - Terms and Conditions of Engagement;
    - Payment terms;
    - Insurance requirements;
    - Whether proposals can be submitted electronically;
    - Any specific requirements concerning the structure/contents or presentation of the proposal.

Most professional operators will have their own data request templates specifying their information needs prior to submitting a proposal.

Once the bids have been received, they will have to be evaluated. The most formal methods of evaluation include:

- Defining the appropriate technical evaluation criteria;
- Applying relative scoring to each of the criteria;
- Ensuring that the proposals are evaluated by a team rather than an individual since this will reduce the possibility of bias;
- Reviewing the cost of the proposals and then dividing the costs by the technical score. This will give a measure of the value for money for each proposal and should be the key decision-making criterion.

The Request for Proposal Evaluation Criteria (Appendix A1) provides a template with suggested criteria and weightings for evaluating EMIS Audit proposals.

3. Prior to the EMIS Audit

This section deals with the contact the auditor should have with the client prior to the EMIS Audit and suggests the work that the auditor should have completed before going to the site. It addresses the information needs of the auditor and the preliminary data analysis.

There are likely to be constraints on the time available to an external auditor for an EMIS Audit, with a resulting pressure to complete as much as possible while on-site. Therefore, it is recommended that the auditor have access to information prior to arrival on-site in order to avoid wasting time on-site searching for relevant information, as well as to generate insights to help focus activity during the audit phase.

The auditor's time will be most effectively spent if the customer has prepared in advance as much of the data and information as the auditor will typically require during the audit, and if key individuals in the organizational hierarchy are available to meet with the auditor during site work.

Equally, the auditor should provide a suggested schedule for the on-site audit and a proposed list of individuals or those with specific functional responsibilities who should be met during the site work. The EMIS auditor's approach should be sufficiently flexible to allow the audit work to be adjusted to the time constraints faced by the site's management team.

Background Information for the EMIS Auditor

To improve the effectiveness of the support provided to the client, the client should be adequately prepared for the EMIS Audit. In practice, this means:

- Approving the approximate schedule prior to the audit. The auditor should anticipate meeting with representatives of the site's management team during the audit and it is imperative to secure their availability (see Table 2-2);

- Ensuring that they have all documentation related to current energy management systems and procedures available for the audit. Relevant documentation is likely to include one or more of the following:
  - Written Energy Management Policy (if available);
  - Improvement targets for organization;
  - Energy audit reports; and
  - Comparisons of consumption against energy drivers.
- Committing to a senior management presentation of the audit findings.
- Prior to the visit, data on the site's energy consumption and production should be made available in an electronic format and be forwarded to the EMIS auditor. This Manual and Tool includes a suggested Data Request Template, included as Appendix A2, which the auditor should send to the client. It is recommended that the auditor send the request to the client at least four weeks prior to the audit and have the information returned at least two weeks prior to the audit. This will ensure that the auditor has sufficient time to conduct the preliminary data analysis and that the client has time to collate any additional information for the audit.

Table 2-2 Meetings During the EMIS Audit

Who	Why	How Long
Senior Management Team	Initial "Kick-Off" Meeting Facilitated discussion on EMIS Purpose End of "Site Work Wrap-Up"	1 hour 2 hours 1.5 hours
Production Management	Current operational responsibilities Improvement systems in place Logical Energy Account Centres Energy awareness Key Performance Indicators Utility Drivers Process understanding	Variable, depends on scope and scale of responsibility 1 – 3 hours
Financial Management	Current accounting regime for energy costs Current accounting regime for other operational costs Energy Account Centres vs. Cost Centres Internal and external reporting requirements	1 – 2 hours

Who	Why	How Long
IT Management	Systems environment for data analysis and reporting Structure of existing data historians Availability of production data	2 – 3 hours
Engineering Management	Existing energy sub-metering and opportunities/ constraints on data capture systems Logical Energy Account Centres Key utility systems Project opportunities for energy saving	2 – 3 hours
Maintenance Management	Is energy conservation integrated within scheduled maintenance activities? What is process for reporting energy efficiency issues and taking corrective action?	1 hour
Production/Shift Supervisors	Energy awareness Opportunities for energy saving Information needs and preferred communication channels	Ad-hoc
Production/Shift Operators	Energy awareness Opportunities for energy saving Information needs and preferred communication channels	Ad-hoc

Information Requirements

Generally, three main classes of information should be sought from the site prior to the EMIS Audit. Remember: part of this information should have been provided during the bidding/proposal stage. When moving into the project, the auditor should only request those data elements not currently held.

Table 2-3 provides guidance on why certain items of information are being requested. A basic Data Request Template (Appendix A2) is provided to record the information.

Table 2-3 Basic Data Request

What	Why
GENERAL SITE INFORMATION	
Site Layout Drawing (A3/A4 scale)	Generally for use as a map when walking around the site to locate key process or utility equipment, such as the boiler plant, chiller plant, air compressors.
Any process schematic available	These will enable the auditor to understand process flows and products.
Gas, electricity, water, compressed air distribution drawings (if available) as either schematics or layouts	These will provide the auditor with an understanding of the complexity of the distribution system and the metering that already exists.
Site floor area (and volume)	Useful for estimating space heating loads as a function of overall loads.
Number of employees	Gives an approximate measure of the scale of operation.
Key contact persons	For site access, metering systems, trend data, etc.
Operating hours, by shift, daily, weekly, monthly, annual	Again, gives an approximate indication of the scale of operation and can be used as an indicator for the complexity of the analysis task required in ongoing management, as well as an indication of when energy is being consumed.
Brief details of principal products manufactured	This information is required to determine whether the product portfolio and production mix are going to be relevant utility drivers.
Utility System Capacities	Understanding of the types of utility systems (i.e., electrical, steam, gas, air, etc.) in operation — also useful for an approach to metering that would focus on the efficiency of utility generation.

What	Why
QUANTITATIVE DATA	
Utility Consumption and Costs: Monthly/ Weekly consumptions and costs for all utilities (e.g., electricity, gas, oil, water, effluent), ideally for a period of three years	More detail than requested in the proposal stage. Will be needed to perform the data analysis to determine the savings estimates from improved operational control.
Information regarding the tariffs applied to utilities (e.g., fixed charges, unit consumption charges, billing periods, taxes, demand and distribution charges)	Will be used to calculate the cost savings from EMIS implementation. Knowledge of the split between consumption and demand charges is critical for calculating cost savings.
Demand profiles if available showing typical summer, winter weekday and weekend demand for utilities (e.g., gas, electricity)	Are there opportunities for load profile management to reduce demand charges? Is there evidence of excessive consumption during non-productive periods?
SUB-METER INFORMATION	
Sub-metered consumption and demand (if available) data. If monthly, then three years; if weekly, then one year	This is to provide sufficient data points to allow regression analysis with a degree of confidence. Will allow calculation of savings potential at an EAC or sub-meter level as well as at site level.
PRODUCTION DATA	
Monthly/weekly production rates (tonnes manufactured, sales tonnes, sales units, raw materials inputs, etc.) of key product groups; ideally over the same period/frequency as the sub-metered data	In order to conduct the data analysis required to estimate savings potential, the auditor will require a consistent data set. Having energy data at a different timing or frequency to the production data will limit their ability to derive valuable insights.
MANAGEMENT SYSTEM INFORMATION	
Details of any production or environmental management systems in place, (e.g., Six Sigma, TPM, TQM, ISO14001)	An EMIS should be embedded within the context of an EnMS. The objective of this request is to understand whether the site has experience with operation of formal management systems. If Yes, then an EMIS should be integrated into existing systems and structures.
Details of any relevant environmental legislation at the federal, provincial or municipal level and impact on the site	These may act as either stimuli or constraints for EMIS implementation. Knowledge of the regulatory context is useful to understand the regulatory drivers the organization is facing.

Preliminary Analysis

It is useful to conduct a number of types of analysis prior to arriving on-site:

- Breakdown of energy consumption by utility – this will help define which utilities should be the focus for expenditure on new metering (Figure 2-2).
- Breakdown of consumption by cost (Figure 2-3): while consumption is one guide, expenditures by utility are also important. Does reviewing the contributions to the cost base change the focus for expenditure on metering? Can pseudo-metering be part of the solution?
- Trend Analysis: this (Figure 2-4) is useful to determine whether energy consumption is generally increasing or decreasing and may also highlight seasonal variations, which can be indicators for the types of utility drivers to include in the preliminary analysis. It is possible to plot average monthly consumptions for the year to date in order to hide the influence of seasonal factors and show only the underlying trends in consumption.
- Single regressions (Figure 2-5): using tools such as the Data Analysis Add-in (which in some cases can be added to the computer through Excel options) the auditor should compare the variations in energy consumption for each utility against production and environmental factors. This will help to isolate the key utility drivers at the site level. If sub-metered energy data and the associated production breakdown are provided, then the auditor should attempt regressions at lower levels in the organization's energy consumption.
- Multiple regressions: multiple regressions (Figure 2-6) should only be attempted if the auditor has discovered correlations using single regressions and these make some sense, i.e., there appears to be some justification for the energy consumption and the variable to be related.

Figure 2-2
Breakdown of Energy Consumption

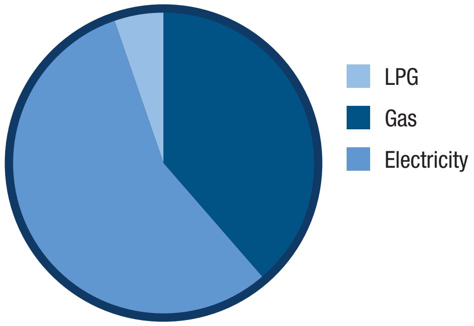


Figure 2-3
Breakdown of Energy Cost

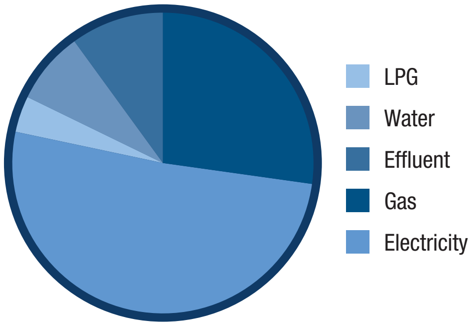
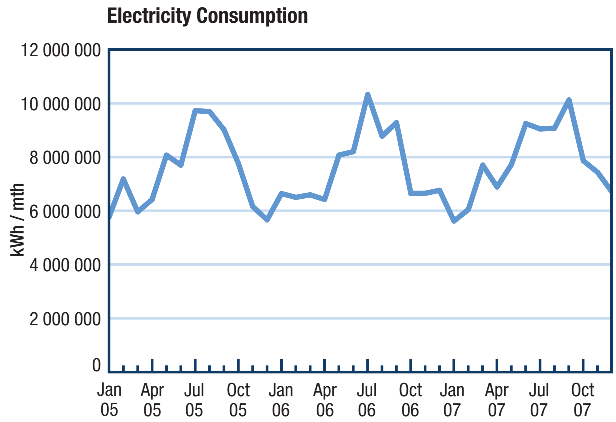


Figure 2-4 Electricity Consumption Trends

Raw Data



Smoothed Data

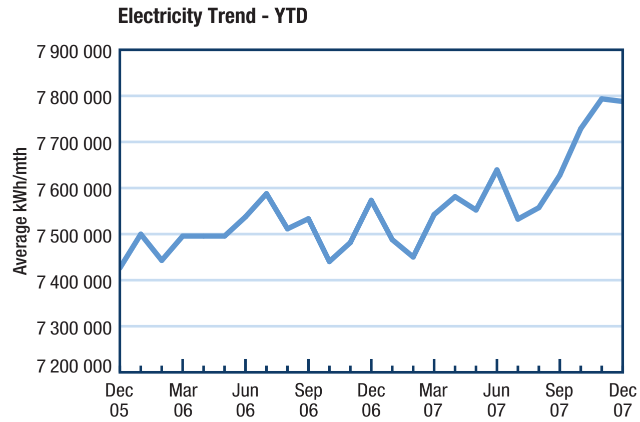


Figure 2-5
Single Regression Electricity

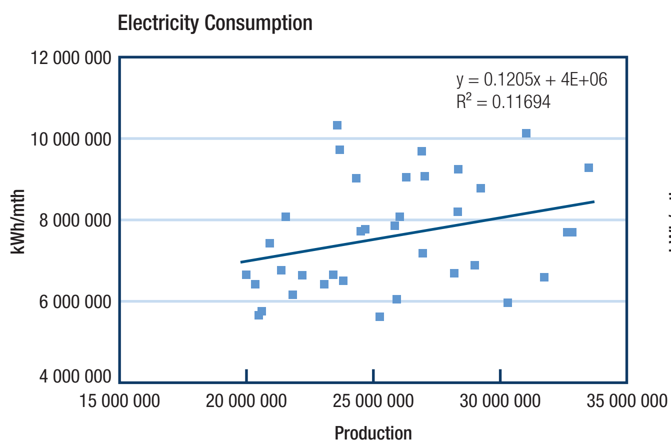
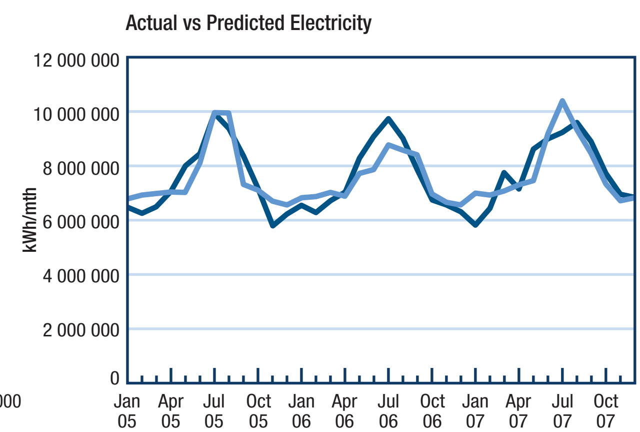


Figure 2-6
Actual and Predicted (from Multiple Regressions)



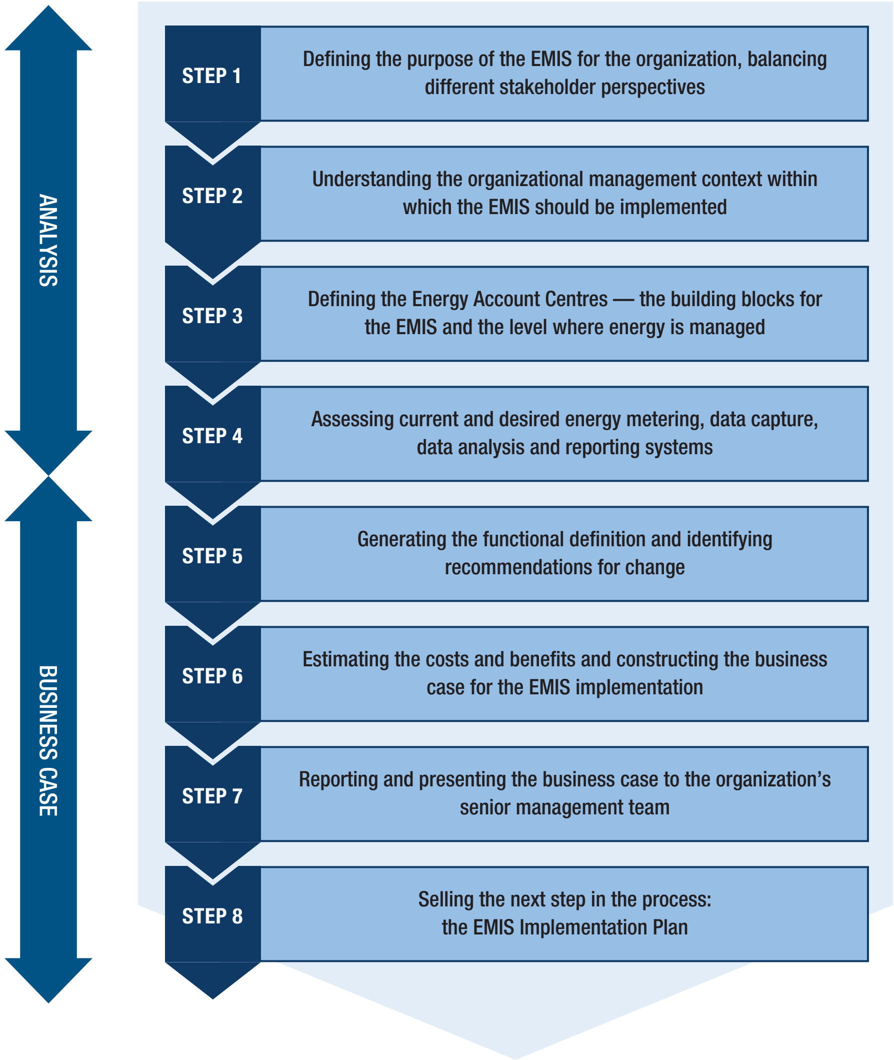
Correlations – a word of warning!

With regressions, a good correlation does not always mean that the variable is a relevant utility driver, as both the variable and the energy consumption could be influenced by some other independent variable.

4. EMIS Audit

In general terms, an EMIS Audit consists of two stages: the Analysis (steps 1 to 4) and the Business Case (steps 5 to 8), as shown in Figure 2-7.

Figure 2-7 EMIS Audit – Key Steps



Numerous assessment templates and tools included in this Manual can be used to assist the auditor throughout the audit. They can be used for mature organizations as a comparison against what is currently the case, and for novice organizations as a description of what should be the case. Remember that these templates are not an end in themselves; their purpose is to provide a structured assessment methodology and to identify gaps in the current practices of the client site. These gaps should then guide the auditor in identifying appropriate recommendations for change.

4.1 Step 1 – Defining the Purpose of an EMIS

The first step in an EMIS Audit is to define the purpose of implementing an EMIS in the client's organization. Discussions with key stakeholders within the organization should include identifying who is accountable for energy management and who is empowered to make decisions that have an impact on energy performance.

The auditor should recognize that prior to the audit, the management team and other stakeholders at the client site may have only a limited understanding of what an EMIS is. The process that the auditor uses to define the purpose can represent an important step in increasing awareness and understanding about the benefits of EMIS to them.

One technique for defining the purpose of an EMIS is drawn from "soft systems methodologies" developed by Peter Checkland[1] and others, which historically have been used in the design and implementation of information systems in organizational settings.

The technique starts with the auditor and the management team developing what is termed a "root definition" for the EMIS. Root definitions take the form of:

A system to which "Q" sets a purpose "P" in order to achieve "R",

Where:

- P = the Purpose of an EMIS, i.e., summarized by the question "What?" – What is the EMIS to achieve for the organization?
- Q = Any Qualifiers? Best summarized by the question "How" – How is the EMIS to do this and what are the limitations on the operation of EMIS?
- R = the Results, best summarized by the question "Why?" – Why is this organization interested in EMIS and what results do they expect?

Different people within the organization will have different perspectives on P, Q and R and an understanding of the range of Ps ascribed and the range of Rs expected helps to frame the overall scope of the EMIS, and can inform both the subsequent stages of the assessment process and the development of recommendations.

The following are examples of how different functions responsible within an organization may express different root definitions for EMIS:

Finance Manager

"A system to deliver better cost allocation to our products, through the measurement of energy consumption in order to improve the profitability of our production."

Plant Manager

"A system to improve the operational efficiency of our site through identification and elimination of energy wastage in order to reduce our overall production costs."

[1] Checkland P.B. and Howell S. *Information, systems and information systems: making sense of the field*. Toronto: John Wiley & Sons, 1998.

Environmental Manager
"A system to improve energy efficiency through the management of energy performance in order to comply with the environmental permit/licence requirements of our regulatory agency."

Marketing Manager
"A system to improve how customers perceive our company by demonstrating our concern about our impact on the environment in order to increase our market share."

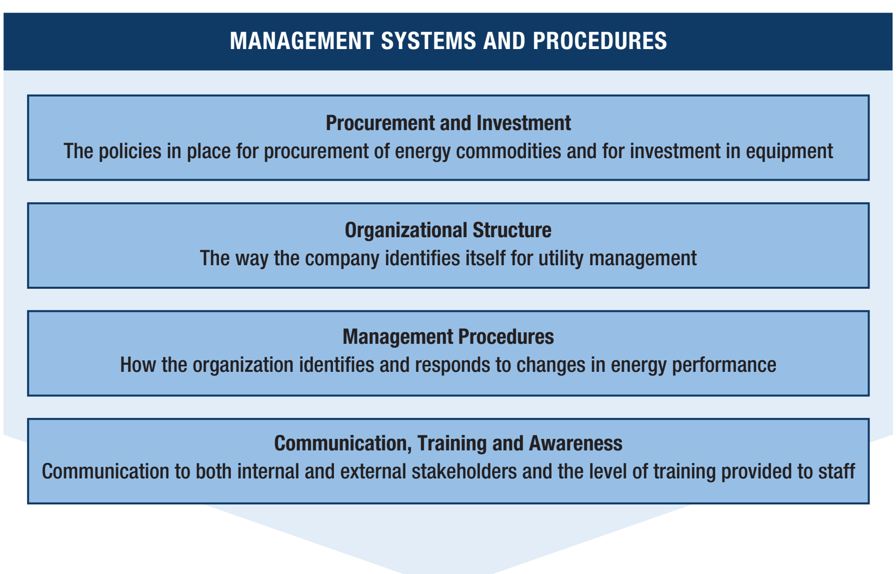
While none of these sample definitions are contradictory, each expresses something different about the expected deliverables from the EMIS and hence can inform the overall system design.

It is best to try to develop the root definition with the senior management team as a form of facilitated discussion with the objective of achieving consensus typically at the kick-off meeting on the first day. It is equally possible to do this through individual discussions and then to present the various views to the management team at the wrap-up meeting with the objective of achieving consensus.

4.2 Step 2 – Understanding the Current Organizational Management Systems

Understanding the current management systems and procedures provides the context for an EMIS. In this step, the management systems and procedures are assessed to ensure the client has the organizational elements in place to translate the insights gained from data analysis and reporting into corrective action (Figure 2-8). If the client has an existing utility management system this means assessing the system from the perspective of embedding an EMIS into it. If the client does not currently operate dedicated energy or utility management, this means reviewing the management systems in place for manufacturing, environment or quality improvement and identifying how utility management could either be embedded into these or could adopt similar methodologies and structures.

Figure 2-8 Management Systems and Procedures Assessment – Dimensions



Each of the dimensions in Figure 2-8 is addressed in detail below and guidance is provided in the use of the assessment criteria. The actual assessment templates are found in Appendix A3 and can be used with Spreadsheet E1, which captures data and creates pie charts, and will compare scores against ideal scores.

Procurement and Investment

There are four recognized procurement and investment criteria:

1. Policy to specify energy performance in all major investments: in addition to production rates, product quality, etc., are there any energy performance specifications determined for any new plant?
2. Specific procurement policies for efficient products (e.g., motors, lighting, controls): are there specific policies in place to purchase only high-efficiency items, such as motors and lighting when replacements are necessary?
3. Use of data and analysis in procurement of utilities: is there evidence of analysis of energy commodity procurement and management from the viewpoint of ensuring that the conditions are in place to address: i) operational requirements and maximum flexibility of the facility; ii) negotiation of optimal contracts; iii) ensuring that daily scheduling and interruptible options are taken advantage of; and iv) bills are analyzed for errors and detailed consumption data is kept.
4. Maintenance budgets include repairs to energy systems: does the maintenance budget include specific line items of expenditure for repairs and improvements to energy systems?

Organizational Structure

Assessing the organizational structure covers five criteria:

1. Explicit energy management program: is there an explicit energy management program or guiding vision for energy management activities at the site?
2. Objectives set for utility performance improvement: have objectives been set? These may also be termed strategic targets for the organization.
3. Explicit management commitment: is the site's senior management committed to improving energy performance and, if so, what form does this commitment take?
4. Energy teams established and key stakeholders included: is there an energy management team or some other organizational grouping tasked with oversight of the energy management program and, if so, what is its composition?
5. Accountability for energy performance devolved to production/operations: are line managers, operations team and operators held accountable to their managers for energy performance? If the production and operations staff are held accountable for performance, are they also empowered to initiate changes to improve performance?

Management Procedures

Management procedures should be assessed against seven criteria:

1. Regular reviews of energy performance: is the review of energy performance aligned with the reporting frequency of the data analysis systems?
2. Actions assigned and followed-up: are actions assigned to individuals as part of the review process and then followed-up in subsequent reviews?
3. Staff incentives: Is staff motivated to improve the energy performance of the equipment under their control, and what form do the incentives or motivations take?
4. Sufficient resources allocated: have sufficient resources been allocated to operate a management system in terms of management time?
5. Regular reviews: how frequently is the operation of the management system reviewed to ensure that it continues to be effective?
6. Operational/Maintenance schedules: do operations or maintenance schedules exist to reduce energy performance, e.g., start-up/shut-down lists, preventive maintenance linked to energy consumption?
7. Active reporting systems: is there a reporting system for utility waste issues (e.g., steam leaks, compressed air leaks) that facilitate their identification and correction? For example, are triggers sent to initiate a corrective work order?

Communication, Training and Awareness

The following criteria should be considered when evaluating the communication, training and awareness component:

1. Training of operational staff: Do operational staff receive training on the utility performance of the plant items under their control?
2. Training of energy team and senior management: do the management and energy team(s) have sufficient knowledge of utility use to manage this resource?
3. Communication of energy performance to all staff: how is utility performance communicated to staff? Internal newsletters are one example.
4. Energy performance included in reports to external stakeholders: is any information on utility performance communicated to external stakeholders (e.g., emissions, savings achieved)?
5. Awareness campaigns undertaken regularly: are awareness campaigns held regularly reminding staff of their obligations to reduce utility consumption and providing guidance on how this can be achieved?

4.3 Step 3 – Defining the Energy Account Centres

Defining the Energy Account Centres (EACs) is absolutely fundamental to EMIS Implementation. Energy Account Centres (EACs) are the building blocks of an EMIS; they are the level in the organization at which energy performance is managed. This means that the site must be able to measure all energy flows at the EAC level, identify the factors that influence energy performance and assign accountability to a single person, sometimes known as the Energy Management Champion, within the management structure. Defining the EACs in the site is one of the most important actions of the EMIS auditor. EACs need to be logical levels from which to manage energy resource use; they should also reflect organizational structures and responsibilities within the client organization.

There is no precise definition of what an Energy Account Centre looks like; this is determined by the type of production process, the size of the energy flows, and the division of responsibility in the organization. An EAC may be an individual item of process equipment, a production area or process or an entire production line. The only requirements for EACs are:

- Associated drivers can be measured;
- A production variable is identifiable;
- Ownership of EAC cost can be established;
- Accountability can be assigned;
- EAC cost ownership fits the company's existing structures;
- Cost savings justify the costs of energy measurement.

Cost savings are important. Remember, you may need multiple meters on a single utility, such as electricity or gas, in order to measure all of the energy flows into a single EAC, and if the measurement costs outweigh the potential value that such measurement could generate, then the scale of the EAC is too small.

There are effectively four stages to EAC definition:

Stage 1 – Mapping the EAC to the production process;

Stage 2 – Aligning the EACs with the organizational responsibilities;

Stage 3 – Verifying that the EACs can be measured individually, given the constraints of the utility distribution systems; and

Stage 4 – The sanity check – ensuring that the costs of metering at the EAC level are justifiable given the expected savings.

Mapping the Energy Account Centres to the Process

The first stage will typically involve discussions between the EMIS auditor and the site's own process

perspective, decisions are governed by:

- The energy consumption of the unit operations within the process: if certain unit operations are not especially energy intensive they can be grouped together within an EAC. If a particular unit operation is energy intensive it may justify being an EAC in its own right.
- The ability to measure inputs and/or outputs to the process. The energy performance of the EACs is measured through its relationship with the utility drivers, i.e., the production, environmental and operational drivers. For an EAC to be manageable, the utility drivers relevant to that account centre must be measurable.

In addition to the process EACs, the utility generation account centres should also be defined. These will typically be:

- Boiler house or steam generation systems;
- Compressed air generation systems;
- Refrigeration systems;
- Air handling units for large scale space heating/air conditioning; and
- Water treatment and wastewater treatment plants.

The energy consumption of these account centres will typically be targeted against the supply of the utility to the process (e.g., boiler natural gas against steam generated, refrigeration electricity against the supply of chilled water).

Aligning the Energy Account Centres

Once the EACs have been initially defined, the next step is to map them to the organizational responsibilities. Each account centre should fall under the responsibility of one individual in the organizational hierarchy, so that they can be held accountable for performance.

Based on the process, a single individual may have responsibility for multiple account centres. In these circumstances, the EACs can be grouped into departments, where the individual has departmental responsibility. This individual can then be provided with reporting at both an EAC and a departmental level, where the performance of the department is the aggregate of the performance of the EACs within that department.

The energy performance of the department becomes the sum of the energy performance of the individual EACs and the energy performance of the site is the sum of the energy performance of the departments. It is then possible to report on actual consumption, target consumption, variance and CUSUM (cumulative sum of the differences) all the way up through the organization. Figure 2-9 displays this hierarchy.

Utility Distribution Constraints

In the previous two stages, the EACs have been defined on an ideal basis, taking into consideration both the process and the organizational demands. This is the point at which compromises start to occur. The first constraint is likely to be the layout of the utility distribution systems, which may limit the ability to devise a metering system allowing for the measurement of all utility flows (or indeed utility drivers) into and out of an EAC.

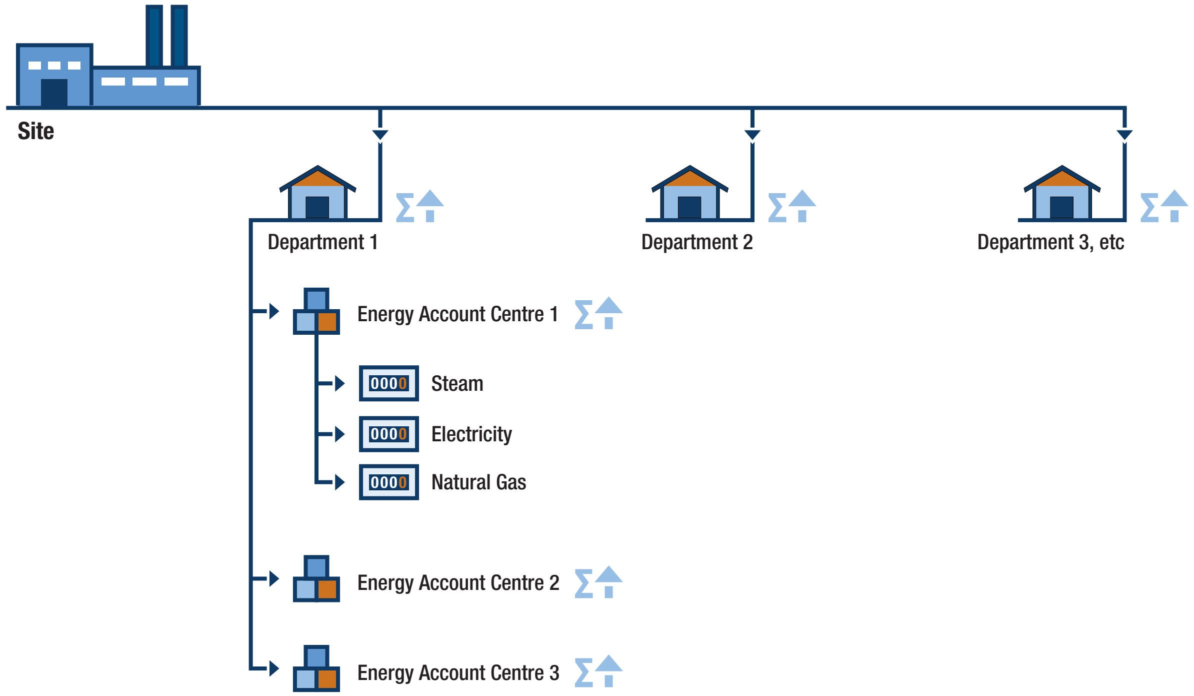
If this situation occurs, it may be necessary to consolidate EACs into larger groupings if that would allow energy flows or utility drivers to be measured.

The Sanity Check

The final check on the Energy Account Centre structure happens after the metering and data capture assessment. As will be explained later, one of the purposes of the metering and data capture assessment is to determine any changes to energy or utility driver metering.

If the number of meters and hence the probable cost of the new meters is high, it may be difficult to justify their inclusion in the EMIS system on the grounds of potential cost savings alone. Again, the solution in this situation is to consolidate EACs, reviewing those EACs with the smallest potential consumption first.

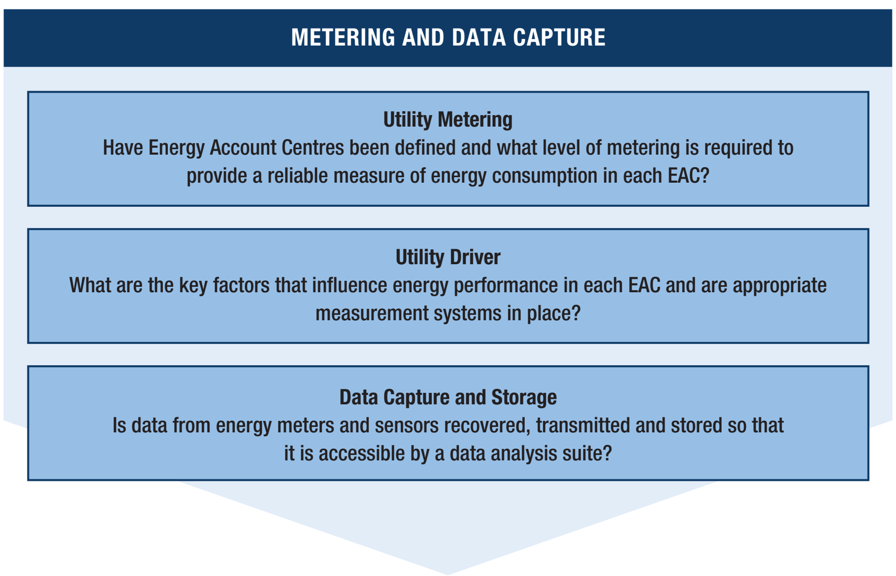
Figure 2-9 Breakdown of Site Departments and EACs



4.4 Step 4 – Assessing Metering, Data Capture and Data Analysis and Reporting

Metering and Data Capture include the elements of the energy management information system that provide raw data for analysis and encompass the energy meters and other process sensors, as well as the data capture systems (Figure 2-10). This assessment asks the question: does the site have sufficient meters of adequate quality to provide robust measurements of energy flows into each of the Energy Account Centres identified? A tabulated assessment matrix for each of the areas shown in Figure 2-10 is included in Appendix A3.

Figure 2-10 Metering and Data Capture Assessment – Dimensions



Utility Meters

The primary sensing elements (meters, sensors, etc.) are the source and foundation of an EMIS. Their proper design, installation and maintenance will impact the accuracy and reliability of the utility data. The assessment tool, found in Appendix A3, provides an overall indication of the suitability of the current metering systems and where further effort is required to “shore-up” the front-end metering systems.

The utility meters assessment can be broken down into five categories:

1. Key Energy Account Centres (EACs) – facilities should be assessed on their ability to divide their operations into appropriate EACs.

2. Sub-meter Coverage on EACs – represents the amount of energy consumption actually being metered within an EAC. While a facility has their main key utilities (gas, electric, etc.) metered, sub-meters measure utility feeds into specific EACs. The largest sources of energy consumption should be measured within all EACs. Auditors should compile a list of all utilities feeding each EAC. Sub-metering Coverage is represented as a percentage of sub-meter measured energy consumption versus the facility's actual energy consumption.

3. Meter Types Appropriate for Function – this assessment is to ensure that the meters being used have the correct range, measurement units and process conditions for the application and surrounding environment. Facilities are scored on a 0 to 10 scale based on their ability to use the appropriate meters for the application.

4. Meter Installation Satisfactory – this assessment is to ensure that the mechanical installation of the meters is correct, the metering systems are easy to maintain, calibrate, calibration records are kept and their piping is appropriate for the meter. Facilities will be scored on a 0 to 5 scale based on these requirements.

5. Meter Accuracy and Repeatability – is the final assessment for utility meters. As meters start to age, their performance will begin to decline unless proper maintenance, calibration and periodic inspections are performed. There should be reference materials that illustrate proper calibration and maintenance procedures. As well, external factors and process conditions may contribute to errors in measurement.

Some things to remember when assessing meters are:

- Meters that measure volumetric gases or vapours often require external pressure and temperature compensation. Natural gas measurement using turbine meters requires pressure and temperature compensation to reference conditions.
- It is ideal to measure mass rate when the desired outcome is mass total. Steam, for example, is typically measured as mass rate and then converted to energy total.
- The range of highest to lowest flow rates that can be accurately measured are called rangeability or turn-down ratio.
- Metering signals must be correctly compensated for in the host (PLC) system. An example would be meter k-factor, which is used to convert pulse trains into measured volumes.
- The ratios of PT (voltage or potential transformers) and CT (current transformers) must match the receiving devices.
- The ranges of PT and CT must be appropriate for measurement against name plate ratings on electrical equipment.
- When serial data is transmitted, requirements to handle roll-over of any register values in the meter or host (PLC) system must be confirmed. An example is when passing short integer values.

Utility Drivers

Utility drivers are factors that can influence how much energy is being used for a given EAC. Three types of utility drivers are recognized:

1. Production drivers typically include:
   - Production volumes;
   - Product type, if different operating conditions exist based on product type;
   - Building occupancy hours.
2. Environmental drivers are features of the environment in which production takes place; generally these are beyond the control of the organization. Typical environmental drivers are:
   - Ambient conditions such as temperature and relative humidity;
   - Derived ambient conditions such as Heating Degree days and Cooling Degree Days.
3. Operational drivers are the operational conditions within the direct control of the organization and which influence energy consumption. They include:
   - Temperature set points;
   - Pressure set points;
   - Production status (i.e., whether a line is running).

Identifying the correct drivers to use depends on basic knowledge of the production process so it is useful to involve the site's own experts in the process of identifying relevant drivers. The risk the auditor faces when following this route is that the expert will reel off a list of some 10-15 factors, most of which cannot be measured on an ongoing basis. The skill of the auditor lies in narrowing down such long lists to those that have the greatest influence and recognizing that the impact of the remaining factors will generally be lost in the "normal" variation of energy performance.

There are three things to consider when assessing utility drivers:

- That the key drivers have been identified;
- That measurement of the driver is appropriate. The same issues about sensor type, accuracy, repeatability and rangeability apply to driver measurement, as much as to energy measurement; and
- That the drivers can be aligned in time with the energy consumption measurements (e.g., if energy metering is providing integrated total consumptions on a 15-minute basis, then the driver is either totalled or averaged over the same time period.)

Drivers that are identified and selected should have an impact on the process of the system. Each driver's impact on the energy consumption of the system should be identified and measured properly.

Data Capture and Storage

Data Capture and Storage involves recovering data from the meters so they can be used in analyzing the facility's energy consumption. Some examples of Data Capture and Storage systems are:

- Programmable Logic Controllers (PLC) such as AB RSLogix platforms. These are often used for capturing the data;
- PC based databases such as MS Access and SQL Server. These types of systems are used for storing data;
- Remote Terminal Units (RTUs). They are used primarily for capturing data and performing industry specific metering calculations (AGA and ISO); and
- Rockwell software applications such as Data Historian.

The five different areas in Data Capture and Storage that can be assessed are:

1. Effort in Meter Reading and Data Entry – deals with the assessment of the manual effort required to collect and store data from the meters in the facility. The less manual effort required, the more successful the outcome.

2. Error Checking Mechanisms Included – deals with ensuring that error checking exists in the data capture and storage systems and the assessment of the error checking systems that are in place. The more automated these systems are, the more successful the outcome. An important consideration is that totalizers should be configured for proper range and roll-over, since error checking would not necessarily uncover that issue.

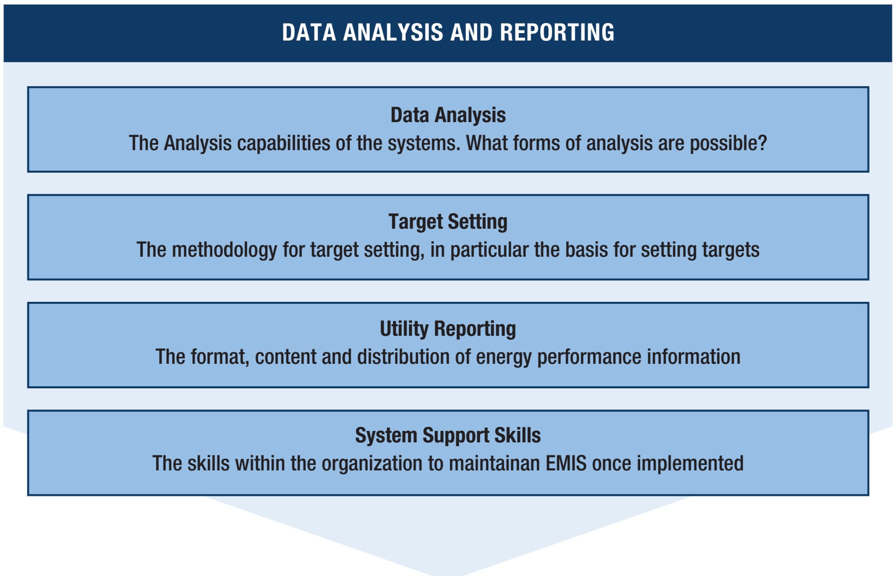
3. Frequency of Data Capture Appropriate – assesses whether the frequency at which the system captures data is suitable for the EAC. Ideally, the Data Capture System should be password-protected in order to prevent operators from being able to manipulate the system but still allow maintenance personnel to understand and troubleshoot it.

4. Degrees of Separation between Meters and Storage – assesses the reliability of the Data Storage System in its ability to automatically collect and store data.

5. Historical Data Storage Sufficient – deals with the size of the Data Storage System. The size of the system must be appropriate in order to be able to report on shifts, days, months, and even years of data.

Scoring in all areas requires subjective opinion during the audit.

Figure 2-11 Data Analysis and Reporting Assessment - Dimensions



Data Analysis and Reporting Assessment

Data analysis and reporting at the facility are assessed in terms of people, practices, software and tools (Figure 2-11). The assessment is to ensure that the installed analysis and reporting tools and software are capable of providing the necessary analysis and reports to effectively target energy consumption for each Energy Account Centre.

Processes are considered in the distribution and communication of this analysis and performance against targets.

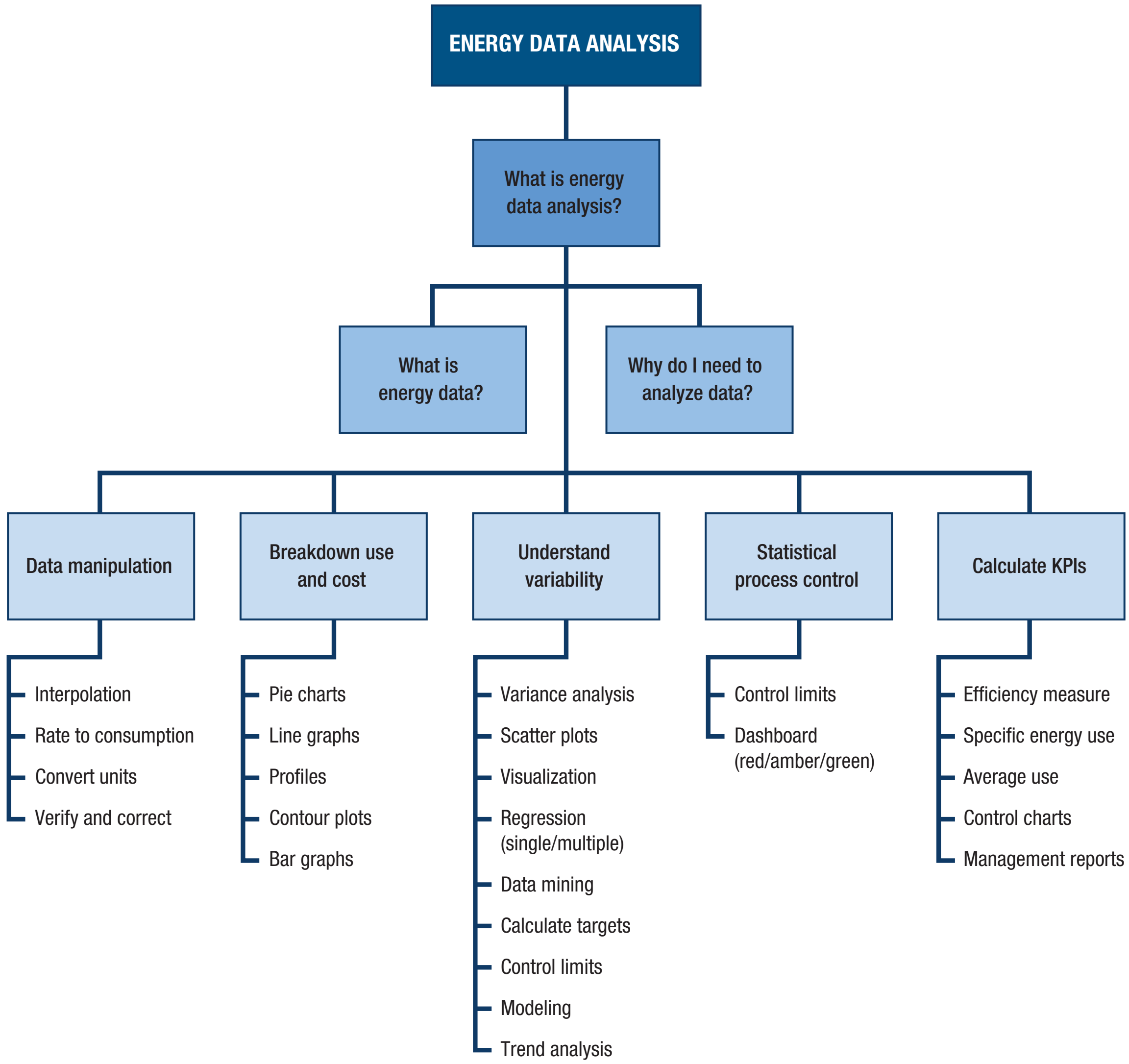
People are required to maintain the reporting system and to ensure that reports are distributed and communicated effectively. This section includes an assessment of the system support skills necessary to operate and maintain an EMIS.

As before, each of the components in Figure 2-11 is addressed in detail and guidance provided in the use of the assessment criteria. A tabulated assessment matrix for each area is included in Appendix A3.

Data Analysis

Energy data analysis includes the manipulation of data on energy consumption and drivers in order to determine energy consumption, targets and KPIs over a given period. The primary aims of data manipulation are shown in Figure 2-12 and are adapted from Natural Resources Canada's *EMIS Handbook – Energy Management Information Systems* (see PART D).

Figure 2-12 Objectives of Data Analysis



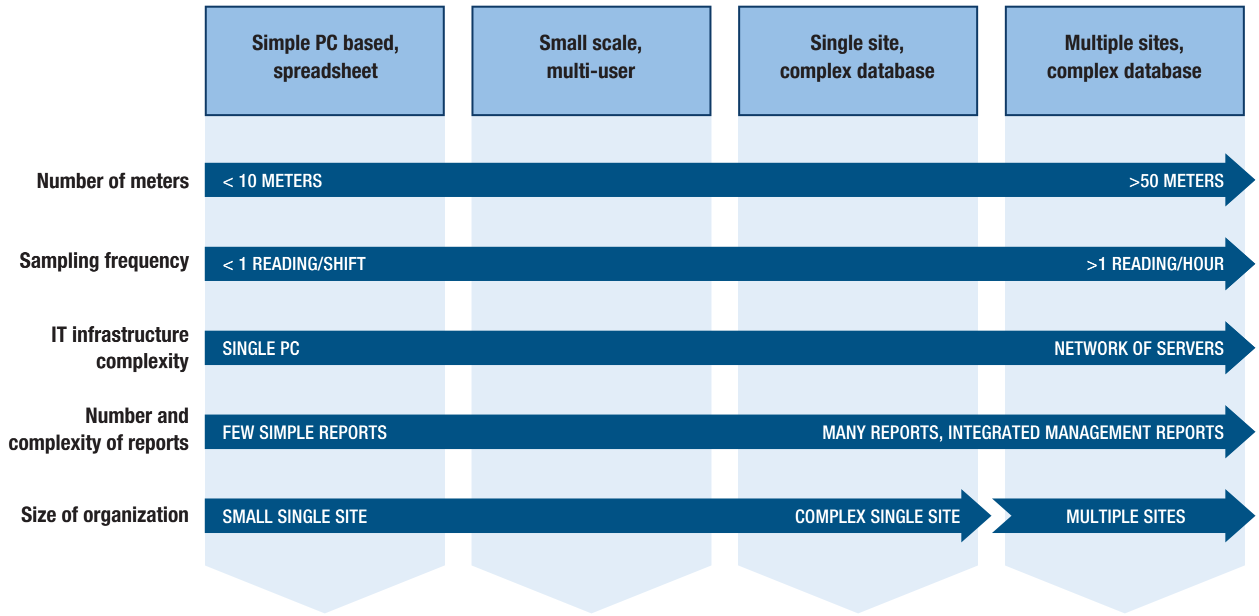
Five criteria should be considered when assessing data analysis activities:

1. Scale of system appropriate to complexity of analysis – As part of an EMIS Audit, it is necessary to determine what analysis is required for all parts of the organization by the client. These requirements may include targeting on a shift by shift basis, trend analysis, control plots, bill validation, load profiling. It is necessary to determine whether the EMIS system is capable of providing the level and detail of analysis required by the client.

Suggested analysis considerations are shown in Figure 2-13 below.

Consideration must also be given to whether the EMIS is to provide analysis for a large number of meters and whether it is required to serve a single operational site or multiple locations.

Figure 2-13 EMIS System Complexity



2. System Architecture – Is the data historian directly interrogated by the EMIS or is it necessary to extract data from the data historian and process it independently?

3. Comparison of performance against drivers – Is the energy consumption compared and correlated against utility drivers such as production rate, product mix, ambient temperature or occupancy? Are the appropriate drivers used? Utility drivers are independent variables that have a direct impact on energy consumption (e.g., production rate, product mix, occupancy and ambient temperature). It cannot be assumed that these drivers have a significant impact on consumption. The best practice is to perform multiple regressions against a number of drivers and then only consider those drivers which have a statistically significant relationship.

4. Data analysis over flexible time frames – Can data analysis be performed on a daily, weekly or monthly basis using the same database, i.e., is it possible to change the time frame over which analysis is performed without having to create a new database? Can data for analysis be selected over a flexible time period or between any start and finish date and time?

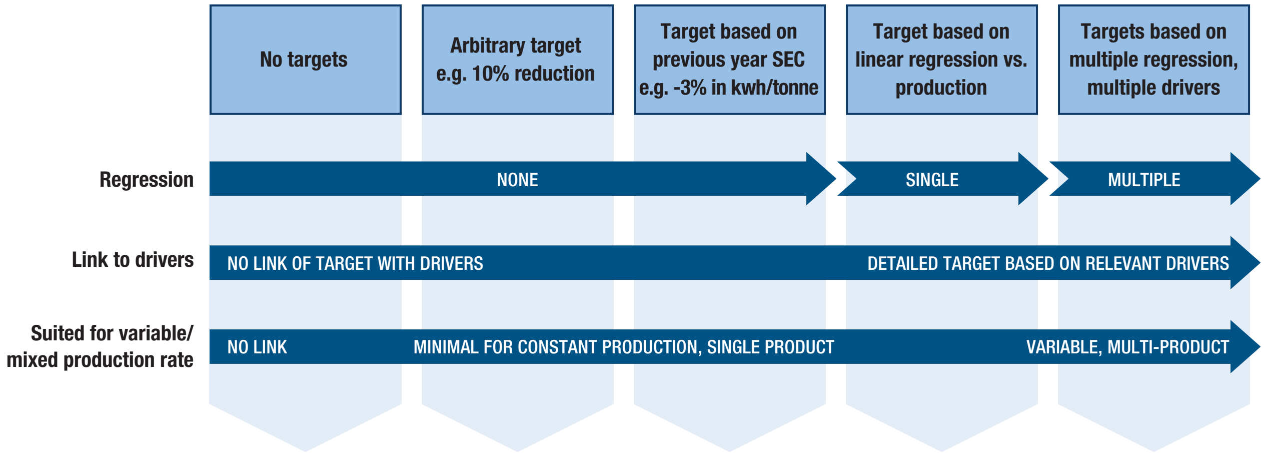
5. Data aggregation over flexible time periods – Is it possible to aggregate consumption and provide reports in terms of consumption over a shift, day, week, month, etc.?

Target Setting

Assessment of target-setting involves five criteria:

1. Targets based on analysis of data – Are targets set based on a set number or on some form of analysis of consumption and utility drivers? (Figure 2-14)

Figure 2-14 Spectrum of Targets



2. Realistic targets defined – Are the targets realistically achievable within a meaningful time frame? It should also be considered whether targets are too slack and, as such, may not provide incentive for improvement.

3. Targets accepted by EAC owners – Have targets been set remotely and imposed on local managers or supervisors? Are the targets realistic and accepted?

4. EAC owner accountable for performance and empowered to make improvements – Is the EAC owner directly responsible for performance or does someone else have control? Are they empowered to implement improvement measures?

5. Target setting process inclusive – Have the individuals who will be accountable for the performance against target been involved in the target-setting process? Is there local ownership of the targets?

Utility/Energy Performance Reporting

Seven criteria are included in evaluating this aspect of an EMIS:

1. Production of performance reports – Can reports be produced automatically and by several people?
2. Timeliness of reports – How quickly are performance reports available after the period of measurement?
3. User friendliness of reports – Are the reports understood by users and do they contain data that have been mutually agreed upon?
4. Content of reports – Is the data or information in the reports sufficient to stimulate action and discrete enough to direct the focus of the action?
5. Readership of reports – Are the reports available to all or restricted to a small set of key users? Are the reports paper-based or live and generated directly from the data?
6. Ability to roll up performance – Is it possible to drill down and look at performance from a site level, to department, to EAC, and is the data consistent through the hierarchy?
7. Integration with other IT systems – Is the data in the performance reports available to other internal IT systems?

System Support Skills

An EMIS is a system involving hardware for data capture (e.g., meters and networks), software for analysis and reporting, and people — the management system part of EMIS. In this section we look purely at the technical skills required to maintain the hardware and software.

Five criteria are included in evaluating this aspect of an EMIS:

1. Capability to maintain meters and data capture system – Metering systems and data capture networks require routine maintenance and can require repairs;
2. Data capture, analysis and reporting on a single network – Are the systems on a single network where components can readily communicate?
3. IT environment up to date – Are operating systems and software up to date and maintained? Is technical support available if required?
4. Capability to maintain and operate an EMIS – Is there the ability to correct data, reset targets and modify reports?
5. Technical skills to analyze data and set targets – Data analysis uses statistical methods and target setting often uses regression analysis. Do the people available and involved have the skills necessary to analyze the data and set targets?

Management Tools for Auditors

Prior to leaving the site the auditor should verify that they have gained sufficient information and understanding of the site to be able to demonstrate that they have met the criteria when drafting the EMIS Audit Report (Step 7). The Audit Checklist (Appendix A4) contains the key steps the auditor should complete.

Following the site time, the auditor will need to prepare the report. It is reasonable to expect that an EMIS report will be completed within two weeks following the end of the site work. Another rule of thumb is that the auditor should typically spend one day of reporting time per four days of site work.

Guidelines for the amount of total site time spent on each activity are in Table 2-4.

Table 2-4 Approximate Time Requirements of Each Audit Activity

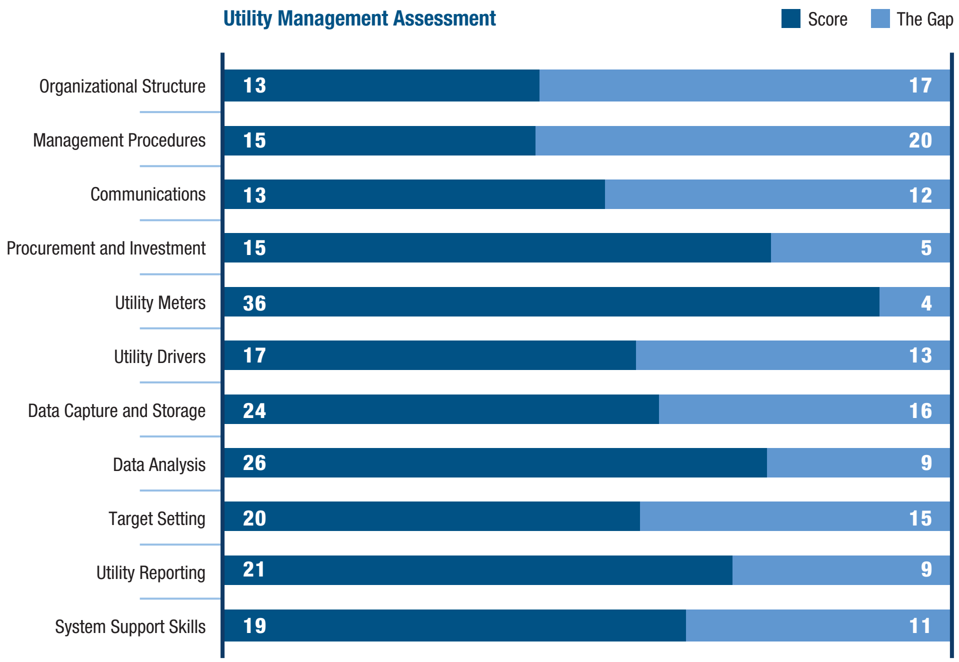
Activity	Approximate % of Site Time
Purpose Definition	10%
Management Systems and Procedures Assessment	20%
Definition of EACs	10%
Metering Audit (including EACs)	15%
Data Capture Systems Assessment	15%
Data Analysis and Reporting Systems Assessment	20%
Development of Initial Recommendations and Preparation for Wrap-up Meeting	10%

4.5 Step 5 – Business Case: Identifying Recommendations

The Business Case is developed through the identification of feasible and desirable changes. Recommendations should be framed within the overall objectives and aspirations of the client organization and be consistent with the importance of its utility costs. A $2,000,000 EMIS implementation plan will be unacceptable to an organization whose energy spending is $5,000,000 per year.

By gathering information on the client and using the assessment templates from Step 4, the auditor should be able to score the client against the multiple criteria and arrive at a quantitative and qualitative assessment of the profile of the client site, in terms of their current EMIS and energy management program. This will provide the basis for developing recommendations appropriate to the site. Figure 2-15 and Spreadsheet E1 show the typical output of an EMIS Audit presented as a Gap Analysis.

Figure 2-15 Gap Analysis from an EMIS Audit



There are four main stages in developing recommendations, which are expanded upon in the following sections:

Stage 1 – Generating the functional definition of the EMIS **–** this should explain to the organization what the EMIS will do and how it will do it.

Stage 2 – Identifying the recommended changes required – these will be the concrete actions that the organization should take and will involve:

- Changes to metering systems;
- Changes to data capture and storage systems;
- Changes to data analysis and reporting systems;
- Actions in terms of management systems and procedures; and
- Actions in terms of training, awareness and communications.

Stage 3 – Prioritizing the recommended changes and providing cost estimates where relevant.

Stage 4 – Calculating and presenting the savings from the EMIS (discussed in Step 6).

Generating the functional definition of the EMIS

The most appropriate EMIS for an organization depends on a number of key factors:

- The size and scale of the organization;
- The defined purpose of the EMIS; and
- The budget available for implementation.

It is possible to define five levels of an EMIS, from the most basic spreadsheet-based system at Level 1 to a real-time data capture and analysis system (closely integrated to the site's control system) at Level 5. This is shown in Table 2-5. In generating a functional definition for the EMIS, the auditor may make reference to its various levels to identify and communicate what would be the most appropriate level of system for the organization. As with any classification, the levels are not cast in stone and systems that share features between two levels are equally acceptable.

The functional definition should build on the definition of purpose for the EMIS that was agreed upon with the site and should be used both to communicate what the EMIS would "look" like for the site and to provide a framework for the recommendations for change.

The key deliverables from an EMIS should include:

- Early detection of poor performance;
- Support for decision making;
- Effective performance reporting;
- Auditing of historical operations;
- Identification and justification of energy projects;
- Evidence of success;
- Support for energy budgeting and management accounting; and
- Provision of energy data to other systems.

For a small organization, all of these deliverables could easily be achieved through a Level 1 system. At the other end of the spectrum, if you are responsible for managing the energy on a multi-million dollar production facility or facilities with over 100 energy meters per facility and capturing data at 15-minute intervals, a spreadsheet would not be sufficiently powerful to meet your needs; you would be seeking a Level 3 system or above.

Another factor to consider when generating the functional specifications (and to a lesser extent when considering the overall purpose of the EMIS) is the available budget for action. The total cost of an EMIS will be highly dependent on:

- The level of metering and data capture systems the organization has at the outset;
- Whether there is existing network infrastructure in place to carry the data from the meters to the data historian; and
- If the system is a single site or enterprise system managing multiple sites.

The client organization will still have to invest capital and sometimes, more importantly, management time and other staff resources to gain maximum benefit. When developing the functional specification, the auditor should ensure that the proposed system is within the budgetary capability of the client organization, given the expected level of benefits to the organization from EMIS implementation.

Table 2-5 EMIS Levels

EMIS Level	Outline Description	Qualifying Features
V	Real time data system closely integrated with SCADA or other process control systems. Minute by minute data frequency. Network based system with multiple users. Users can call on a suite of performance reports that can be user-configured to enable data mining and analysis.	Real time data entry and analysis. Flexible data frequencies. Integration with SCADA or process control systems. Single site but can cascade upper level data for corporate reporting.
IV	Not real time but data system operating at flexible analysis intervals (e.g., hourly, shift based, daily). Data entry automatic with energy consumption and other variables on 15 minute-1 hour frequencies and production data on hourly or shift based. Web or intranet based with multiple users. A suite of performance reports can be user configured to enable data analysis.	Automatic data entry and analysis. Flexible data frequencies. Single site but can cascade upper level data for corporate reporting.
III	Data system operating at fixed analysis intervals (e.g., shift based, daily, weekly, monthly). Data entry automatic with energy consumption and other variables on 15 minute-1 hour frequencies and production data on shift based or daily basis. Web or intranet based with multiple users. A suite of performance reports can be user configured to enable data analysis.	Automatic data entry and analysis. Fixed analysis intervals. Fixed data frequencies. Single site but can cascade upper level data for corporate reporting.
II	Database system operating at fixed analysis intervals (e.g., daily, weekly, monthly). Data entry either manual or automatic with daily consumption or meter readings for utilities and other environmental variables and daily data for production. Stand-alone or network-based but requires specific software on user's machines to access the data. Limited analysis and reporting capabilities (i.e., trending, specific energy ratios).	Stand-alone or network-based. Manual or automatic data entry (able to import standard data files from metering systems). Single site system.
I	Spreadsheet or equivalent based system relying on manual data entry. Weekly or monthly data frequencies. Stand-alone system used by system owner and reports shown to other stakeholders.	Stand-alone system. Manual data entry. Single-site system.

Identifying Recommendations

Based on the main gaps identified through the EMIS Audit and the functional definition for the system, the auditor should identify the main recommendations for change using the following headings:

- Metering – What are the EACs identified for the site? What additional meters are required to measure the energy consumption for each EAC? What are the approximate sizes of the fluid meters and what are the expected sizes of the electricity meters? For the meters, what level of sophistication is required for the primary measurement?
- Data Capture – How will the data be transferred from the meters to the data historian? Is new network infrastructure required?
- Data Analysis – What are the data analysis requirements for the EMIS? How frequently should analysis take place?
- Reporting – What reports are required? Who are the target audience for the reports and what are their specific information requirements? How are reports to be communicated to key stakeholders — on a “push” or “pull” basis?
- Management Systems – What changes to the management systems are required to enable the organization to exploit information delivered by an EMIS?
- Training, Awareness and Communications – What management and employee development programs are required for the organization to operate an EMIS?

In a conventional energy audit the auditor might be expected to identify both costs and benefits at a recommendation level; this is not the case for an EMIS. The expectation is that approximate costs of each action will be identified; however, the benefits should be estimated for EMIS implementation, which would include all the recommendations.

The EMIS Audit is the first stage in a program of activities leading to EMIS implementation. If the audit is successful it will be followed by preparation of the implementation plan. This means that in the audit stage, a detailed design of EMIS is not expected, as this would fall naturally in the EMIS implementation planning stage. The level of detail required in the recommendations should be sufficient to:

- Communicate the concept of EMIS to the client organization;
- Identify the actions necessary to breach the gap between the current status of EMIS at the client and the appropriate level of EMIS for them;
- Develop budget costing for the program;
- Identify any preconditions associated with each recommendation (i.e., What are the underlying requirements for the recommendation to be implemented?)

Prioritization

As a precursor to preparing the EMIS Implementation Plan, it is recommended that the auditor also provide guidance in the EMIS Audit Report on the overall time-scales necessary for the subsequent stages leading to EMIS implementation. Detailed information is not required, as the purpose of providing this information is mainly to manage the expectations of the client organization regarding the overall time-scale necessary for EMIS implementation.

Moving on from the time-scales, recommendations should be prioritized, identifying for each the order in which they should be addressed (i.e., 0–4 months, 4–8 months, 8–12 months, 12–18 months, 18+ months).

4.6 Step 6 – Estimating Benefits and Costs

Estimating the benefits and costs of EMIS implementation should include the following: estimating EMIS savings using statistical techniques such as regression analysis and additional savings that may be sustained by an EMIS such as behavioural changes. The costs will include changes to metering and data capture systems, implementation of data analysis, and reporting routines and management skills development.

Estimating Savings

Spreadsheet E2 provides an example of estimating savings using single or multiple regression techniques as the basis. The methodology for savings estimates is as follows:

- Perform the linear regressions using data over three years if using monthly data or one year if using weekly data;
- Generate the performance equation for the best fit line;
- Calculate the predicted consumption from the performance equation;
- Assume all positive variances (i.e., where actual consumption is in excess of the predicted consumption) can be eliminated through the EMIS. In numerical terms this represents 50 percent of the current level of variation in energy performance;
- Compare sum of positive variances to total consumption over the period and this becomes the initial estimate of savings potential expressed as a percentage of current consumption.

This gives a conservative savings estimate and only considers reducing operational variability. This is only one of the ways EMIS implementation can reduce the energy consumption of a process or site, the other two methods being “system operation improvements” and “equipment improvements.” While equipment improvements relate to installation of new technologies to change the overall performance characteristics of the process, systems operations improvements are less evident. Typically, systems operations improvements will result from:

- Parameter changes (i.e., changing the operating set points of the processes);
- Behavioural changes (i.e., changing the way people operate equipment, for example, reinforcing standard operational procedures for start up and shut down);
- Maintenance changes (i.e., increasing the frequency of preventative maintenance on equipment to reduce wastage; for example, compressed air leakage reduction, steam trap surveys).

The estimating savings methodology does not necessarily address these forms of saving and, if data analysis is the only methodology used, these savings will not be identified.

When reviewing the process and talking to the operators, the EMIS auditor should develop an awareness of possible areas for systems operations improvements and gain an impression of the likely potential for savings that these would lead to. This increased understanding might then be used to flex the savings estimate gained from data analysis. In any event, the principle of conservative savings estimates should be maintained.

Estimating Costs

The main concern regarding estimating costs is the level of accuracy expected.

While it is in the nature of most auditors to want to determine the most accurate level of costs and savings possible during the EMIS Audit, this is unnecessary. At this stage in the process, estimating costs within a margin of error of +/- 30 percent is sufficient to determine whether there is a strong enough case for the organization to proceed to the next stage — the "EMIS implementation plan."

If this is the case, there is no need to approach potential vendors of metering, data capture or data analysis and reporting systems to obtain budget costs for implementation. The use of figures gained from past experience or general rules of thumb should be sufficient.

The audit report asks for the costs associated with each recommendation, and the auditor should make a best estimate of where the costs will fall in the overall program. We would advise the auditor to provide the savings estimate for the EMIS program as a whole and not try to assign proportions of the overall savings to metering, data analysis, training and awareness, etc., as this may encourage the client to "cherry pick" and not commit to a full implementation.

Constructing the Business Case

Organizations make financial decisions on the basis of projected economics. Spreadsheet E2 – the EMIS Business Case Tool should assist EMIS auditors in constructing the business case for an EMIS.

The tool has been built on the principles of discounted cash flow and asks the auditor to generate the inputs on the costs and benefits side. The tool also contains functionality to generate sensitivity analysis and assess the impact of flexing initial assumptions on the amount and timing of cash flows.

4.7 Step 7 – Reporting and Presenting the Business Case

One of the commitments of the EMIS auditor is to present and report to the site sponsor and senior management team on the findings, prior to leaving the site, and in more detail within the report. This will ensure that when the EMIS Audit Report is delivered it contains no major surprises for the organization and hence should be accepted without need for major revisions. The objective of this presentation is to gain immediate feedback on any recommendations that the auditor is considering for inclusion in the EMIS Audit Report and should include:

- Agreed purpose and functional definition of the EMIS;
- Estimated benefits;
- How the proposed EMIS will integrate with existing systems;
- Management systems and procedures actions.

The suggested contents of the **EMIS Audit Report** are:

1. An overview of the current situation with respect to energy management information including:
   - Energy consumption: a summary of energy consumption by energy type, preliminary energy balances, costs and trends;
   - Systems: an assessment of the existing metering and data capture systems in the plant for generating energy performance information that is useful for eventual management of the EACs;
   - Data analysis and reporting: an assessment of the data analysis and reporting systems in the facility for storing, analyzing and providing actionable information to relevant personnel in the facility, for purposes of managing and reporting on energy performance;
   - Organizational capacity: an assessment of the current organizational capacity to manage energy through existing or new management systems.
2. A preliminary description of the recommended EMIS including, where applicable:
   - Purpose: a clear purpose statement and functional objectives of the EMIS;
   - Energy Account Centres: a preliminary design for EACs that considers the energy consumption centres, cost accounting structure and organizational accountabilities;
   - Metering and data capture: hardware, instrumentation, sub-meters, DCS/SCADA, data historian, networks and IT infrastructure etc. required to effectively measure performance at the EAC level, including energy and associated drivers of energy use;
   - Data analysis and reporting: data analysis, reporting, monitoring, optimization and decision support tools, as well as systems integration with existing IT systems and with existing management and reporting systems;
   - Management systems: required changes to existing management systems, structures and/or accountabilities, as well as personnel training required for effective management of energy as a result of improvements to energy management information.

3. An estimate of the preliminary cost and projected savings from implementation of the proposed EMIS including:
   - Benefits: a description of the potential benefits of implementation of an EMIS or its components including:
     - Direct energy savings that can be achieved through reduced variability of energy usage, reduction in standing load and waste and/or improved efficiency;
     - Specific low cost/no-cost eligible projects that can be implemented as a result of the proposed EMIS if applicable;
   - Costs: an estimate of the projected cost to install, maintain and operate the proposed EMIS;
   - Project Management: a description of the approach, team and schedule for implementation of the proposed EMIS.
4. Definition of scope for the EMIS Implementation Plan:
   - The cost to implement the proposed EMIS plan as described in Part B of the Manual and Tool.

A suggested structure for the EMIS Audit Report is shown on the following page. Much of the information obtained when using the EMIS Audit Assessment Tool (Spreadsheet E1) can be attached to or incorporated into the final report.

EMIS Audit Report – Suggested Table of Contents

1 Introduction

2 Executive Summary

3 Current Situation

- 3.1 Energy Consumption and Costs
- 3.2 Existing Systems
- 3.3 Existing Metering and Data Capture Systems
- 3.4 Existing Data Analysis and Reporting Systems
- 3.5 Existing Organizational Capacity

4 EMIS Recommendations

- 4.1 Purpose of the EMIS
- 4.2 EMIS Functional Definition
- 4.3 Energy Account Centres
- 4.4 Recommendations Tables:
  - Data Capture Recommendations
  - Data Analysis Recommendations
  - Reporting Recommendations
  - Management Systems and Procedures Recommendations
  - Training, Awareness and Communications Recommendations

5 The Business Case

- 5.1 Business Case Methods and Assumptions
- 5.2 Financial Returns

6 Next Steps

Appendices/Excel Worksheet

- EMIS Evaluation Matrix (A1)
- Data Request Template (A2)
- Assessment Criteria and Scoring (A3)
- EMIS Audit Assessment Tool (E1)
- EMIS Business Case Tool (E2)

4.8 Step 8 – Selling the Implementation Plan

The EMIS Audit is the first stage in a process to determine the business value of an EMIS and hence persuade customers to implement it. As well, the purpose of an EMIS Audit is to "sell" the idea of an EMIS Implementation Plan to the customer. If the initial business case and audit report look promising, the next step is an EMIS Implementation Plan, as described in PART B.

B

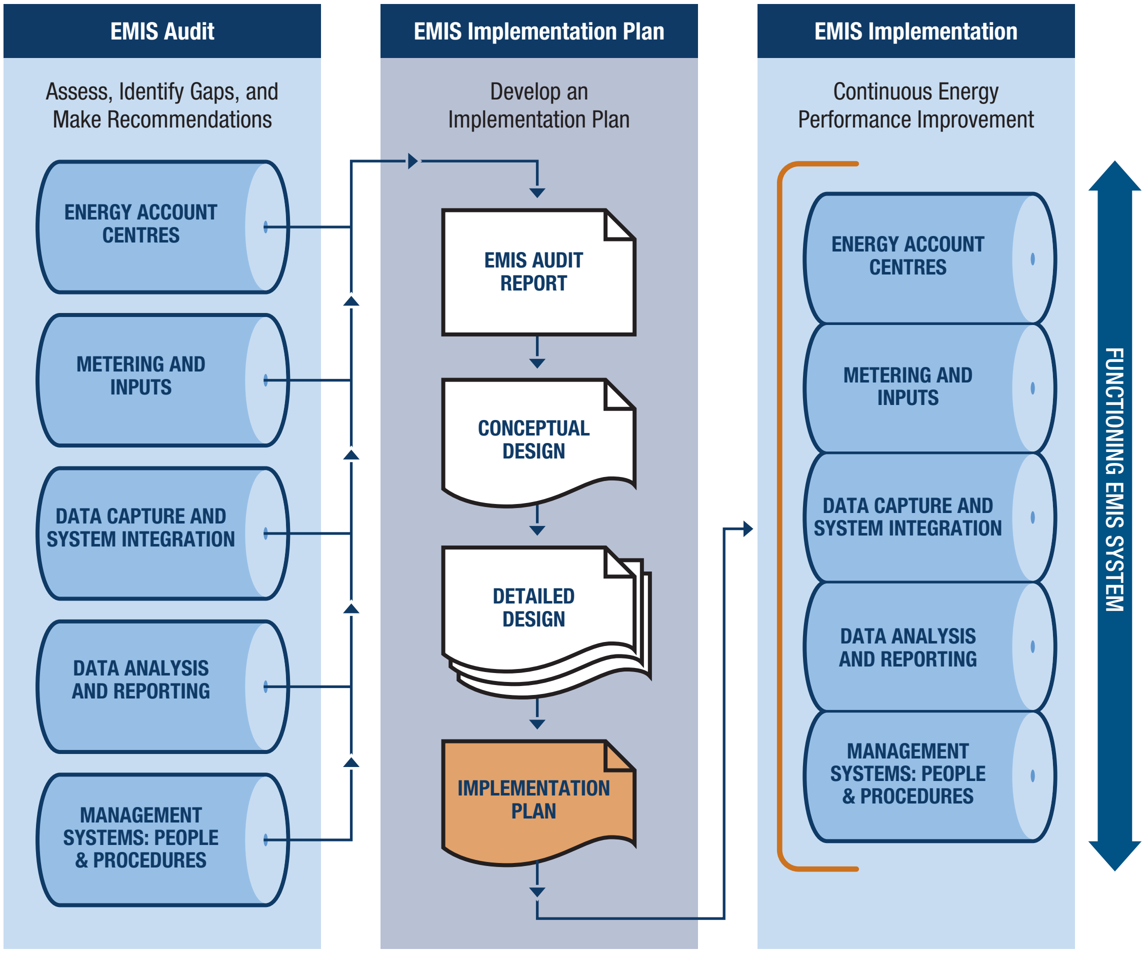
IMPLEMENTATION PLAN

PART B - IMPLEMENTATION PLAN

1. Introduction

The Implementation Plan phase (Figure 3-1) is the second stage in planning an Energy Management Information System (EMIS). It provides a roadmap for successfully implementing an EMIS.

Figure 3-1 Second Phase of EMIS Implementation – EMIS Implementation Plan



The EMIS Implementation Plan phase builds on the EMIS structure introduced in the EMIS Audit, presents accurate costs for implementation and details the scope of the project and the resources needed by the organization to manage it. It provides a schedule to implement and manage an EMIS. Table 3-1 summarizes the outputs from the EMIS Audit and the conceptual and detailed design activities of the implementation phase, and shows how they are linked.

Table 3-1: Outputs from EMIS Audit Through to EMIS Implementation Plan

	EMIS Audit	EMIS Implementation Plan	
EMIS ELEMENT	**AUDIT RESULTS**	**CONCEPTUAL DESIGN**	**DETAILED DESIGN**
Business Level Overview	▪ Draft EMIS purpose ▪ Preliminary Energy Account Centre (EAC) structure ▪ Projected savings ▪ Recommendations	▪ Approval to implement the EMIS as a business system to manage energy ▪ Approval of EMIS purpose statement ▪ Approval of the overall EMIS scope showing structure, people and economic summary ▪ Approval of proposed EAC owners and potential allocation of resources	▪ Not applicable
Energy Account Centres	▪ Preliminary EAC structure	▪ Master view of EAC structure ▪ Location of EACs ▪ EAC owners ▪ EAC layout with metering	▪ Final detailed EAC structure
Metering and Inputs	▪ Gap analysis results ▪ Metering and utility driver measurements identified ▪ Cost and approach determined	▪ Illustrations of EACs with metering and inputs identified. ▪ Utility metering single-line diagrams and high level metering requirements ▪ List of new metering and energy driver inputs.	▪ Metering take-off completed ▪ Specifications for metering and installation requirements ▪ Supplier quotations obtained ▪ Installation resources (internal/external) identified ▪ Cost estimate finalized

	EMIS Audit	EMIS Implementation Plan	
Data Capture and System Integration	▪ Gap analysis results ▪ Data capture/storage and system integration issues identified ▪ Preliminary options and costs determined	▪ Data flow mapping from meter and utility drivers to reporting and analysis tools ▪ List of data capture and storage options for all meters and inputs ▪ All existing communication protocols identified	▪ EAC Architecture Diagrams ▪ Specifications for data capture and system integration requirements completed ▪ Suppliers' quotations obtained ▪ Installation resources identified (internal/ external) ▪ Cost estimate finalized
Data Analysis and Reporting	▪ Gap analysis results ▪ Scope of data analysis, reporting requirements ▪ Performance equation and target setting support requirements ▪ Preliminary options/ costs	▪ Requirements to align new meters and inputs to data capture method ▪ List of new hardware or software required ▪ Map of current and proposed energy information flow ▪ Summary of users and report types, inputs and calculations required	▪ Software functional specifications developed ▪ Suppliers' quotations obtained ▪ Required resources (internal/external) identified ▪ Cost estimate finalized
Management Systems: People and Procedures	▪ Gap analysis of current capability to manage energy; systems, organization and people ▪ Recommended organizational approach to managing energy ▪ Preliminary estimate of training and management support to establish energy management system	▪ Framework and management system for managing energy established ▪ Roles, responsibilities, and allocation of resources defined ▪ Skills and potential skill gaps identified	▪ Training needs analysis conducted ▪ Training needs specification defined ▪ New program, procedures, policies, and process operating guide produced ▪ Communication plan developed ▪ Costs estimate finalized

2. Purpose and Organization

The purpose of Part B is to assist companies to carry out a conceptual and detailed design of an EMIS, and develop a detailed project management plan for its successful implementation. The objective is to have detailed work packages for each of the elements of the EMIS structure introduced in the EMIS Audit as follows:

- Energy Account Centres (EACs)
- Meters and Inputs
- Data Capture and Systems Integration
- Data Analysis and Reporting
- Management Structure: People and Procedures

These work packages can be used to outsource individual elements or when choosing a turn-key EMIS solution. The Implementation Plan identifies and explains cost savings and risks at a level of detail that will enable decision making for implementation.

Part B is presented as a functional and instructional guide and has three sections:

- **Developing the Conceptual Design:** describes how to translate insights gained from the Audit Report into a clearly developed EMIS conceptual design. It covers the development of a business-level overview of the EMIS to identify Energy Account Centres (EACs), the building blocks of EMIS, then the development of draft work packages for each EMIS component. This step will facilitate input from key stakeholders before committing resources to the detailed design of the EMIS.
- **Defining Detailed Design Including Specifications and Bids:** describes how to build on your conceptual design using templates to produce detailed work packages and accurate cost estimates. The detailed work packages created in this section can be used to specify work for external service providers and suppliers and to acquire bids.
- **Preparing the Implementation Plan:** takes the contents developed in previous sections to build the Implementation Plan. This section prepares the Implementation Plan for final delivery and readies your organization for working within an operational Energy Management Information System (EMIS). The appendices in Part C provide detailed technical reference material and templates for preparing the Implementation Plan.

3. Developing the Conceptual Design

The Conceptual Design serves as a basis for the EMIS and the starting point for developing an EMIS Implementation Plan. The EMIS conceptual design should facilitate sign-off from management and key decision makers within the organization. Output from the conceptual design stage serves as input for the detailed design.

In this section, you will first define those key stakeholders and individuals who will approve all aspects of the conceptual design. You will then create a conceptual design for each element of your EMIS structure consisting of the following aspects or work packages:

- Business-Level Overview
- Energy Account Centres (EACs): Master EAC structure and individual EAC detail
- Metering and Inputs
- Data Capture and System Integration
- Data Analysis and Reporting
- Management Systems: People and Procedures

Use the templates, worksheets, appendices and examples provided to define stakeholders and create work packages for each of the elements. Each section provides guidance on creating these conceptual design materials.

Stakeholder Definition and Conceptual Design Sign-Off

It is important to get input from key stakeholders on the conceptual design of the EMIS before committing resources to the detailed design of your system. Sign-off on the conceptual design is a critical input to the detailed design phase. The following activities should be part of the conceptual design phase to ensure success:

- Identify the key stakeholder groups and individuals required for conceptual design approval
- What issues should be presented and discussed with them?
- What information must be prepared to facilitate these discussions?
- What specific decisions, sign-offs, and inputs must result from the meeting(s) to finalize the conceptual design stage?

Use the Stakeholder Definition, Information Needs and Decision Worksheet (Appendix B5) to identify the types of stakeholders, issues, conceptual design outputs and decisions that may be required to get sign-off on your conceptual design.

Template for Conceptual Design Elements

Throughout this section, you will generate the conceptual design for each element in the EMIS structure. In many cases, you will already have sufficient detail in the EMIS Audit to produce the conceptual design. If so, at this stage you must only communicate and formalize what was defined in the EMIS Audit and receive buy-in from key stakeholders. Figure 3-2 shows a sample work package template. It can be used for each element and includes these headings:

- **Objective:** purpose of this conceptual design element
- **Exhibit:** diagram or flowchart representing the EAC structure
- **Activities:** description of activities required to complete the conceptual design
- **Stakeholders:** list of people with roles and responsibilities in this process area
- **Design Considerations:** description of technical aspects, parameters and limitations, business requirements, risks, and human performance factors
- **Conceptual Design Outputs:** a checklist to ensure you have everything required to proceed to the Detailed Design.

Figure 3-2 Work Package Template

Title

Objective

- Describe this area of the EMIS process

Exhibit

- Insert diagram or flowchart

Activities

- Describe the functions and tasks included in this work area

Stakeholders

- List the people who have a role or responsibility related to this process

Design Considerations

- List factors to consider

Conceptual Design Outputs

- List any additional references, documents, or approvals required to support the conceptual design of this work package

The following sections provide instructions on how to use the above template to develop a conceptual design for each of the work packages.

Business-Level Overview

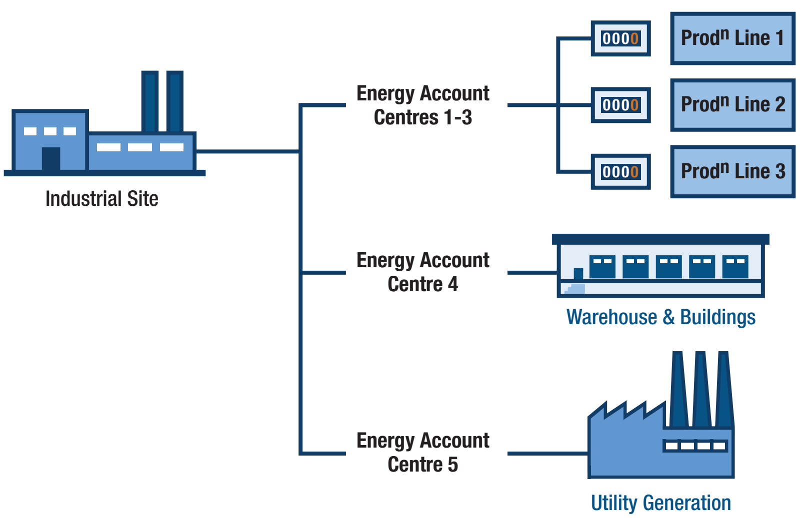
Objective

The business-level overview presents the EMIS structure from a business perspective to decision makers for the purpose of obtaining sign-off on key elements of the system. The business-level overview defines:

- EMIS purpose statement (e.g., the purpose of our Energy Management Information System is to reduce energy consumption while optimizing production. We will achieve this through improved management control and accountability for energy consumption at all levels of the organization.)
- EMIS structure and organizational requirements
- EMIS economic summary and key economic drivers for implementing the system

Exhibit

Figure 3-3 Example of an EMIS Business Level Overview Diagram



MANAGER	APPROX. ENERGY $/YEAR
Manager 1	$6-million
Manager 2	$1-million
Manager 3	$1-million

MANAGER	APPROX. ENERGY $/YEAR
Manager 4	$3-million

MANAGER	APPROX. ENERGY $/YEAR
Manager 5	$4-million *Includes onsite generation

EMIS ANNUAL ECONOMIC SUMMARY	
Site Energy Costs	$15,000,000.00
Potential Savings	$750,000.00
Projected EMIS Implementation Cost	$1,000,000.00
EMIS Operating Cost	$35,000.00

Activities

Produce and review the following with decision makers:

- Draft EMIS Purpose Statement. This may have been completed during the EMIS Audit. Revisit the Purpose Statement now to obtain its approval. It serves as a guide for your EMIS design.
- EMIS Business-Level Overview diagram (Figure 3-3). This diagram shows the:
  - Fundamental structure of EMIS
  - Economic drivers for EMIS
  - Key people impacted by EMIS

Facilitate a discussion on the specific types of financial and non-financial value your organization wishes to generate by implementing an EMIS.

Stakeholders

Corporate resources, plant managers, production managers

Design Considerations

Did you consider?

- That the EMIS structure and cost needs to be proportional to the savings potential within the EACs
- That EAC accountability should align with the existing organizational structure

Conceptual Design Outputs

- ❒ Approval of the EMIS Purpose Statement
- ❒ Approval to implement the EMIS as a business system to manage energy
- ❒ Approval of the overall EMIS structure (as shown in the EMIS Business-Level Overview diagram)
- ❒ Approval of the proposed EAC owners and the potential allocation of resources

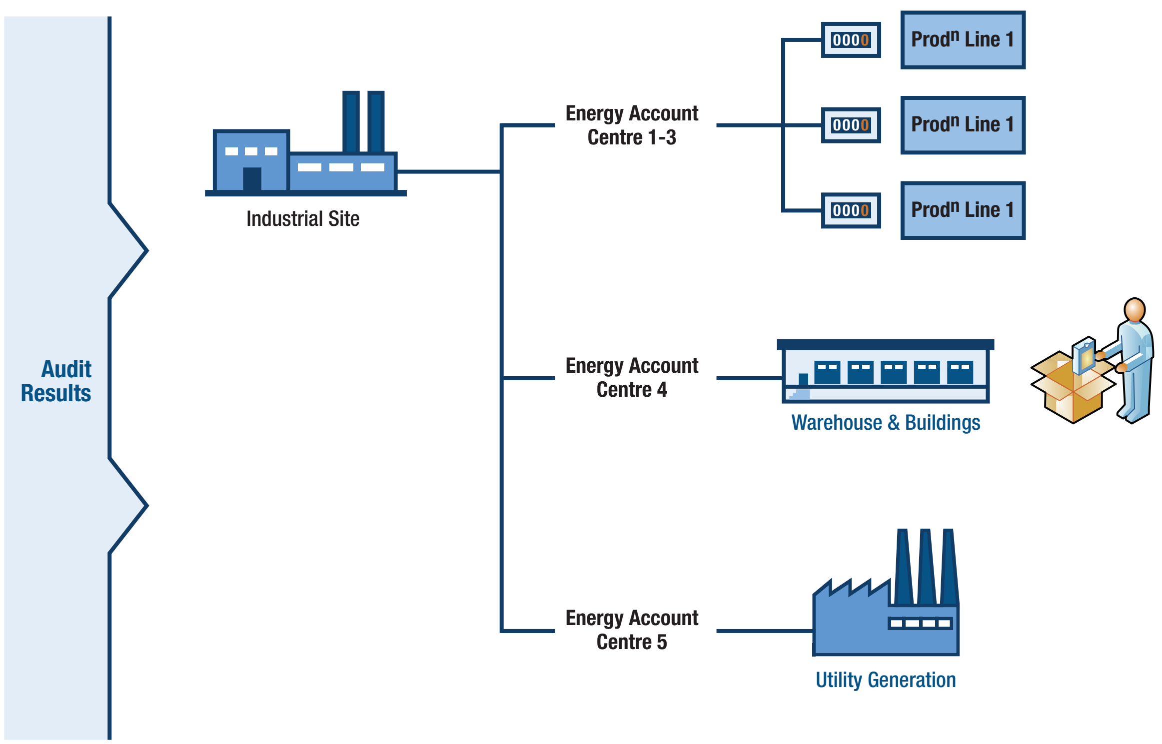
Energy Account Centres

Objective

Energy Account Centres (EACs) are the foundation of your EMIS structure. Your organization manages energy performance at the EAC level. At this stage, formalize the EACs developed in the EMIS Audit and finalize the EAC structure through dialogue with key stakeholders. Create a line drawing (or other illustration) to show the grouping.

Exhibit

Figure 3-4 Example of an EAC Diagram (shows EACs for a production and shipping/receiving department and on-site utility generation)



Activities

Produce overview diagrams to show:

- The Master EAC structure
- Individual EAC structures
- Populate the EAC Structure Table with levels 1-4: Appendix B6

Stakeholders

List the EAC owners (as defined in the Business-Level Overview)

Design Considerations

Did you consider?

- The EAC structure developed at the EMIS Audit stage
- All relevant inputs that can be measured and that justify investment based on the performance improvement/financial result that could result from managing the input. For example:
  - management of end-use energy consumption such as the paper machine
  - management of on-site utility generation efficiency (boilers, compressed air, and so on)
  - aggregated EACs
- Define EAC process owners
- Develop sufficient detail at each EAC to facilitate discussion and buy-in from EAC owners
- Incorporate inputs from Business-Level Overview

Conceptual Design Outputs

❐ Illustration of EAC structure clarifying:

- Master view of EAC structure
- Location of specific EACs
- EAC Owner
- New and existing metering and inputs (energy drivers) required to calculate energy performance at the EAC level

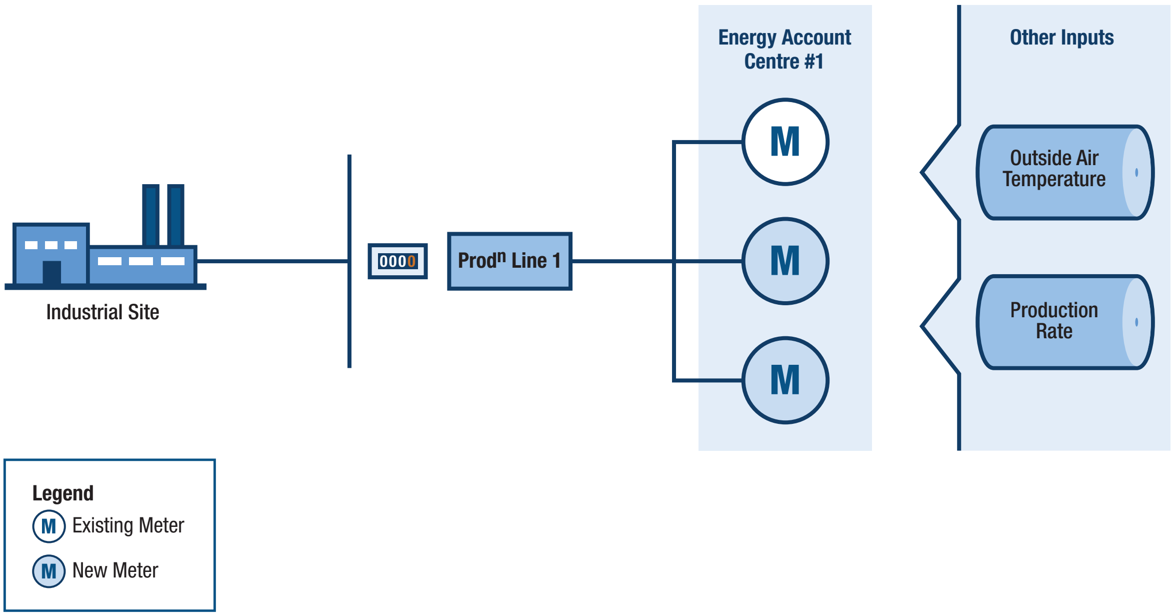
Metering and Inputs

Objective

Metering and inputs provide further specification of the Energy Account Centres. From the EMIS Audit, you should have a list of current meters that track consumption and recommendations for additional meters and inputs. Inputs are external variables that impact consumption. For example, outside temperature can have an impact on energy consumption. In this case, outside air temperature is an external variable (commonly referred to as an energy driver). For the Conceptual Design of meters and inputs, engage with EAC owners and engineering and instrumentation personnel to identify the meters and inputs that warrant monitoring in order to meet your EMIS goals.

Exhibit

Figure 3-5 Example of an EAC Conceptual Diagram with Meters and Inputs



Activities

- Create a line drawing to illustrate meters and inputs for each EAC
- Conduct meetings with EAC owners and operating teams to identify where you need meters and utility driver inputs
- Produce utility metering single-line diagrams
- Conduct meetings with engineering and instrumentation to review metering and input measuring issues

Note: You will produce detailed metering specifications in Part B – Chapter 4.

Stakeholders

- EAC owners and teams
- Engineering and instrumentation managers

Design Considerations

Did you consider?

- Whether an investment in metering justifies potential savings.
- That EAC owners and teams should be encouraged to identify the key energy drivers in their EAC. New insights may emerge that require additional metering or energy driver input considerations.
- Involving engineering, instrumentation, and maintenance staff to discuss:
  - Communication requirements between metering and data collection system
  - Meter types, location, and reliability issues
  - Serviceability and calibration requirements

Conceptual Design Outputs

- ❒ Illustrations of EACs with metering and inputs identified. Each EAC line must have its own diagram.
- ❒ Approval of EAC Conceptual Design by EAC owners.
- ❒ Approval of the utility metering single-line diagrams and metering requirements by engineering, instrumentation, and maintenance managers.
- ❒ List of new metering and energy driver inputs.

Data Capture and System Integration

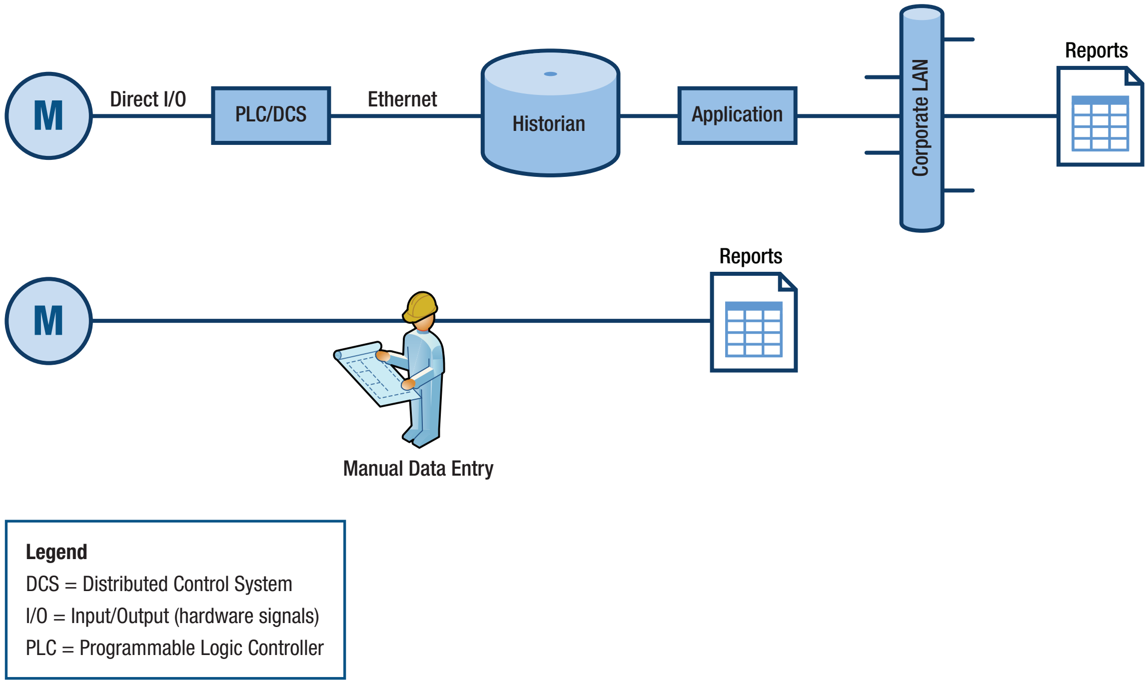
Objective

Data Capture and system integration maps the data flow from the meter to the report. For the conceptual design, you must define how data is gathered, transferred, and stored.

Many large, complex facilities, such as a pulp mill, gather data electronically and store it in large computer systems such as historians. This allows data to be shared across the facility or corporate networks. Therefore, scope this work with care. It is important to consider all stakeholders and their requirements. At smaller operations, operations personnel can gather and record data manually by entering the information in a spreadsheet shared at their location.

Exhibit

Figure 3-6 Example of Data Capture and System Integration Diagrams (shows two scenarios: one with a complex network, the other using simple manual data capture).



Activities

- Create a data capture and system integration diagram using the list of new metering and utility driver inputs.
- Confirm that new hardware (for meters and energy driver inputs) is compatible with existing technology. Pay close attention to existing communication protocols. Different vendors and different vintages of equipment may not work with newer technology. Understand and identify existing communication protocols for your current infrastructure.
- Identify proprietary software or communication protocols.
- Identify system integration requirements.
- Identify requirements for additional input data points (such as tags) at the various interface points of the system. Record requirements for additional hardware or inputs for energy drivers (such as outside air temperature, production rates, environmental or operational factors).
- Define power requirements including uninterruptible power supply for all hardware.
- Confirm reporting requirements (who needs what and how often?).

  Note: This can impact the sampling rates and frequencies, which can result in further infrastructure requirements such as increased data storage capacity.

Stakeholders

IT department, instrument and electrical technicians

Design Considerations

Did you consider?

- All the necessary inputs for calculating performance?
- Where the calculations/computations will be performed?
- What data analysis and reporting methods are used?
- Will special reporting software or Excel be used?

Conceptual Design Outputs

- ❒ Diagram or flowchart showing proposed system (network or manual process) for data capture and system integration of data from meters and inputs to data storage and reporting applications
- ❒ List of data capture and storage options for all meters and inputs
- ❒ List of all existing communication protocols
- ❒ Requirements list for aligning new meters and inputs to data capture method
- ❒ List of any new hardware or software requirements

Data Analysis and Reporting

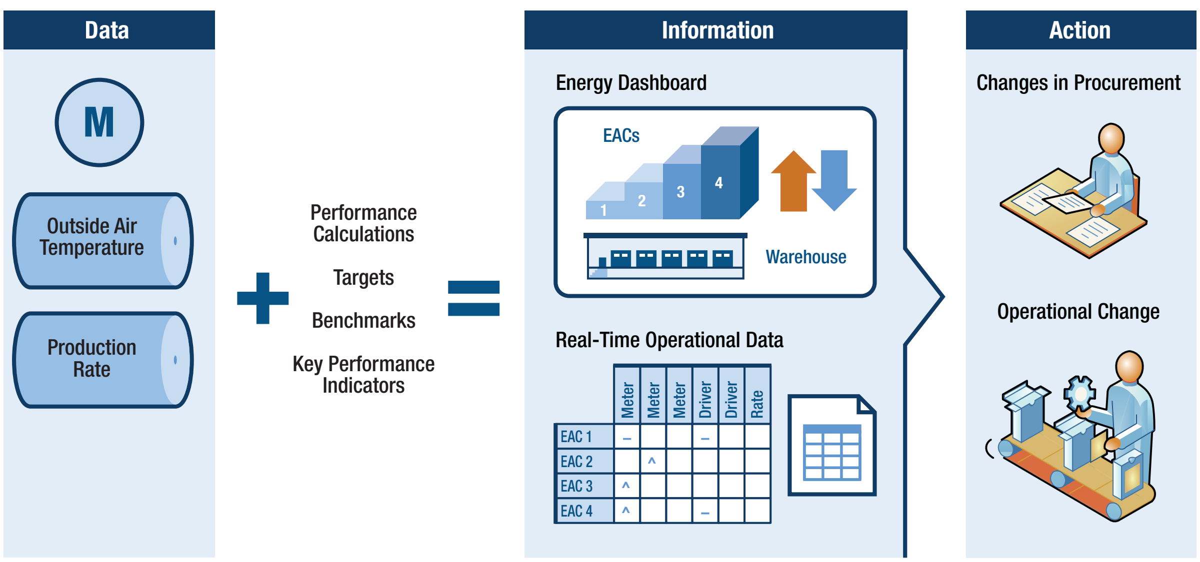
Objective

The objective of the conceptual design for the data analysis and reporting EMIS element is to map the flow of information, from the data capture and storage system, to meters and inputs, to the analysis and reporting tools. This section also identifies the type of reports and information needed and by whom.

The effort required for data analysis and reporting depends upon the complexity of the EMIS, the number of calculations, and the reporting requirements.

Exhibit

Figure 3-7 Example of Conceptual Diagram on Data Analysis and Reporting (shows how data from meters and energy driver inputs translates to energy performance information that enables action for change).



Activities

- Review Data Analysis and Reporting Gap Analysis from the EMIS Audit
- Review NRCan EMIS Handbook sections on Data Analysis and Reporting (see Part D)
- Using Appendix B7, clearly define:
  - The type of report required by the user
  - Report Users and User levels

    - Typical report content
    - Performance calculations required to produce report. Performance Calculations refer to meaningful energy information. This information shows your organization how you are performing against targets for improved productivity and energy efficiency. These calculations take raw data and translate them into predicted targets, which can be used to manage rather than simply monitor energy.
    - Metering and Input data required for calculation
    - Report frequency

Stakeholders

Finance, procurement, all levels in the energy management structure

Design Considerations

Did you consider?

- The future energy management structure? This will influence reporting requirements.
- Who needs what information in which format to make which decisions?
- Report type and frequency. Consider how reporting impacts your targeted savings and benefits. The following lists report types to consider (there may be others relevant to your site):
    - CUSUM analysis for sustained savings from capital project investments
    - Variability analysis reports for optimizing productivity and energy performance at the specific EACs
    - Operating range alarms for control of specific processes
    - Reports to trigger and actions to take on causes of good/bad performance
    - Site-wide electrical peak demand management
    - On-site utility generation optimization
    - Energy forecasts and trends for optimizing energy procurement
    - Corporate reporting for comparison of multi-plant portfolios
- Data retention and storage requirements.
- IT security policies (such as firewalls, Virtual Private Networks, and so on)
- Resource requirements for system maintenance
- Information access levels

Conceptual Design Outputs

❐ Map of current and proposed energy information flow

❐ Summary of users and report types, inputs and calculations required

Management System: People and Procedures

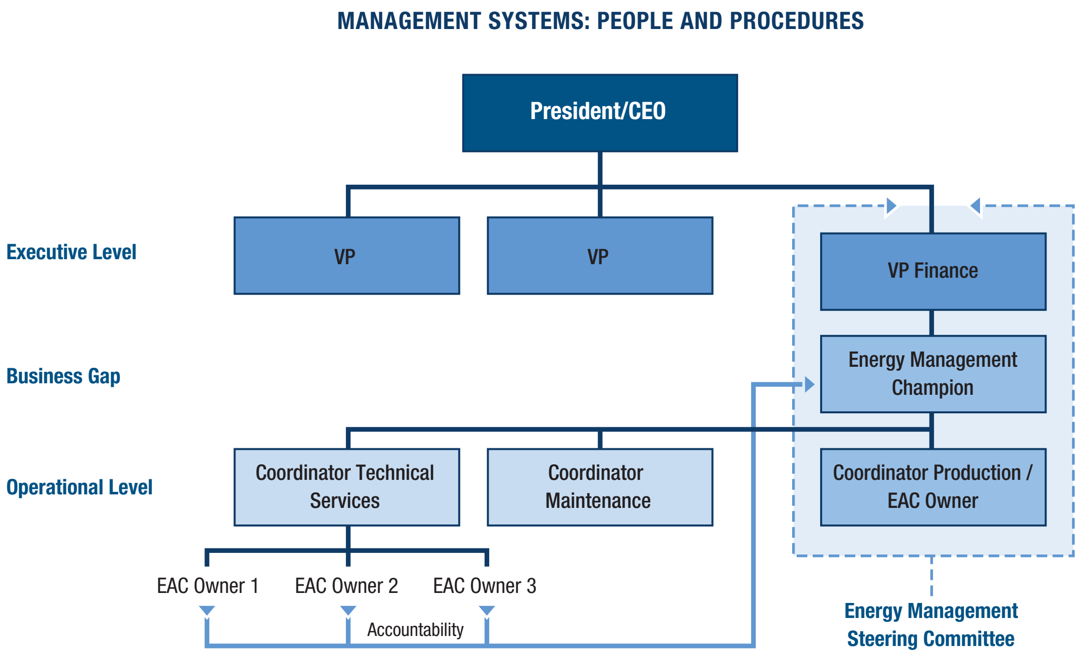
Objective

This work package shows the organization (its people, processes, and procedures) and how to translate the insights gained from EMIS data analysis and reporting into energy performance actions. At the conceptual design stage, consider:

- Establishing the organizational structure for managing energy through the EMIS
- Identifying the specific roles and resources required
- Defining the new or existing management systems that will be impacted, involved, or required in order to implement the EMIS
- Defining the new or existing procedures that will support and enable the organization to use the EMIS to deliver continuous improvements

Exhibit

Figure 3-8 Example of an EMIS People and Procedures Diagram



Activities

- Review Gap analysis on Management Systems and Procedures conducted at the EMIS Audit stage
- Establish a clear policy and framework for managing energy (see Appendix B8)
- Define the management system within which EMIS will operate (see Appendix B9)
- Define roles and responsibilities within the EnMS and describe each in sufficient detail to permit discussion and agreement on the proposed roles and time allocations (see Appendix B10)
- Define new or existing procedures that will support and enable the organization to use the EMIS to deliver continuous improvements (see Appendix B11)
- Conduct meeting with Steering Group to discuss and finalize issues such as:
  - Energy management policy and framework
  - Roles and responsibilities
  - Specific personnel assigned to key functions
  - Management system issues
  - Procedural issues

Stakeholders

Energy Management Steering Group

Design Considerations

Did you consider?

- If there is corporate commitment to establish an energy management steering committee?
- If there is a corporate energy management mandate?
- Whether energy management will be embedded into existing management and operating systems or if new systems are required for the EMIS?
- What new roles and responsibilities are required?
- What skills are required to fulfil the roles and responsibilities and what resources are best suited to them?
- What is the meeting frequency at each level?
- What management systems are required, impacted or necessary to enable deployment of the EMIS?
- What new and existing procedures are required to support ongoing functioning of the EMIS?

Conceptual Design Outputs

- ❒ Formalized commitment to manage energy
- ❒ Establishment of a framework for managing energy
- ❒ Definition of roles, responsibilities, and allocation of resources
- ❒ Identification of skills and potential skill gaps

4. Detailed Design, Specifications, and Bids

This section provides guidance on how to define an Energy Management Information System; with it, you will create a detailed design for an EMIS structure based on the conceptual design from the previous section. With the help of technical resources and worksheets you will:

- Define detailed work packages
- Prepare specifications for work
- Prepare proposals and specifications to engage the help of third-party service providers and suppliers for different work packages

Remember: With the detailed design you are delivering an operating Energy Management Information System that will deliver on projected savings from your EMIS Audit.

To review bids and refine cost estimates and projected savings, refer to the tools and guidance in Appendix B12.

Energy Account Centres

The Energy Account Centres' structure produced in Section 3 is the basis for detailed design work in this section. At this phase, the EACs require no further work.

Metering and Inputs

Objective

The objective of this section is to guide you through the detailed design of your EMIS metering and input elements to produce a detailed cost estimate for required metering and inputs.

Getting Started

The locations of new meters and inputs are based on the individual Energy Account Centre (EAC) requirements detailed in Part B – Chapter 3. The following outputs from that chapter are required (conceptual design of metering and inputs):

- Illustrations of EACs with metering and inputs identified. Each EAC line must have its own diagram;
- Approval of the utility metering single-line diagrams and metering requirements by engineering, instrumentation, and maintenance managers; and
- List of new metering and energy driver inputs.

Input types will vary according to EAC design and reporting requirements. Examples of inputs include outside air temperature, humidity, production rates, etc. For example, if outside air temperature is an energy driver, a new outside air temperature sensor may be an input for the performance calculations of a specific EAC. Refer to Appendix B13 for a comprehensive description of inputs.

Note: In some cases, the data source may already exist and simply require mapping to the EMIS.

Outputs and Activities

- Produce a metering and input take-off worksheet using the templates found in Appendix B13.

A metering and input take-off worksheet is an organized list of all new metering and input requirements. Consider incorporating the following in your list:

  - All new meters and inputs by type. Meter types are: liquid, gas (includes steam), and electric. Input types are: hard wired sensors, pseudo points (software calculated inputs) and other
  - Quantities required for each type of meter and input

- Complete specifications for metering and installation requirements
  - Complete a detailed technical specification sheet for each new meter.

    Note: Here you record details such as size, turn-down ratios, pressure/temperature compensation requirements, communication protocol, etc.

    Refer to Tables B13-1 to B13-4 for the Liquid and Gas Meter and Electrical Meter specification sheets and supporting information.

  - Produce installation drawings for the meter installers.

- Identify suppliers – obtain quotes

  At this stage adequate information exists to approach suppliers for quotes. Remember that metering and inputs can easily be outsourced alone or bundled as part of a turn-key EMIS implementation.

  The metering and input take-off worksheet and detailed specification worksheet provide sufficient detail for costing of materials.

  Note: Costs such as supplying power to the meters, communications, configurations and calibrations should be accounted for in the scope of work.

- Identify installation resources (internal/external)

  You may want to consider using internal resources to install some or all of the meters. Note that physical installation requirements differ from meter configuration and calibration. Allocate resources accordingly. For example, if installing a steam meter, you may have to interrupt a process and cut into a steam line. You may want your staff to carry out this task but outsource the meter configuration and calibration.

  Note: If you are using existing meters and inputs, account for servicing and calibrations of all hardware, in order to validate the data being collected.

Data Capture and System Integration

Objective

The objective of this section is to guide you through the detailed design of your data capture methodology for all new and existing meters and inputs that are to be integrated into your EMIS, and to produce a detailed cost estimate for the required data capture and system integration elements. The specifications you produce here include all hardware and software required to: collect the necessary data from the meters and inputs; perform analysis; store data; and generate reports.

Getting Started

You will need the following outputs from Part B – Chapter 3 (conceptual design of data capture and system integration):

- Data flow mapping from meter and energy drivers to reporting and analysis tools
- List of data capture and storage options for all meters and inputs
- List of all existing communication protocols
- Requirements list for aligning new meters and inputs to data capture method
- List of any new hardware or software requirements

Note: It is critical that the detailed design for data capture and system integration is based on the requirements for data analysis and reporting (next section). Carefully consider:

- data storage requirements, not only for short-term reporting but also for subsequent analysis of historical consumption patterns (e.g., in support of an energy audit)
- frequency of reporting
- timing intervals required to support the analysis
- storage requirements

Data Capture and System Integration Model Variations

- Meters may be connected by direct I/O to the PLC, or they may be intelligent enough for Ethernet or other plant-wide connectivity.
- The database server may have a historian used for data collection that is independent of the EMIS.
- An intermediate data concentrator may exist for collection from several, unrelated data sources.
  - For network-capable meters, the data concentrator may host a third-party application, which interfaces to the meters for data capture.

Outputs and Activities

- Update data flow mapping from meter and energy drivers to reporting and analysis tools (data architecture).
- Complete specifications for data capture (hardware/software) and detail the system integration requirements.

  Refer to Appendix B15 for guidance on: capturing data from all meters and inputs, database capacity, and hardware specifications. Appendix B15 provides typical specifications for data capture and storage systems. The detailed specifications will vary according to the complexity of your EMIS; some reference materials may list components that are not relevant to your situation.

  Data capture and storage options can vary greatly, from manual meter readings with no database entry, to completely automated monitoring and collection systems. New technology and software solutions enable more automation options than ever before.

- Identify suppliers – Obtain quotes

  Focus on the functional requirements rather than producing a prescriptive specification for this work package. Unlike metering and input specification, which is very prescriptive in nature, data capture and systems integration should only specify how you want your EMIS to perform. When you define functionality only, you enable service providers and suppliers to present your organization with a wider range of possible solutions.

- Identify installation resources (internal/external)

  Determine whether any of this work can be resourced internally. In some cases, because of the expertise required, it may be appropriate to outsource everything as a package. However, if you have IT expertise in-house, you may want them to play a lead role in coordinating this work package.

- Finalize cost estimates

  Produce costing in a summary sheet (refer to Appendix B14 for a summary sheet template).

Data Analysis and Reporting

Objective

The objective of this section is to guide you in a detailed design and costing estimate of the data analysis and reporting elements of your EMIS.

Getting Started

You will need the following outputs from Part B – Chapter 3 (conceptual design of data analysis and reporting):

- Map of current and proposed energy information flow
- Summary of users and report types and required inputs and calculations

Before you begin this section's activities, refer to the reference document in Part D.

Outputs and Activities

- Develop software-functional specifications
- Summarize the data analysis and reporting requirements by user type using the Data Analysis and Reporting Worksheet in Appendix B7

  An EMIS delivers value to organizations by turning energy consumption data into management information. The scope of required reporting may range from variability analysis at each EAC, to electrical peak demand management for the site, to cost analysis of the energy component of specific products. The scoping out of the reporting requirements will drive the requirements for data analysis and, consequently, determine the type of software approach to data analysis and reporting. Take time to properly determine the range of reports required by user type, the calculations required to analyze data to produce the report, all data inputs required to support the calculations, as well as the data source.

- Produce functional requirements for the data analysis and reporting system using the template in Appendix B16

  Appendix B16 provides a template for preparing the functional specification for the data analysis and reporting software. Whether you plan to purchase a software system from a third-party vendor or use your existing company system, it is important to think through the detailed reporting software requirements as indicated in Appendix B17.

  Poor data analysis can quickly destroy the value of the EMIS. It is critical that targets are set correctly using equations that accurately explain performance, rather than simply being based on a KPI of energy/production. An overly simplified energy/production KPI will automatically lead to better performance when production rates are high and poorer performance when production rates are low. A facility's personnel need to know how energy performance at a higher production rate compares with past performance at the same production rate. Typically, regression equations should be built up to accurately explain the energy consumption of an EAC that considers multiple factors.

In an EMIS statistical regression, calculations are developed at each EAC that correlate well with the EAC energy history. Once the target equation has been established and accepted, actual performance is compared against the results of the target equation, with the difference used as a trigger for investigative action. For example, if the variance is greater than established control bands (such as +/- 1.5 σ), an investigation of the root causes is undertaken. Investigation of variance is then used to drive a process for improvement. It is equally important to identify causes of good performance as well as bad performance: the features that lead to good performance must be embedded within normal operation; causes of poor performance must be identified and eliminated. In addition to reducing operational variability, performance target equations will highlight those aspects of the production process that indicate high base and high variable loads. This can then stimulate process investigation activities to possibly reduce the causes of the high base loads and to reduce the variable component through improving conversion efficiencies. Be sure that the data analysis system is capable of such functions.

It is important to recognize that the EMIS will bring additional benefits beyond financial benefits. Ensure that the scope of the EMIS considers the following:

- An EMIS will allow for facilitation of focus and communication among various organizational levels
- By developing target equations for energy consumption the organization is better placed to forecast energy consumption in advance based on planned production levels – this will provide direct benefit to the procurement function
- An EMIS can be used to monitor and verify carbon emissions from each stage of the process, providing the basis for a carbon management strategy
- Companies often make substantial investment in energy efficiency projects; an EMIS provides a management tool that allows them to both measure the impact of the projects and sustain the gains made

- Identify required resources (internal/external)

Produce a data analysis and reporting software evaluation matrix using Appendix B18 to identify and apply weightings to the functions and compare various options.

Appendix B18 provides an example matrix for considering the relative rankings of the functional requirements for the data analysis and reporting system. It is suggested that this matrix be prepared in order to force thinking about the systems' priorities. This matrix, in combination with the functional specification, can be used to evaluate options appropriate for producing the required reports and conducting the required data analysis including: (a) using existing tools and software, (b) procuring a formalized energy management information software, and (c) adding functions to the existing software being used at the company.

Refer to Appendix B19 to check that planned system changes work with existing systems. This is particularly important if you are managing the changes internally (as external service providers should have considered these issues on their own).

- Identify suppliers - obtain quotes

  Create an RFP and evaluate responses. Include the evaluation grid produced in Appendix B18 in the RFP, then use the same criteria to evaluate each bid. Consider that an EMIS is a learning tool. Over time, you will want to modify the equations and calculations. Ensure that the chosen system is flexible and can accommodate ongoing changes.

- Finalize system costing

  Consider using Appendix B18 for comparing costs and capabilities of different software. Consider not only the original purchase cost when evaluating existing or new software options but also the "time cost" for resource time to use, maintain and modify the software and reports. For any business, "time" is a precious commodity and systems that require intensive manual entry, or are slow and cumbersome to use, quickly become outdated.

Management Systems: People and Procedures

Objective

The objective of this section is to guide you through the detailed design of the management system of your EMIS and produce a detailed cost estimate for the required system.

Getting Started

You will need the following outputs from Part B – Chapter 3 (conceptual design of management systems: people and procedures):

- Formalized commitment to manage energy
- Establishment of a framework for managing energy
- Definition of roles, responsibilities, and allocation of resources
- Identification of skills and potential skill gaps

Without a clearly defined organizational structure, designated responsibility and the resources necessary for managing energy, an EMIS will deliver very little. In addition, within a well-defined structure with designated responsibilities and sufficient resources, new skills are crucial to effectively operate and manage an EMIS and ensure delivery of its intended benefits. This section focuses on defining and addressing the gap between the skills required to effectively use an EMIS to manage energy and an organization's existing capabilities, and establishing a communications plan for engaging the organization in energy management using an EMIS.

Outputs and Activities

- Conduct a training needs analysis (TNA) and skills assessment

  Refer to Appendix B20 for the step-by-step process for these. The main steps are:

  - Step 1: Define tasks to be performed by each role within the energy management organizational structure;
  - Step 2: Define the skills required by each role to perform the tasks;
  - Step 3: Define the skill gaps between the required role and the organization's existing capabilities;
  - Step 4: Produce the TNA overview defining existing gaps in the organization that must be addressed through training;
  - Step 5: Develop a skills assessment;
  - Step 6: Prepare the skills assessment report;
  - Step 7: Contact qualified service providers and/or training consultants and have them submit proposals for training;
  - Step 8: Complete the training plan following proposal selection.

- Revise existing processes, policies, and procedures and produce new documentation to include EMIS operation

  Your organization's information should:

  - Introduce and train new users on the system
  - Document roles and responsibilities for EMIS operations
  - Provide operations and maintenance procedures for EMIS operations
  - Allow regular users to access or customize reports
  - Enable users to access wider functions they might not access day-to-day
  - Define and formalize how the system will operate

- Develop a Communications and Awareness Plan

  Refer to Appendix B21 for guidance on producing a communications and awareness plan. Effective communication is a key part of any Energy Management Information System. It will ensure that both implementation and ongoing operation are successful. Relevant and regular information on the energy performance of the plant or equipment within an EAC contributes to increasing employee motivation and commitment to take an active part in achieving the organization's energy objectives and targets.

5. Preparing the EMIS Implementation Plan

The previous sections involved preparing detailed requirements that help us understand each of the EMIS elements. This section describes the EMIS Implementation Plan requirements including the level of detail required for each section of the Plan, an outline of requirements for such supporting items as the business case, project plan, implementation schedule and the project team.

The Implementation Plan should address risk. In the EMIS Audit, the savings estimates are based on a "business as usual" view of the world. The EMIS Implementation Plan can be used to model different scenarios and thus develop a risk-weighted profile for EMIS.

a) Table of Contents

The following is a recommended Table of Contents for the EMIS Implementation Plan. The activities you completed to create the work packages in the detailed design phase (Part B – Chapter 4) will provide the information needed to deliver a comprehensive plan.

EMIS Implementation Plan – Suggested Table of Contents

1. **Executive Summary**
   - 1.1 Summary of Costs and Benefits
2. **EMIS Structure and Scope**
   - 2.1 Business Overview
   - 2.2 Energy Account Centres
   - 2.3 Metering and Inputs
   - 2.4 Data Capture and System Integration
   - 2.5 Data Analysis and Reporting
   - 2.6 Management Systems: People and Procedures
   - 2.7 Training, Communications and Awareness Actions
   - 2.8 Project Contingency
   - 2.9 Implementation Project Management
   - 2.10 EMIS Risks and Impacts
3. **Implementation Schedule and Project Plan**
4. **Estimating Costs**
5. **Estimating Savings**
6. **Business Case**
   - 6.1 Financial Return
   - 6.2 Methods and Assumptions
7. **Appendices**

b) Executive Summary

The executive summary should include a concise statement of the overall benefits and costs of EMIS implementation at the site or organization and address the overall approach used to derive the savings potential and cost breakdown. Table 3-2 shows a recommended structure for the costs and benefits summary.

Table 3-2 High-Level Costs/Benefits Summary Breakdown

	Year 1	Year 2	Year 3	Total
Costs				
Hardware				
Software				
Systems Integration				
Training				
Management Support				
Installation				
Project Management				
Project Contingency				
Subtotal Cost				
Govt/Utility Incentives				
NET COST				
Annual Savings				
Less Ongoing Operational Costs				
NET BENEFIT				

c) EMIS Structure and Scope

This is the main body of the EMIS Implementation Plan and should include, at a minimum, a detailed description of the changes, impacts and costs associated with each of the EMIS elements, as well as a view to project management, contingency and impacts.

- *Business Overview*

  The Business Overview should restate the EMIS purpose and highlight the scope of the EMIS implementation at your facility.

- *Energy Account Centres*

  This section should summarize the EAC Structure. The following information is required for each EAC:

  - What utility meters already exist
  - What new utility meters will be installed
  - Which utility meters will be derived values from existing or new utility meters
  - What driver measurements already exist
  - What new driver measurements are required

  It is recommended that this information be provided in a tabular format. Appendix B6 shows a recommended structure for the EAC presentation.

  Within this table it is acceptable to use:

  E – for an existing meter or measure

  N – for a new meter or measure

  The Comments field is for any additional explanation required in order to understand the table, for example, what particular drivers are being measured.

- *Metering and Inputs*

  This section should define what new meters will be installed, and what particular energy driver inputs will be measured. You will need to demonstrate for each EAC that the likely utility drivers have been identified and that suitable measurement types have been defined. Any assumptions made regarding sizing of the flow meters or current transformers for the electrical meters should also be defined.

  This section should also define what costs have been obtained through bids from third-party suppliers and what costs remain as estimates. If bids have been received for meters or input measurement, both the original technical specification and the accepted bid should be included in the Appendices.

  If no new metering or input measurement is required for EMIS implementation, this section must state this and explain why.

- *Data Capture and Systems Integration*

  This section should describe any required data capture and storage changes. If presenting changes to data capture and storage systems, this section will need to define what costs have been obtained from third-party suppliers and what costs remain estimates.

  This section should also address what other systems integration work will be required, such as EMIS links to other business systems.

  If any bids have been received for utility meters both the original technical specification and the accepted bid must be included in the appendices.

- *Data Analysis and Reporting*

  This section should describe any changes that will be implemented to data analysis and reporting and, in particular, highlight any improvements that EMIS implementation will bring in terms of visibility of management information.

  This section specifically needs to address:

  - reporting frequency (e.g., real time, hourly, shift basis, daily, weekly, monthly);
  - report availability (e.g., via paper, email or intranet);
  - report access (e.g., by the Energy Management Champion, Sponsor or Steering Group, or Improvement Teams).

  As with the other section, if bids have been obtained from third-party suppliers for data analysis and reporting systems, then the section should provide an upper level summary of the costs, and the original specification and accepted bid should be included in the appendices.

- *Management Systems: People and Procedures*

  The proposed management structure for the EMIS needs to be presented. This should include a description of the roles and responsibilities for each element in the upper managerial structure. This section should also outline high level procedural changes and the impact this could have on operations

- *Training, Communication and Awareness*

  The primary purpose of the training section is to present the site or organization's overall training plan. The skills assessment should be included in the appendices indicating a clear link between the training needs analysis and the training plan proposed in this section.

  Where bids have been obtained from third parties for provision of training, the appendices should also include the information sent to the training providers and the accepted bid from the preferred supplier.

  The communications and awareness section should describe who has responsibility for internal communication regarding the energy management information system, proposed means of communicating information and how to review and respond to employee proposals and comments.

- *Project Contingency*

  There may be a need to include a project contingency within the overall project costing. In this section of the Implementation Plan the need for the contingency should be justified and its likely uses described.

  A common need for a contingency is to act as a "metering and small projects fund." One of the difficulties of an EMIS is to identify in advance all the relevant drivers for each EAC. This can sometimes mean that additional driver measurements are required to improve the target equations.

  Another difficulty with an EMIS, and one in which an EMIS is fundamentally different from technical energy efficiency measures, is that the precise source of savings is not 100% known in advance. If it were, then there would be little reason to implement an EMIS. To capture savings there may be a requirement for improved controls, or other small measures that only become visible once an EMIS is implemented. Having a budget for these changes will facilitate their implementation.

- *Implementation Project Management*

  This section should describe who will be responsible for which aspects of the EMIS implementation. You may have a mix of internal and external project management resources. This section could also touch on key project resources.

- *EMIS Risks and Impacts*

  This section should outline risks and impacts associated with the EMIS implementation. Items to consider:

  - Are there internal resource constraints?
  - Will the proposed implementation cause any process interruptions?
  - What systems will the new EMIS impact?
  - Will the EMIS need to integrate with existing business systems?
  - If so, will it need to be reconfigured to use data from the EMIS?
  - Will this implementation affect other energy efficiency projects?

d) Implementation Schedule and Project Plan

The project plan will:

- Identify the critical activities that determine the overall time requirement (i.e., the critical path);
- Identify key constraints that fix scheduling of activities (i.e., target setting as an activity will be impossible until the relevant meters are in place and the data is available in the data historian);
- Help guide decisions regarding phasing of implementation. For example, if there is a long lead time for new meter installation due to scheduling downtime to allow safe installation, the program could be adapted to commence implementation with existing meters, then add meters progressively to the system;

- Help program in activities which require time away from the site or the organization's management team, e.g., the training program;
- Identify the amount of time necessary to deliver performance reports to the management team and subsequently, to develop sufficient capacity internally to start to generate savings.

The project time-plan is also used as the basis for reporting to the management team on progress in implementing the EMIS in terms of activities completed to schedule. Figure 3-9 shows a sample project plan.

Figure 3-9 Sample Project Plan

ID	Task Name	Start	Finish	Duration		April 2009				May 2009				June 2009		
					29/3	5/4	12/4	19/4	26/4	3/5	10/5	17/5	24/5	31/5	7/6	14/6
1	Meter specification	30/03/2009	10/04/2009	2w												
2	Meter purchase	10/04/2009	18/06/2009	10w												
3	Metering installation	18/06/2009	15/07/2009	4w												
4	Metering commissioning	15/07/2009	21/07/2009	1w												
5	IT network specification	30/03/2009	10/04/2009	2w												
6	IT operating system analysis	10/04/2009	23/04/2009	2w												
7	IT network commission/test	23/04/2009	03/06/2009	6w												
8	IT security resolution	22/05/2009	11/06/2009	3w												
9	Software specification	04/05/2009	22/05/2009	3w												
10	Software supply	22/06/2009	26/06/2009	1w												
11	Software install/configure	03/08/2009	21/08/2009	3w												
12	Training specification	22/05/2009	11/06/2009	3w												
13	Training delivery	03/08/2009	11/09/2009	6w												
14	EMIS operation	25/08/2009	07/09/2009	2w												

e) Estimating Costs

The Implementation Plan should include a detailed breakdown of costs. The quality of the cost information provided can be improved by noting whether the costs were obtained from a bid or remain estimates and, if estimated, who did the estimate. Appendix B14 shows the preferred layout for project costing.

f) Estimating Savings

This section needs to detail the approach used to arrive at the savings estimates and should cover:

1. Whether, and at what level, statistical regression has been used to arrive at an estimate of the amount of variability that cannot be explained by variations in the utility drivers?
2. How the savings potentials from this regression analysis have been calibrated to the situation on site (i.e., through discussions with line operators and supervisors, through observation of operational practices, through detailed auditing of specific equipment or systems)?
3. What types of measures are likely to be identified by the EMIS and which will contribute to achieving the savings potential estimated?
4. Which scenarios have been used to predict the baseline energy consumption over the three-year (or longer) analysis horizon?
5. How probabilities associated with each of the scenarios have been determined or agreed upon with the client site or organization in order to arrive at a risk-weighted estimate of savings.

g) Business Case

The business case should comprise the financial assessment using costs and savings derived in previous sections. The costs included in the business case should cover the full-time horizon for analysis and not just the first-year costs included in the section on estimating costs.

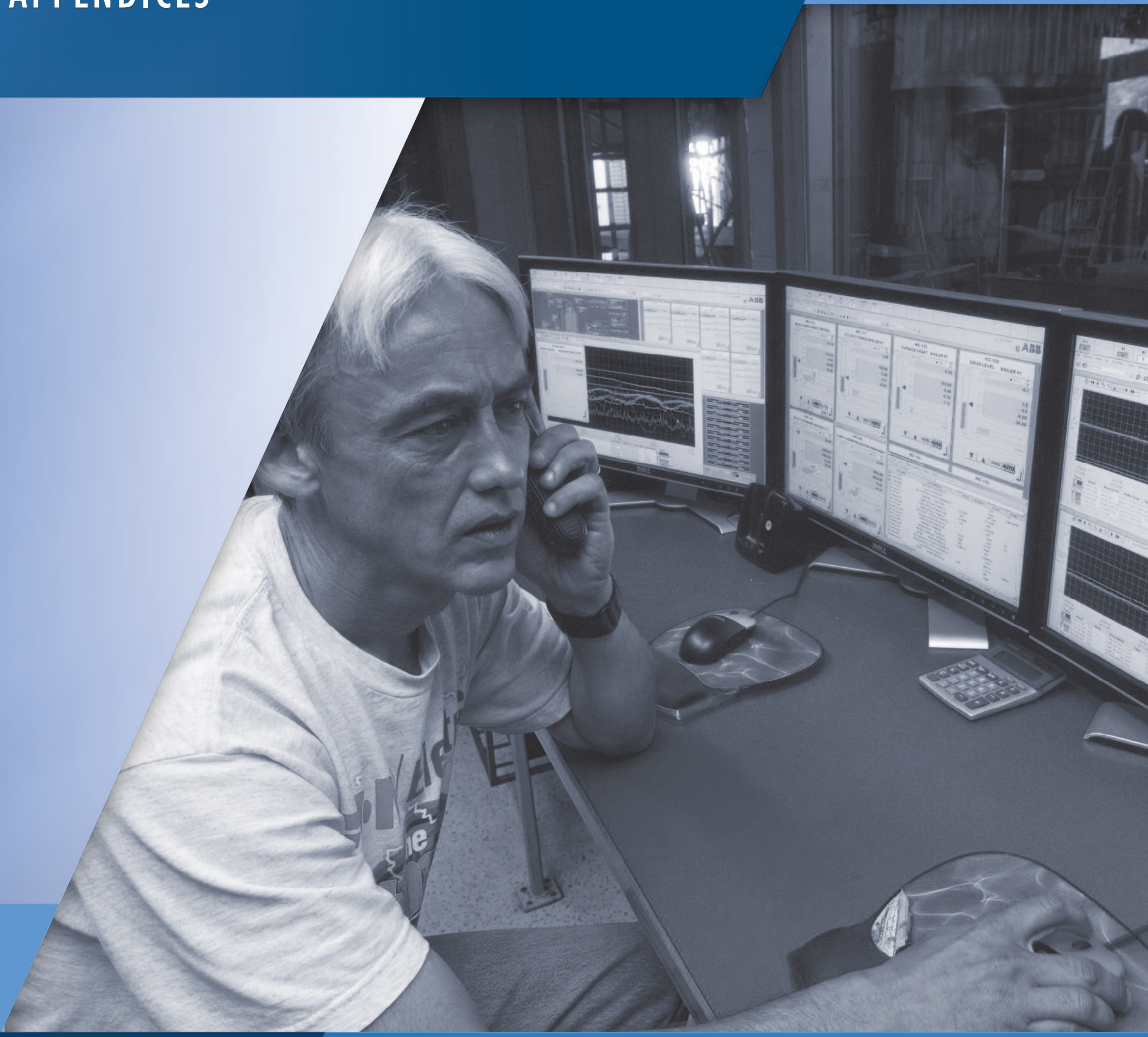
The business case should be calculated using discounted cash flow techniques and not simple payback. Any new assumptions embedded in the business case calculation that have not previously been described in the main body of the Implementation Plan, or in the sections on estimating costs or savings, should be articulated and justified.

h) Appendices

Given that much of the content in the actual plan is a summary of findings, the appendices should include background material for further reference. Appendices may include detailed cost estimate sheets, the full business case and project plan, and so on.

C

APPENDICES



PART C - APPENDICES

In order to support the EMIS Audit process and implementation plan and ensure consistent outputs, supporting tools have been developed and included as resources. The appendices (Table 4-1) include templates, assessment guidelines and tools.

Table 4-1 Summary of Templates, Tools, Features and Benefits

Template	Features	Benefits
PART A		
A1 Hiring an EMIS Auditor – Request for Proposal Evaluation Criteria	Template with suggested criteria, questions and scoring to evaluate the proposals of several EMIS Audit contractors	Provides a scoring of several contractors to help in making the best choice
A2 Pre-EMIS Audit Data Request Template	Form to record all relevant data required prior to the start of the audit, such as current energy management systems and procedures available prior to the audit	Generates insights to help focus activity during the audit phase and saves time for the auditor
A3 Assessment Criteria and Scoring	Worksheets with criteria to assess the level and performance of various energy management systems	Provides a separate Excel workbook that calculates the score and demonstrates gaps EMIS Audit Assessment Tool.xls
A4 EMIS Audit Checklist	Checklist that covers key steps to follow for a thorough EMIS Audit	Ensures no stone is left unturned
PART B		
B5 Stakeholder Engagement/ Sign-off Worksheet	Worksheet with questions and suggestions to define stakeholders	Helps map out key stakeholders at key stages
B6 Energy Account Centre Structure	Table to record all EAC structures and owners for each of the EMIS elements	Provides master view of EAC structure
B7 Data Analysis and Reporting Planning Worksheet	Worksheet to record and identify types of reports needed and by whom	Provides reminder of reporting requirements
B8 Energy Management Policy and Framework	List of elements to consider in an energy management framework	Describes the policy and key elements to consider when managing energy

Template	Features	Benefits
B9 Energy Management System Methodologies	Background information on methodologies and approach to manage energy	Defines the management system within which EMIS will operate
B10 Allocation of Roles and Responsibilities	List of roles and responsibilities required to manage energy and maintain an EMIS	Clearly sets out the roles and responsibilities of all players within a properly functioning EMIS
B11 Roles and Skills Assessment Worksheet	Worksheet to assess new or existing procedures and their impact	Provides guideline to forecast skills and training needs and/or impact of new procedures under EMIS
B12 Evaluating External Bids	Criteria and guidance to evaluate bids for each work package	Takes the guesswork out of how and what to look for when evaluating external bids
B13 Technical Specification Sheet for Metering and Inputs	Specification sheets for energy metering (i.e., liquid and gas and electric)	Helps specify and cost out energy metering requirements
B14 Preferred Layout for Project Costing	Template showing an example of layout for project costing	Provides example of breakdown of project costs
B15 Technical Specifications for Data Capture and System Integration	Information on capturing meter readings, database capacity and hardware requirements for detailed design phase	Provides companies with guidance and typical specifications to capture data
B16 Functional Requirements for Data Analysis and Reporting	Templates and tables for preparing specifications for data analysis and reporting software	Provides examples and suggested formats to use when specifying functional requirements
B17 Background Information for Data Analysis and Reporting Software	Information on data analysis and reporting requirements for the EMIS Implementation Plan	Details considerations when preparing the Implementation Plan
B18 Data Analysis and Reporting Evaluation Grid	Template to record and rank requirements for the data analysis and reporting system	Provides a matrix and template to prioritize rankings
B19 Change Checklist for Data Analysis and Reporting	Checklist of possible or planned changes to existing systems and software	Provides a checklist to review existing software and changes in reporting
B20 Training Needs Analysis, Skills Assessment and Training Plan	Step-by-step process to conduct a training needs analysis and develop programs to address gaps or skills required	Provides templates, task description and guidance to complete a training needs analysis and address gaps or training requirements
B21 Developing a Communications Plan	Guidelines to produce a communications and awareness plan within the Implementation Plan	Ensures communications becomes key part of an EMIS implementation

Template	Features	Benefits
EXCEL WORKBOOKS		
E1 EMIS Audit Assessment Tool **E1 EMIS Audit Assessment Tool.xls**	Comprehensive tool to tabulate and capture data on energy consumption	Scores and tabulates energy management systems and commentary Generates graphical representations of this information for use in the audit report Provides much of the information necessary to complete the EMIS Audit Report
E2 EMIS Business Case Tool **E2 The EMIS Business Case Tool Spreadsheet.xls**	Business Case Tool uses macros to tabulate probable costs and benefits and creates summary table and graphs	Allows users to estimate the probable costs and benefits from EMIS at the audit and planning stages

A1 Hiring an EMIS Auditor - Request for Proposal Evaluation Criteria

EMIS AUDIT		Max Score (indicates relative importance)	Section Importance (%)	Contractor 1		Contractor 2		Contractor 3		Contractor 4	
				Issue Score	Total Score	Issue Score	Total Score	Issue Score	Total Score	Issue Score	Total Score
SECTION 1 - UNDERSTANDING SCOPE			**25%**								
	Proponent clearly understands what EMIS is	10		10		10		10		10	
	Will the EMIS have clear functional objectives?	10		10		10		10		10	
	Will the EMIS Audit be tailored to various levels in the plant? Operator level? Energy champion level? Plant management level?	10		10		10		10		10	
	Proponent offers value-added options for consideration	5		5		5		5		5	
Section 1 – score		**35 × 25 ÷ 35 = 25%**									
SECTION 2 - METHODOLOGY AND SCHEDULE			**35%**								
	Proposed methodology is clear and logical	5		5		5		5		5	
	EMIS Audit will include descriptions of existing instrumentation for high energy users and describe recommended upgraded components	10		10		10		10		10	
	EMIS Audit will include descriptions of existing information software and describe recommended software additions	10		10		10		10		10	
	EMIS Audit will describe integration into existing plant information system	10		10		10		10		10	
	EMIS Audit will identify any training requirements of staff	10		10		10		10		10	

EMIS AUDIT		Max Score (indicates relative importance)	Section Importance (%)	Contractor 1		Contractor 2		Contractor 3		Contractor 4	
				Issue Score	Total Score	Issue Score	Total Score	Issue Score	Total Score	Issue Score	Total Score
	Will the EMIS Audit identify capital investment opportunities? And include a payback of the EMIS?	10		10		10		10		10	
	Does the EMIS Audit approach include identifying High Energy Users and Processes?	10		10		10		10		10	
	Will the EMIS Audit have a strategy for monitoring energy with respect to production (i.e., various product grades, production speeds, including plant shutdown)	15		15		15		15		15	
	Timing and availability of the work is appropriate	10		10		10		10		10	
Section 2 – Score		**90 × 35 ÷ 90 = 35%**									
SECTION 3 - PROJECT MANAGEMENT			**10%**								
	Quality Control approach is well presented and clear	5		5		5		5		5	
	Cost Control approach is well presented and clear	5		5		5		5		5	
	Schedule Control approach is well presented and clear	5		5		5		5		5	
	Client liaison and project team structure and roles are clear	10		10		10		10		10	
Section 3 – Score		**25 × 10 ÷ 25 = 10%**									

EMIS AUDIT	Max Score (indicates relative importance)	Section Importance (%)	Contractor 1 Issue Score	Contractor 1 Total Score	Contractor 2 Issue Score	Contractor 2 Total Score	Contractor 3 Issue Score	Contractor 3 Total Score	Contractor 4 Issue Score	Contractor 4 Total Score
SECTION 4 – CORPORATE AND STAFF EXPERIENCE AND REFERENCES		**30**		**30**		**30**		**30**		**30**
Proposal clearly demonstrates process knowledge and related experience	10		10		10		10		10	
Proposal clearly demonstrates energy efficiency knowledge and related experience	10		10		10		10		10	
Proponent has a dedicated business unit or dedicated staff for energy efficiency	10		10		10		10		10	
EMIS Audit staff have an industrial depth of knowledge	10		10		10		10		10	
EMIS Audit staff can access knowledge from other industry sector groups within the company	10		10		10		10		10	
EMIS Audit staff/firm has experience in the specific facility processes	10		10		10		10		10	
EMIS Audit staff have experience in electrical system design	10		10		10		10		10	
EMIS Audit staff have experience in project management	10		10		10		10		10	
EMIS Audit staff have experience in energy management	10		10		10		10		10	
References are provided and are satisfactory	10		10		10		10		10	
Section 4 – Score	**100 × 30 ÷ 100 = 30%**									
Total Score		**100%**				**100**		**100**		**100**

		Contractor 1	Contractor 2	Contractor 3	Contractor 4
Total Score EMIS Audit		100%	100%	100%	100%
Pricing EMIS AUDIT					

Summary of major advantages				
1)				
2)				
3)				

Summary of major disadvantages				
1)				
2)				
3)				

A2 Pre EMIS Audit – Data Request Template

Client/Site Details

Company Name	
Site Address	
Telephone (General)	
Primary Contact Name	
Primary Contact Telephone Number	
Primary Contact E-mail Address	

EMIS Auditor – Coordinates

Name	
Position	
Telephone (office)	
Telephone (mobile)	
Email address	

Background to this Request

This document outlines the sorts of data and/or information that will be required during the course of the EMIS Audit. If the data is provided prior to the study it has a greater value since it allows some preliminary analysis prior to the site work.

Please contact the EMIS auditor if there is anything in this document that requires greater clarification, or if there is any information that you are unable to provide.

General Site Information

- Site layout drawing (letter or legal size paper is fine);
- Any process schematics available;
- Gas, electricity, water, compressed air distribution drawings (if available) as either schematics or layouts;
- Site floor area (and volume if available);
- Number of employees;
- Operating hours, by shift, daily, weekly, monthly, annually;
- Brief details of principal products manufactured.

Typical data requirements

Where data is provided it is preferable to have it in a spreadsheet format, or any other format that can be imported directly into a spreadsheet.

Utility Consumption and Costs

- Monthly/Weekly consumptions and costs for all utilities (electricity, gas, oil, water, effluent), ideally for a period of three years.
- Information regarding the tariffs applying to utilities (standing charges, unit charges, tariff periods, taxes, etc.).
- Demand profiles, if available, for electricity showing typical summer, winter weekday and weekend electricity demand.

Sub-meter Information

- Sub-metered consumption data. Depending on the frequency of the data – if monthly, then three years; if weekly, then one year. This is to give us sufficient data points to allow regression analysis with a degree of confidence.

Production Data

- Monthly/Weekly production rates (either tonnes manufactured, sales tonnes, sales units, raw materials inputs, etc.) of key product groups. Ideally over the same period/frequency as the sub-meter data.

Management Information

- Details of any production or environmental management processes in place e.g., Six Sigma, TPM, TQM, ISO14001, etc.
- Details of any environmental legislation relevant to the site at a federal, provincial or municipal level and impact on site.

Utility Systems

System	Present	# of Systems	Total System Capacity
Boilers/Steam Generation	❒ Yes ❒ No		
Refrigeration/Chilled Water Generation	❒ Yes ❒ No		
Compressors/Compressed Air Generation	❒ Yes ❒ No		
Combined Heat and Power Systems	❒ Yes ❒ No		

A3 Assessment Criteria and Scoring

Management Systems and Procedures

Procurement and Investment

ENERGY PERFORMANCE IN INVESTMENT DECISIONS (SCORE 0–5)	
This criterion checks whether energy performance is included in the decision-making processes for all new items of capital plant and buildings. Since it is easier to design in energy efficiency than to retrofit later, energy performance should be an equal criterion in selection, together with production rates and quality. For energy intensive equipment such as refrigeration or air compressors, energy performance at both full and part loads should be the key criteria in the selection of suppliers.	
Score	**Qualifying performance**
5	An expert reviews all major investment projects to verify that the energy performance has been included in the decision-making process and that all economically viable means are incorporated to reduce the lifetime energy consumption.
3	An expert reviews all major investment projects to verify that the energy performance has been included in the decision-making process. However, first cost considerations have greater weight and some economically viable means to reduce the lifetime energy consumption are excluded.
1	Only energy projects are reviewed and performance is included within the specifications.
0	There is no review of investment projects to address their energy performance.
PROCUREMENT POLICIES FOR LOW VALUE ITEMS (SCORE 0–5)	
This criterion checks whether the organization has standard policies in place for the procurement of low value items such as motors and drives or light fixtures and lighting. It is generally more economical to replace a motor by a high-efficiency motor when it needs replacement rather than by rewinding it. Equally when lighting needs replacement it is important to specify high-efficiency light fixtures and controls.	
Score	**Qualifying performance**
5	The organization has policies and procedures in place to ensure that all small scale procurement is energy efficient.
3	The organization has policies and procedures in place to ensure that most small scale procurement is energy efficient.
1	The organization has policies and procedures in place to ensure that some small scale procurement is energy efficient.
0	The organization operates a lowest first-cost procurement policy for small scale items.

PROCUREMENT OF UTILITIES INFORMED BY DATA AND ANALYSIS (SCORE 0–5)	
This criterion is used to determine the extent to which energy procurement is informed by data and analysis. This covers analysis of energy commodity procurement and management to ensure that: ■ operational requirements are met and maximum flexibility is offered to the facility; ■ optimal contracts are negotiated; ■ opportunities for daily scheduling and interruptible options are maximized; and ■ bills are analyzed for errors and detailed consumption data stored.	
Score	**Qualifying performance**
5	Procurement of utilities is informed by detailed data analysis incorporating forecasts of both production and environmental factors. Opportunities for reducing costs by scheduling and interruptible options are maximized.
3	Procurement of utilities is informed by detailed data analysis incorporating forecasts of both production and environmental factors. Opportunities to reduce costs by scheduling and interruptible options are not explored.
1	Procurement of utilities is based on historic consumption patterns.
0	Procurement of utilities is undertaken in isolation of data or insights that might inform the process.

MAINTENANCE BUDGETS INCLUDE LINE ITEMS FOR ENERGY SYSTEMS (SCORE 0–5)	
This criterion checks whether maintenance budgets include specific line items for regular maintenance activities for those energy systems specifically addressed to reduce wastage. Typical activities would include: Compressed air leakage surveys; Steam trap surveys; Steam leak repairs; Water leak repairs; Thermo graphic surveys of electrical switchgear.	
Score	**Qualifying performance**
5	Site has a regular preventive maintenance and repair program that covers all energy systems.
3	Site has a preventive maintenance and repair program that covers all energy systems but survey frequency is insufficient.
1	Site has an ad-hoc maintenance and repair program for energy systems.
0	Site performs no energy systems surveys.

Organizational Structure

EXPLICIT ENERGY MANAGEMENT PROGRAM (SCORE 0–3)	
This criterion checks for the presence of some form of energy management program without making any judgments regarding the scope and contents of the program, hence the low overall weighting. Typical indicators of an energy management program are: Defined energy management policy; Individuals or groups tasked with reducing energy consumption; Goals or objectives for energy efficiency improvement. It is important to recognize that energy management programs need not be highly formalized and could take the form of repeated ad-hoc initiatives. Having a formal energy management program that is ineffective at improving performance is worse than an ad-hoc program whose initiatives are ongoing.	
Score	**Qualifying performance**
3	The site operates a structured energy management program incorporating regular audits, identification of opportunities and implementation. The energy management program is a central part of the overall site level management system.
2	An energy management program exists and has impacted the performance of the site or ad-hoc activities occur regularly to reduce consumption.
1	An energy management program exists but is ineffective.
0	No energy management programs or activities take place.

OBJECTIVES SET FOR ENERGY PERFORMANCE IMPROVEMENT (SCORE 0–5)	
This criterion is addressing whether objectives have been set for energy performance improvement and the nature of these objectives. The most successful energy management programs distinguish between long-term goals, medium-term objectives and shorter-term targets. Goals are generally unchanging and provide the longer term vision (e.g., “to be the most energy efficient operator in the sector”); Objectives are the key stages towards the overall goal (e.g., “to improve energy efficiency by 50 percent within 10 years”). Targets are more immediate and could be the desired changes within a current year (e.g., “to reduce energy consumption per kg of production by 5 percent”). The second question to address is whether targets and objectives are achievable and if they have been based on analysis and investigation or imposed haphazardly. The motivational levels of those responsible for achieving the targets will be much greater if they believe that these are attainable rather than impossible.	
Score	**Qualifying performance**
5	Goals, objectives and targets have been set on the basis of analysis and investigation and have been demonstrated as achievable. Plans have been agreed upon to meet the targets and objectives.
3	Goals, objectives and targets have been set and are perceived by site level staff as achievable.
1	Goals and objectives exist but they have been set without consideration of what is achievable.
0	There are no goals, objectives or targets for energy performance improvement.

EXPLICIT MANAGEMENT COMMITMENT (SCORE 0–5)	
“Senior management commitment is essential” is a mantra heard whenever a management system is considered. What does management commitment mean in practice? Typical indicators for management commitment are: A board member or managing director acting as the organizational sponsor for the energy management program; The appointment of an individual or team who report to the program sponsor tasked with the day-to-day operation of the energy management program; Management endorsement of the goals, objectives and targets; Inclusion of resources for operation of the energy management program within the annual business plan; Management involvement in raising awareness and communications activities, thus demonstrating leadership by example; Treating investment in energy efficiency the same as all other investments and not applying preferential criteria to production-related investment; Organizational commitment to publish information about utility performance to external stakeholders.	
Score	**Qualifying performance**
5	Active commitment from senior management to act to embed energy management at all levels of organization and resources allocated. Senior management visibility in leadership of energy management actions. Dedicated resource allocated to energy management who is empowered to make decisions and supported by senior management (e.g., energy manager).
3	Senior management is involved in energy management but falls short of commitment. Part time resource allocation to energy management.
1	Responsibility for energy management devolved to energy manager or equivalent with no support provided by senior management.
0	No evidence of commitment from senior management.
ENERGY TEAM(S) ESTABLISHED AND KEY STAKEHOLDERS INCLUDED (SCORE 0–5)	
Successful energy management is people-oriented; the more people involved in the program and engaged with it, the more successful it is likely to be. One way of securing commitment is with the use of energy “teams” that can help to ensure that staff efforts are structured and planned. Depending on the scale of the organization energy teams can operate at a site or department level. What matters is that they combine the range of functional responsibilities needed for energy management: Production/operations; Energy supply; Maintenance; Engineering/technical; Optionally, human resources and finance. The responsibility of the energy team is to manage and implement the program of activities that constitute the energy management program, whether this involves the investigation of variance or leading awareness-raising and communications plans.	

Score	Qualifying performance
5	Energy teams defined and their respective roles and responsibilities agreed to. Energy teams actively involved in investigation of variances, identification and implementation of corrective action and awareness raising and communications.
3	An energy team has been set up and roles and responsibilities agreed to but involvement is too infrequent to be effective.
1	An energy team has been set up but roles and responsibilities have not been defined.
0	No energy teams in place.

ACCOUNTABILITY FOR UTILITY PERFORMANCE DEVOLVED TO PRODUCTION/OPERATIONS (SCORE 0–10)

Some of the major barriers to improving energy performance arise from either the lack of accountability for energy performance or accountability being misallocated.

In most production environments, decisions on the part of production management are key determinants in the energy performance of the plant through:

Their control of operational parameters such as pressure and temperature;

Scheduling of products;

Lack of standard operational procedures for start-up and shut-down, which results in machines running empty.

Other issues for which the responsibility for energy performance is held by technical or engineering functions — typically these functions are directly responsible for energy supply but have little influence over energy consumption.

Energy management programs are far more likely to succeed if the production or operation management are held accountable for all of the resources used in production, including raw materials, people and utilities.

Score	Qualifying performance
10	Production or operational departments are held directly accountable for their utility consumption. Energy costs are a line item on the departmental or operational budget and managers are offered incentives to meet targets for performance improvement.
7	Production or operational departments are held directly accountable for their utility consumption. Utility costs are a line item on the departmental or operational budget but no incentive programs are in place to meet targets. Where sub-metering exists, costs have been split into direct and indirect charges based on meter readings.
5	Production and operational departments are held jointly accountable for utility consumption, together with the technical departments. Where sub-metering exists, it is not used to split energy costs into direct and indirect charges.
3	Production and operational departments are held jointly accountable for energy consumption, together with the technical departments.
0	Accountability for energy consumption resides with the technical or engineering department; the production departments are charged for utilities on the basis of historical allocations and treat energy costs as production overheads.

Management Procedures

REGULAR REVIEWS OF UTILITY PERFORMANCE (SCORE 0–5)	
With or without an EMIS providing information and reports, it is important that review processes exist to verify that the utility performance of the plant remains at an optimum. Where basic utility data capture and analysis exists — for example, use of data from the monthly utility receipts for the site as a whole, coupled with calculation of specific utility ratios using production data — the review process may simply involve comparison of the current month's ratios with historic trends. More sophisticated organizations may receive weekly utility data and make comparisons with production and other factors known to influence performance such as ambient temperature, operation hours, etc. This comparison may use statistical techniques such as regression and CUSUM. Unless regular reviews of utility performance take place, changes in performance will pass unnoticed and no corrective action will be triggered. The frequency of the review process and its scope will be determined by the reporting frequency of the data. Clearly this should be aligned with the importance of utility costs to the organization — an organization whose utility bill is less than $50,000/year and less than 1 percent of total costs will have different review requirements than one whose bill exceeds $5,000,000 and 8 percent of total costs.	
Score	**Qualifying performance**
5	A regular review process is embedded in the management systems of the site and is held at a frequency appropriate to the importance of energy costs to the organization.
3	A regular review process is embedded in the plant's management systems but there is inconsistency between the frequency of the review process and the importance of utility costs to the site.
1	Utility costs are reviewed on an ad-hoc basis.
0	No review process exists beyond annual budgeting.
ACTIONS ASSIGNED AND FOLLOWED UP (SCORE 0–5)	
Where review processes do exist there will be occasions when the energy performance either varies from historic trends or from predicted amounts. The root causes of this variance should be identified: if the plant is performing better than expected, there is justification for trying to understand why and ensuring that the factors become normal practice. If the plant is operating worse than expected, again, there may be sufficient justification for understanding why and eliminating the underlying causes. In both cases the action to identify the root cause will need to be assigned, either to an individual or to a team, and should be followed up at the subsequent review meeting. More sophisticated organizations operate "Action Registers" or "Action Databases," which store information on the nature of the variance, what was assigned to resolve the issue, the outcome (i.e., cause and response) and date of resolution. These registers become part of the organizational knowledge base and, in the case of multi-site organizations, can be used to share information across sites. The aim of this criterion is to verify whether the client has some organizational system in place to assign actions to individuals or teams and to ensure that those actions are completed.	

Score	Qualifying performance
5	Action register or equivalent operated as part of review system with actions assigned to individuals or teams, follow-up of previous actions and agenda items in the review process. Knowledge gained in process shared throughout organization or site.
3	Action register or equivalent operated as part of review system but no follow-up of previously assigned actions. Ad-hoc process for assigning and following up of actions.
1	Utility review process not done systematically to identify actions. Actions identified intermittently and rarely followed up.
0	No process exists for capturing and managing actions.
STAFF OFFERED INCENTIVES TO IMPROVE PERFORMANCE (SCORE 0–5)	
As mentioned earlier, the more people actively involved in the program, the more successful it is likely to be. However, involvement is not sufficient; in general, people will require incentives to improve performance. There are three important aspects to offering incentives: Awareness – staff must be aware of the role they can play in reducing the energy consumption of the plant equipment or items under their direct control; Motivated – they must be sufficiently motivated to want to improve the performance; Rewarded – they should be rewarded when their actions lead to improved performance.	
Score	**Qualifying performance**
5	Staff are motivated to improve performance of equipment under their responsibility, are aware of impact they can have, and there exists recognition and reward systems to motivate behaviour.
3	Staff understand impact they can have and are reasonably motivated but a lack of recognition and reward schemes results in motivation being temporary and unsustainable.
1	While staff are aware of the impact they can have on utility performance, the absence of adequate recognition and reward systems means action rarely occurs.
0	Staff unaware of and uninterested in impact they can have on utility performance.
Sufficient resources allocated to management system (Score 0–5)	
Resources will be required to maintain and operate an EMIS and an energy management system. Typical resource needs include: Maintenance of hardware – e.g., meters and data capture; Maintenance of software – e.g., updating targets, production and distribution of reports; Management time – review meetings, action plans, corrective action, communication and awareness; Staff resources – energy team(s) operation, technical studies to identify root causes of variances; Financial resources – (Annual budget allocation?) If the client has an existing utility management system, this will involve verification that sufficient resources are allocated to maintain the system fit for purpose. If the client lacks a dedicated energy or utility management system this will involve reviewing other management systems in place and confirming that the client has experience in dedicating resources to operation of management systems.	

Score	Qualifying performance
5	Adequate resources assigned to the energy management system and its operation, which is a primary responsibility of all concerned.
3	Although resources have been allocated to the management system, they are insufficient given the system's scale and scope. Although considered a primary activity, responsibilities are sometimes not assumed.
1	Insufficient resources allocated to management system, operation of management system seen as ad-hoc secondary activity and not part of the roles and responsibilities of the individuals concerned.
0	No resources assigned to the management system.
0	Staff unaware of and uninterested in impact they can have on utility performance.

REGULAR REVIEWS OF MANAGEMENT SYSTEM PERFORMANCE (SCORE 0–5)

Remember that utility management is a continuous cycle and that, at intervals, the whole system and the way it matches the needs of the organization should be reviewed. This review should address possible needs for changes to the system, working from the initial objectives through the organizational structure and responsibilities to the procedures.

In this part of the assessment, the auditor should seek evidence that the organization is maintaining the management system and that it has not become the equivalent of "organizational concrete" — in place and unchanging.

Score	Qualifying performance
5	The management system is subject to regular reviews and there is evidence of the system evolving to meet the changing requirements of the organization.
3	The management system is subject to review but these happen on an irregular basis. Some evidence of the system evolving.
1	Although in principle the system is subject to reviews, there is no evidence of reviews having taken place.
0	There are no procedures in place to review the management system.

OPERATIONAL/MAINTENANCE SCHEDULES FOR REDUCED UTILITY CONSUMPTION (SCORE 0–5)	
This criterion looks for concrete examples of management action to reduce energy consumption and hence improve energy performance. An operational schedule for improved utility performance may involve start-up and shut-down lists to ensure that all equipment that can be is, in fact, turned off. Equally, it could include recommended operational parameters where these are under the direct control of an operator and not embedded in a control system. Where the organization has a control system that includes logic for optimizing energy consumption, then they should score highly in this criterion. Maintenance schedules could include: Regular leak detection programs for compressed air or steam leaks; Thermographic surveys for heat losses from high temperature equipment (e.g., furnaces, ovens, steam lines); Steam trap surveys to detect passing traps. Preventive maintenance tasks in Maintenance Management Systems that improve energy efficiency.	
Score	**Qualifying performance**
5	There is evidence of management action to reduce energy consumption in all possible areas relevant to the site.
3	There is evidence of management action to reduce energy consumption in most possible areas relevant to the site.
1	There is evidence of management action to reduce energy consumption in some possible areas relevant to the site.
0	There is no evidence of management action to reduce energy consumption.

ACTIVE REPORTING SYSTEM FOR ENERGY WASTE ISSUES (SCORE 0–5)
Many manufacturing improvement systems promote the role of the equipment operator in maintaining the equipment under their control. Energy management systems are no exception and encourage equipment operators to look out for areas of energy wastage as part of their daily checks: Compressed air leaks; Water leaks; Steam leaks; Missing or damaged insulation, etc. For these types of systems to be effective, an organizational infrastructure should exist that allows operators to report issues relating to energy wastage, and, that allows these issues to be resolved. In practice this means having in place: A means of reporting the issue; A means of prioritizing these issues within the framework of the maintenance routines; A feedback loop to the operator who identified the issue, to confirm that it has been noted and will be resolved and the approximate timescale for its resolution. Without the feedback loop the operator may feel that the effort to identify issues is wasted and may not do so in future.

Score	Qualifying performance
5	Active reporting system for utility wastage exists with prioritization and feedback loops.
3	Active reporting system exists with prioritization of corrective action, no feedback loops exist.
1	Active reporting system for utility wastage exists but no attempts are made to prioritize corrective action and no feedback exists for the person who identified the wastage source.
0	No reporting system for utility wastage.

Communication, Training and Awareness

TRAINING OF OPERATIONAL STAFF (SCORE 0–5)	
This section reviews the amount of training operational staff receive on utility use in their areas of control. It is not uncommon for operators to be unaware of the costs of the energy resources under their control and to not have been provided with training on how to conserve resources. This section of the assessment addresses the amount of training the operators have received regarding the energy consumption characteristics of equipment under their control. It should be used as the basis for any recommendations regarding training and development programs as part of the EMIS implementation.	
Score	**Qualifying performance**
5	Equipment operators receive regular training and refresher courses on the energy performance of the equipment under their control and the steps to take to optimize performance.
3	Equipment operators receive training on the utility performance of the equipment under their control and the steps to take to optimize performance when they first use the equipment.
1	Equipment operators receive training on the utility performance of equipment under their control but it does not address how to optimize performance.
0	Training of operators does not address the utility performance characteristics.
TRAINING OF ENERGY TEAM AND SENIOR MANAGEMENT (SCORE 0–5)	
Due to their broader mandate, the energy team should have a more developed skills set than the operational staff. The expectation of the energy team is to be held accountable for the implementation of energy management activities, including reviewing utility performance reports, identification of significant variances, root cause identification and resolution, communication and raising awareness, etc. These skills may fall outside the team's normal activities; they may require specific training for this role. The outcome of this assessment should also be used to define the training and development programs as part of the EMIS implementation.	

Score	Qualifying performance
5	Energy teams have received specific training to enable them to fulfil their roles and responsibilities.
3	Energy teams have received training in most subjects related to their roles and responsibilities, but some training needs remain.
1	Energy teams have received training in some subjects related to their roles and responsibilities, but significant training needs remain.
0	Energy teams have received no specific training.

COMMUNICATION OF ENERGY PERFORMANCE TO ALL STAFF (SCORE 0–5)

Earlier criteria addressed the awareness and motivation of all staff in engaging with a utility management program. In order for the staff to be aware, they need to be provided with regular information on utility performance for their area of responsibility and also for the entire site.

It is important that all utility information is communicated in a way that is understood by the target audience — few people outside of the key technical areas have any concept of how big an mmBTU is or even a kWh. This means that information should be presented in terms of cost or as performance ratios (e.g., 85% of target).

If staff members do not receive regular information on performance, they will stop being concerned about it; behaviour may revert to previous practices.

In overall terms, information can be "pushed" to the staff, generally via their line management hierarchy or "pulled" by the staff i.e., it is made available but it is up to the individual concerned to access it. The most successful communication strategy adopts a mix of "push" and "pull" with which critical information is provided to staff and, if interested, they can access more broad-based information on a pull basis.

Score	Qualifying performance
5	Organization operates a "push/pull" communication strategy whereby all staff members receive regular information on energy performance in a format that is understood by them.
3	Organization operates a "push" strategy or provides information in a format that is not immediately understood.
1	Organization operates a "pull" strategy or only provides information to a small subset of the staff.
0	No energy information is communicated to staff.

ENERGY PERFORMANCE INCLUDED IN REPORTS TO EXTERNAL STAKEHOLDERS (SCORE 0–5)

Organizations will be more likely to sustain energy savings if they are committed to reporting energy performance to external stakeholders such as investors and customers.

Score	Qualifying performance
5	Organization is committed to reporting energy or emissions performance information to external stakeholders. Information is provided in sufficient detail to easily identify trends in performance.
3	Organization includes energy or emissions performance information in reports to external stakeholders but it is insufficient to identify trends in performance.
1	Organization only reports energy or emissions performance information to internal stakeholders (i.e., from site to corporate).
0	No reporting of energy performance to either internal or external stakeholders.

AWARENESS CAMPAIGNS UNDERTAKEN REGULARLY (SCORE 0–5)	
Previous criteria have addressed offering incentives and communication; this criterion looks at the programs or activities in place to maintain awareness of energy or related issues within the site.	
Score	**Qualifying performance**
5	Regular awareness activities take place that adequately maintain staff's awareness of energy and related issues.
3	Some awareness activities take place but too infrequently to maintain performance levels.
1	An awareness program has been delivered on a one-off basis.
0	No awareness activities take place.

Utility Metering and Data Capture

Utility Meters

KEY ENERGY ACCOUNT CENTRES (EACS) IDENTIFIED (SCORE 0–10)	
The identification of Energy Account Centres (EACs) is the means whereby energy consumption within a site or facility is delineated. EACs should, at a minimum, match the accounting cost centres for a facility to allow management to treat energy as any other input cost for that centre. In more complex production processes, the use of accounting cost centres may not lead to a sufficiently discrete separation of energy consumptions and costs; as a result, there be a need for multiple EACs within each ACC. In these circumstances, EACs may be individual production areas, whole production lines or, if the energy consumption is significant, an individual unit operation such as a drier or furnace. An important consideration is that all of the production equipment within the EAC should be under the responsibility of one operation or production manager who should be held accountable for the performance of that EAC. A single operations or production manager may be responsible for multiple EACs. Another factor to consider is that performance and targets should be set and managed at the EAC level.	
Score	**Qualifying performance**
10	EACs are delineated at an appropriate scale and scope for the site's operations or processes.
7	In most cases, EACs have been set at an appropriate level, but further EACs are required to provide a sufficiently discrete view to set targets and manage performance.
5	EACs are set at an Accounting Cost Centre level but this is not sufficiently discrete to either set appropriate targets or manage performance.
3	EACs are defined at a Departmental level.
0	No EACs have been identified.

UTILITY SUB-METERING COVERAGE ON EACS (SCORE 0–10)	
Once the optimal Energy Account Centres have been defined, the next stage in an Energy Management Information System is to ensure that all utility flows into the Energy Account Centre are measured. Remember to include both primary utilities — electricity, natural gas, oil, etc. — and secondary utilities, such as compressed air, where relevant. These measurement devices are referred to as sub-meters, to make the distinction between them and the fiscal meters used to measure the primary utility flows to the site. Sub-metering should cover the highest amount of energy possible within each of the EACs. This will allow for the most accurate overall representation of energy usage. Sub-meters should not be considered where the financial value of the energy flow is insufficient to provide justification for the meter installation. In order to calculate this coverage, the following data should be determined for each EAC: Overall weighting of energy for each EAC. This is subjective and the sum of the weighting should total 100%. These have been tagged below as Weighted %. Approximate percentage of the amount of energy being monitored for each EAC. These have been tagged below as Measured %. Assessments can be made based on the following factors: Nameplate energy ratings on equipment throughout the facility; Relative size of piping going into an EAC, that which is measured vs. not measured; Overall Utility Sub-metering Coverage (%) = SUM [(EAC1 Weighted %) × (EAC1 Measured %) + (EAC2 Weighted % × EAC 2 Measured %) + … + (EAC N Weighted %) × (EAC N Measured %)].	
Score	**Qualifying performance**
0–10	The scoring is based on the overall percentage of sub-metering coverage in increments of 1; 0% coverage receives a score of 0, and 100% coverage receives a score of 10 (e.g., coverage of 70%–79% would receive a score of 7).
METER TYPES APPROPRIATE FOR FUNCTION (SCORE 0–10)	
All meters should be fit for purpose (i.e., capable of reading the expected range of energy flows to a sufficient level of accuracy across the flow range). This criterion concerns the selection of meter types and asks the auditor to consider whether they are appropriate for the function. Primary considerations for appropriate meter function are: Rangeability – Calculated by taking the ratio of the meter maximum flow rate to the process low flow rate. Consider the range of flow the meter is capable of metering. Different meter elements will have different flow ranges, which are a function of the physical characteristics, e.g., orifice plates generally have low rangeability due to the relationship between flow and pressure drop (a square law) — this means that a 4:1 turndown at the orifice plate equates to a 16:1 turndown at the differential pressure transducer. Appropriate measurement – Inherent characteristic of any meter will measure volume (velocity), mass or energy rates. Consider for example whether the meter measures mass rate, assuming this is the required parameter for reporting. Process conditions. – Consider whether the meter is appropriate for the process temperature and pressure. Hot water may, for example, flash into steam because of meter pressure drop; similarly if the meter is measuring steam or gas, are pressure and temperature compensation necessary?	

Score	Qualifying performance
10	All sub-meters have been selected with due regard to the range of energy flows expected and are appropriate for measurement and process conditions.
7	The majority of the sub-meters have been selected with due regard to the range of energy flows expected and are appropriate for measurement and process conditions. Some meters will need replacement.
3	Some sub-meters have been selected with due regard to the range of energy flows expected; however, the majority will need replacement.
0	Meters not functional and/or meter reading suspect.
METER INSTALLATION SATISFACTORY (SCORE 0–5)	
The long-term viability of the metering system is contingent on correct installation and, therefore, the ability to maintain these systems. Meters that are harder to maintain will not be inspected or calibrated on a regular scheduled basis. Indicators of a satisfactory installation will include the presence of calibration records and evidence of regular recalibration. Other aspects to consider include: Metering systems are easy to maintain and calibrate. Factors are: the meter can easily be taken out of service for inspection; the meter is accessible; and any transmitters can be isolated from the process for calibration. Mechanical installation is correct. Key points are: meter aligned with piping; manufacturer's recommendations are followed, and any external tubing (impulse) is as short as possible. For example, steam orifice meters require a level head of water to be maintained in the transmitter tubing. Refer to manufacturers O&M manuals for information on specific meters. Upstream and downstream piping is appropriate for the meter. Typically, process meters require straight pipe (no elbows or restrictions) upstream and downstream of the meter. This is measured in terms of pipe diameters. Typical upstream values are 10 to 15 pipe diameters and downstream values are 5 to 10 straight pipe diameters. Score is based on inspection and site operations feedback. Most meter manufacturers have detailed resources available on their websites to assist users in selecting and installing their equipment correctly.	
Score	**Qualifying performance**
5	All metering systems are installed correctly and can easily be inspected/calibrated.
4	Only some of the meters have issues related to installation.
2	At least ½ of the meters have issues related to installation.
0	More than ¾ of meters not functional and/or not installed correctly.

METER ACCURACY/REPEATABILITY UNDERSTOOD (SCORE 0–5)	
Accuracy and repeatability considerations are: Age of the metering systems. Periodic inspection of metering systems is recommended by manufacturers. Consider whether the meter has been maintained or calibrated. Steam may erode the edges of any orifice plate causing inaccurate differential pressure readings, for example. Calibrations are required for pressure, temperature and differential pressure transmitters. Pressure and temperature compensation should also be considered in most applications. External fixed factors are sometimes used in meter or receiving equipment that can impact measurement totals. Factors may not be appropriate or not updated frequently. Process conditions may have changed since the system was commissioned. Examples might be converting natural gas from actual (uncorrected) conditions to standard conditions using fixed pressure and temperatures. Standard conditions are required to reconcile against billing volumes and to convert volume to energy. Another common error found is incorrect ratios used for current transformers in electrical measurement. Meter type may not be appropriate for process fluid. Dirty or viscous fluids have an impact on the metering accuracy. Score each meter with one point for each item above. Average based on total number of meters.	
Score	**Qualifying performance**
5	Metering systems are maintained and/or calibrated, external factors and fluids are appropriate for meter type.
1–4	Score based on calculated percentage.
0	Metering systems not maintained. Management or operations do not trust results.

Utility Drivers

KEY DRIVERS IDENTIFIED (SCORE 0–10)	
There are three main types of "utility driver" i.e., factors that influence the energy performance of an EAC: Production – e.g., production levels and production mix. Environmental – e.g., ambient temperature, humidity. Operational – control temperatures and pressures. For each EAC, the relevant utility driver(s) need to be identified, namely those that have the greatest impact on the energy performance of the account centre. For each EAC, a list of all possible utility drivers is created, which is subsequently reduced through discussion with the site staff to isolate those that have the greatest impact on energy performance. The scoring for this section is a subjective percentage based on how well the drivers listed account for all variables that can affect energy consumption.	
Score	**Qualifying performance**
0–10	Scoring is based on the overall percentage of drivers that have been listed for each EAC; 0% coverage receives a score of 0, and 100% coverage receives a score of 10 (e.g., coverage of 70%–79% would receive a score of 7).

DRIVER MEASUREMENT APPROPRIATE TO FUNCTION (SCORE 0 –10)	
In the same way that energy meters need to be both selected and installed correctly, bearing in mind the type of energy flow being measured and the physical qualities of the energy flow, so the measurement and sensors for measuring utility drivers must likewise be chosen and installed correctly. Particular issues specific to driver measurement relate to the measurement of variable absolute values, such as temperature, pressure and relative humidity and the period over which these absolute values are either sampled or averaged in order to arrive at a measure of the driver. This score determines not only whether the facility has determined how to measure the drivers, but also ensures that the measurements have been correlated to the energy consumption for each EAC. If drivers have not yet been defined for each EAC, regardless of whether measurements are being taken, the score should be 0.	
Score	**Qualifying performance**
10	Drivers have been identified, measurements have been defined in order to monitor the drivers, and these correlate to the energy consumption of the EAC.
7	Drivers have been identified, measurements have been partially or fully defined, but there is no correlation between a change in the given measurement and the energy consumption of each EAC.
4	Drivers have been identified for each EAC, but specific measurements have not been defined for each driver.
0	No drivers have been identified.
CORRECT MEASUREMENT OF DRIVERS (SCORE 0–10)	
This score determines whether they are actually measuring the drivers which have been determined for each EAC. Scores are based on equipment being in place that monitors the measurable for each driver. If drivers and their measurement type have not been defined for each EAC, the score should be 0. In order to prevent the collection of data that will not be used, it is important to begin by defining the drivers and their measurement type prior to putting equipment in place to monitor the drivers.	
Score	**Qualifying performance**
10	The correct drivers to measure have been identified, and they are, in fact, being measured.
7	They know their drivers and the reasons for their importance and are measuring the majority of them.
5	They know their drivers and the reasons for their importance and are measuring half of them.
3	They know their drivers and the reasons for their importance but are measuring fewer than half.
0	They don’t know their drivers, drivers are identified incorrectly, or there’s no measurement.

Data Capture and Storage

EFFORT IN METER READING (SCORE 0–5)	
Manual data collection and entry systems become unreliable and cannot offer high resolution data. Data collection may be any or all of the following: Automatically passed from meter to PLC and data historian. No manual effort is required. Data is only passed part way through an automated system. Data is captured by manual reading and then typed into computer systems (Excel or other database). Score by assessing the manual effort required to get the data into a data historian.	
Score	**Qualifying performance**
5	Complete automated System for data monitoring and collection.
4	Automated System for data monitoring; only partial data is collected automatically. Some portions of automated system not functional.
3	Data is monitored via the DCS or SCADA system but are not captured by a database and must be recorded manually.
2	Manual readings are taken from meters or remote totalizers and entered into a database.
1	Manual readings are taken from meters with no database entry.
0	Energy meters are not in place or not accessible.
EFFORT IN DATA ENTRY (SCORE 0–5)	
If automated systems are in place to collect data and no human intervention is required, score high. Are the manually recorded readings directly typed into the database or are further conversions required before entry? If the data entry system matches the same order as the manually recorded data, less chance exists to enter data in the wrong areas. Easiest data entry is when both screen and list are in the same order. Data entry is an assigned duty with back-up people assigned to cover vacation and sick time. Score based on impression and level of organization of data entry system.	
Score	**Qualifying performance**
5	Automated system in place to store data in a data historian system.
3	Partially automated collection of data into a database. Some data still entered manually.
2	Manual entry into a database.
1	Manual entry into an Excel spreadsheet with no ability to mine data.
0	No database exists.

ERROR CHECKING MECHANISMS INCLUDED (SCORE 0–5)	
This scorecard assesses whether error checking systems are in place to quickly identify faulty readings from the energy meters or driver measurements. Error check might be the operation of utilities against production totals. Out of range or zero should be flagged. Does the system account for data rollover in the meter or receiver system? Has the system been commissioned so that meter readings have been cross-checked against the reporting system? Many metering systems have indexes to indicate non-resettable total meter counts. Some metering systems have error status flags to indicate electronics issues with the meter. For example, an out of range or no-flow situation. O&M manuals should be referenced when installing error checking mechanisms. Score based on impressions of whether any error check systems are in place or reported.	
Score	**Qualifying performance**
5	Error Status from the meters or communications status triggers a flag in the database indicating that the data is inaccurate.
3	Most meters have error or communications flag status or can be cross checked against other metering systems.
2	Data is manually checked in the reports by someone who is familiar with the expected values that should be received from the system. The reports are then adjusted based on the manual inspections.
1	Data is manually checked in the reports by someone who is familiar with the system. The reports are not manually adjusted.
0	Data is not cross checked against any expected values and no error status on metering observed.
FREQUENCY OF DATA CAPTURE APPROPRIATE (SCORE 0–10)	
Both meter and driver data is considered in assessing if data capture frequency is appropriate. Key factors in this area are: Is meter or driver data capture frequency capable of meeting the minimum requirements for the reporting system? A capture rate of one hour will not be adequate to report accurately on a shift system of 7.5 hours for example. Similarly, capturing ambient temperature readings every minute will wastefully increase the amount of data analysis required. Enough resolution is required to identify any meter faults conditions. Examples might be short intervals of flows that exceed meter specifications. Sufficient resolution is required to identify abnormal driver and process conditions. Enough resolution is required to capture peak meter rates. Electrical utility may capture peak electrical consumption based on 15-minute intervals. This will drive the frequency of data capture to match the utility billing. Only automated collection systems can meet these requirements. Score based on above five constraints.	

Score	Qualifying performance
10	Data capture meets all requirements
7	Data capture systems meet majority of requirements, some adjustments are necessary to meet frequency requirements.
4	Data capture systems do not capture data at required frequency.
0	Data capture rate is not appropriate for reporting or does not meet minimum requirements (manual data collection systems).
DEGREES OF SEPARATION BETWEEN METERS AND STORAGE (SCORE 0–10)	
The extent of the chain between the metering systems and historical storage will dictate the reliability of the chain. Shorter and simpler connections between the chains will mean a more reliable data collection system. Score based on overall impressions of any existing system. Manual systems score zero.	
Score	**Qualifying performance**
10	A working system is in place to automatically collect data. The site staff have great confidence in this system.
7	Some meters are not reporting and maintenance effort is required to fix these issues.
5	Some technical issues exist with the meters and historical storage connection chain. This can be fixed with a dedicated effort.
2	Technical issues exist with the data collection and system does not meet requirements. Major re-working of system is required.
0	Data collection is not possible with the current receiver and/or data historian. Also zero if a manual system is used.
HISTORICAL DATA STORAGE SUFFICIENT (SCORE 0–5)	
To report on historical utility usage data is stored in a database. Longer term storage gives more opportunity to view trends in utility usage. Given the frequency of data capture, is the database capable of effectively processing the amount of stored data for reporting (e.g., where reports take hours to generate)? Is the database capable of storing long term data so individual shifts, days, months, seasons and years can be reported on? Score based on impressions of amount of data and overall functionality of the system.	
Score	**Qualifying performance**
5	Database historian can effectively store required amount of data.
4	Database is functioning correctly but some data not captured.
3	Database historian is capable of storing required data but more effort is required to set up database to correctly capture and/or report data.
1	Database needs to be reconfigured to store and capture data. Data historian may not be up to the task.
0	Historical data storage is not possible long-term as the database cannot store quantity of required data.

Data Analysis and Reporting Assessment

Data Analysis

SCALE OF SYSTEM APPROPRIATE TO COMPLEXITY OF ANALYSIS (SCORE 0–5)	
This criterion compares the scale of the EMIS system and the required analysis. The requirements are both the client's own and those necessary to provide accurate and reliable analysis. These are not necessarily the same, as some clients will not realize the full requirements and potential of an EMIS system. Qualifying considerations include: Number of meters and frequency of data storage and analysis; Complexity of reporting and analysis; Single site of multiple site system; Resource requirements to facilitate the analysis.	
Score	**Qualifying performance**
5	System capable of required scale of analysis and technical content. May serve multiple sites. Intuitive and/or simple interface to configure and obtain analysis. Automated analysis requiring no resource.
3	System capable of required scale of analysis and technical content with minimum resource requirements. Specialist input required for initial set-up and definition of analysis.
2	System capable of required scale and technical content but has high resource requirements, i.e., specialist knowledge and input required to achieve analysis.
1	System capable of required scale and technical content but has high resource requirements. Either resources not available or not allocated to the task.
0	System incapable of processing the required amount of data in a timely manner. Technical capabilities of system inadequate to complete required analysis.

CLOSE INTEGRATION WITH DATA CAPTURE SYSTEM (SCORE 0–5)	
This criterion considers how closely the analysis and reporting tool is integrated with the data historian. Closer integration will reduce resource requirements in extracting and processing data.	
Score	**Qualifying performance**
5	Full integration with data historian. Access by analysis and reporting tool to data historian available at all times.
3	Full integration with data historian. Access by analysis and reporting tool to data historian only at pre-scheduled times.
2	Semi-integrated with data historian. Automated data extraction from data historian into separate database.
1	No integration with data historian. Data can be extracted using batch procedure, but this requires specialist.
0	No integration with data historian. Data must be extracted manually from data historian and input into analysis and reporting tool manually.

COMPARISON OF ONGOING PERFORMANCE AGAINST DRIVERS (SCORE 0–10)	
This criterion considers whether the relationship between utility drivers and utility consumption is considered on measuring performance. Utility drivers are independent variables that have a direct impact on energy consumption, such as production rate, product mix, occupancy and ambient temperature. It cannot be assumed that these drivers have a significant impact on consumption. Best practice is to perform multiple regressions against a number of drivers and then to consider only those drivers that have a statistically significant relationship.	
Score	**Qualifying performance**
10	Multiple regression statistical analysis of the impact of all available utility drivers. Regular re-screening of utility drivers to ensure that changes in circumstances have not changed the validity of drivers chosen (e.g., change in product mix, new plant installation).
7	Multiple regression statistical analysis of the impact of all available utility drivers based only on historical data analysis.
5	Comparison with multiple utility drivers based on linear regression. Consideration of each utility driver independently.
3	Simple comparison against utility driver, based on linear regression or visual interpretation.
0	No consideration of utility drivers.

DATA ANALYSIS OVER FLEXIBLE TIME FRAMES (SCORE 0–10)	
The period during which data is analyzed will vary according to audience and the analysis or reporting required e.g.: Previous year; Monthly analysis for budgeting and management reporting; Weekly analysis for operational management; Daily/shift based analysis for production and shop floor; The definition of each of these periods is also important to ensure that analysis periods coincide with actual shift times, corporate reporting periods, etc.	
Score	**Qualifying performance**
10	Flexible and multiple time frames can be selected by the user at any time. These can either be programmed in or used on an ad-hoc basis. Several definitions can be used in parallel for a given period.
7	Flexible and multiple time frames can be selected by the user at any time e.g., 06:00 Monday to 06:00 Saturday, eight-hour shifts
5	Flexible analysis time frames either pre-defined by user or set by system (e.g., last week, month to date, etc.)
3	Fixed analysis period, pre-defined by user to coincide with shifts, work week, etc.
0	Fixed analysis period, defined by system e.g., only daily, midnight to midnight

DATA AGGREGATED OVER FLEXIBLE TIME PERIOD (SCORE 0–5)	
Data historians are typically configured to sample meter readings and variables at a frequency of between one minute and one hour. However, in order to report to different audiences, it is desirable to aggregate both the consumptions and targets over a flexible time frame. For shift operations, the ability to report consumptions and targets over shifts on the previous day will:	
Score	**Qualifying performance**
5	Aggregate data over multiple variable time periods, multiple time period data possible on a single report.
4	Aggregate data over multiple variable time periods, single time period on any given report.
3	Aggregate data over variable time period, but only one definition of the time period at a time.
2	Aggregate data over fixed time period defined by user.
1	Aggregate data over fixed time period defined by system.
0	Not able to aggregate data.

Target Setting

TARGETS BASED ON ANALYSIS OF DATA (SCORE 0–10)	
Have targets been based on an analysis of historic performance or on theoretical performance characteristics or are they arbitrary?	
Score	**Qualifying performance**
10	Target based on multiple regressions, defining both base load and variable load. Separate targets entered for start-up, shut-down, product changeover and downtime, etc.
7	Target based on multiple regressions, defining both base load and variable load.
5	Target based on single regression, defining both base load and variable load.
3	Targets based on data visualization — these are targets based on visual inspection of data and subjective decision of appropriate target. or Ad-hoc targets. Corporate energy reduction targets are often based on a percentage reduction determined by a desire to reduce energy consumption that is not determined by any analysis. Without analysis it cannot be determined if such targets are achievable.
0	No target. Measurement of energy consumption by Energy Account Centre will enable some savings to be identified and improvements made, though without targets, the improvements could not be quantified or sustained.

REALISTIC TARGETS DEFINED (SCORE 0–10)	
Targets should be based on realistic analysis and be achievable in the medium-term.	
Score	**Qualifying performance**
10	Targets based on statistical analysis and account for standard error in analysis. The standard error band will take into account the accuracy of the target achieved and uncertainty in the data points.
7	Targets based on analysis. Target line set at least squares regression line. This represents the average performance of the target data set and is, therefore, historically achievable 50 percent of the time.
5	Target set arbitrarily within achievable range or target calculated using historical consumption and utility drivers. Set at best achieved level.
3	Target set at level not previously achieved.
0	No target.
TARGETS ACCEPTED BY EAC OWNER (SCORE 0–10)	
For targets to be effective the EAC owner must accept the target as realistic and be willing to take action to improve performance.	
Score	**Qualifying performance**
10	EAC owner fully accepts targets and is involved in tightening standards.
7	EAC owner fully accepts targets but unsure how to influence them.
5	EAC owner will go along with targets without full commitment or EAC owner only accepts targets when performance is good.
3	EAC owner does not accept basis for targets. Rejects targets.
0	No EAC owners.
EAC OWNER IS ACCOUNTABLE FOR PERFORMANCE AND EMPOWERED TO IMPROVE IT (SCORE 0–5)	
Does the EAC owner have the authority and ability to implement improvement actions based on the performance shown by the targets?	
Score	**Qualifying performance**
5	EAC owner directly accountable for performance, empowered to take action, and willing to implement changes.
4	EAC owner directly accountable for performance, empowered to take action, but unwilling to implement changes.
3	EAC owner has regular contact with person who is accountable and empowered to make changes. Able to influence this person to make changes.
2	EAC owner remote from decision makers. Can instigate change request but reliant on others to decide whether to implement.
0	EAC owner remote from decision makers and unable to exert any influence.

TARGET-SETTING PROCESS INCLUSIVE (SCORE 0–5)	
To what extent have the owners of the Energy Account Centres been involved in the process of target setting? If targets are to be accepted and owned, the EAC owners should be actively involved in the process.	
Score	**Qualifying performance**
5	EAC owner fully involved in target setting process.
3	EAC owner present during target setting in capacity of observer only.
1	EAC owner aware of target setting, but not involved.
0	EAC owner neither involved nor aware of target setting.

Utility/Energy Performance Reporting

PRODUCTION OF PERFORMANCE REPORTS (SCORE 0–5)	
Can performance reports be produced automatically and by multiple people?	
Score	**Qualifying performance**
5	Reports available immediately at end of reporting period measured e.g., for daily report, day ends at 06:00, reports available at 06:30.
3	Reports available 24 hours after end of period.
1	Reports available one week or more after end of period.
0	Reports available only if produced as a one-off report. Not routinely available.
REPORT GENERATION (SCORE 0–5)	
Who can produce performance reports?	
Score	**Qualifying performance**
5	Automatic report generation, accessible to all stakeholders.
3	Reports generated by wider group of people. Specialist knowledge not required to produce reports.
1	Reports generated by specialists. Cannot easily be produced if these people are not available.
0	No responsibility allocated or explicit skills needed to produce reports.
TIMELINESS OF PERFORMANCE REPORTS (SCORE 0–5)	
How quickly are performance reports available after the period of measurement?	

Score	Qualifying performance
5	Reports available immediately after the end of the period measured e.g., for daily report, day ends at 06:00, reports available at 06:30.
3	Reports available 24 hours after end of period.
1	Reports available one week or more after end of period.
0	Reports available only if produced as a one-off report. Not routinely available.
USER FRIENDLINESS OF PERFORMANCE REPORTS (SCORE 0–5)	
Are the performance reports understood by the users and do they contain data that have been agreed on with the users?	
Score	**Qualifying performance**
5	Reports easy to understand for all users.
3	Some parts of report easily understood, other parts not understood or ignored.
1	Reports too complex for EAC owner to fully understand or explain.
0	Complex reports, understood only by individuals who created them.
CONTENT OF PERFORMANCE REPORTS (SCORE 0–5)	
Are the data or information in the performance reports sufficient to stimulate action and discrete enough to direct its focus?	
Score	**Qualifying performance**
5	Content is ideal for interpreting performance and making improvements. No extraneous content.
3	Contains required information, but masked by irrelevant or unnecessary information.
1	Contains some useful information, but not all information that is required.
0	Irrelevant or incorrect content.
READERSHIP OF PERFORMANCE REPORTS (SCORE 0–5)	
Are performance reports available to all or restricted to a small set of key users? Are reports paper-based or live and generated directly from the data?	
Score	**Qualifying performance**
5	Live generated reports available to all those concerned. Reports available only to those concerned.
3	Live generated reports available to all people concerned. All reports available to everyone, even if not involved. Only some reports relevant to an individual are made available.
1	Paper-based reporting, inconsistent distribution with result that those concerned often do not receive relevant reports.
0	Paper-based reporting with restricted access.

ABILITY TO ROLL UP PERFORMANCE REPORTS (SCORE 0–5)	
Is it possible to drill down and consider performance from a site level, to a department, to EAC and is the data consistent throughout?	
Score	**Qualifying performance**
5	Can drill down, data consistent. All users capable of drilling down.
3	Can drill down, data consistent. Requires specialist knowledge to drill down.
1	Can drill down, but data is inconsistent.
0	Not possible to drill down.
INTEGRATION WITH OTHER IT SYSTEMS (SCORE 0–5)	
Are the data in the performance reports available to other internal IT systems?	
Score	**Qualifying performance**
5	Integrated IT platform. Able to send e-mails, download to Excel, Word, etc.
3	Limited but useful communication with other systems.
1	Can communicate with isolated systems, but not user-friendly.
0	Isolated system on separate platform.

System Support Skills

CAPABILITY TO MAINTAIN METERS AND DATA CAPTURE SYSTEM (SCORE 0–5)	
Can IT hardware/software, faulty meters and communication hardware be diagnosed and maintained in-house?	
Score	**Qualifying performance**
5	Automated condition monitoring and error flagging. Skilled in-house technicians available to perform maintenance and repairs.
3	Reasonable capability. Some preventive maintenance and engineering procedures in place. Procedures include condition monitoring and scheduled calibration and testing.
1	Limited capability. Organization restricted to respond only to breakdowns.
0	No in-house capability.
DATA CAPTURE AND REPORTING ON A SINGLE NETWORK (SCORE 0–5)	
Are data capture and reporting systems on a single network? Is communication between different system components simple?	

Score	Qualifying performance
5	Single network and common communication platform.
3	Both systems on same network, but some limitations in communication between component parts exist.
1	Separate networks, but communication between the networks possible through communication protocols.
0	Systems for data historian and analysis/reporting tool separate and incompatible.
IT ENVIRONMENT UP TO DATE (SCORE 0–5)	
Are operating systems and tools up-to-date and is technical support for these components available?	
Score	**Qualifying performance**
5	All systems up-to-date and compatible.
3	Systems still supported by suppliers, but not all kept up-to-date. Can be updated easily if required.
1	Some parts of system out-of-date and unsupported. Critical parts of IT environment stable and reliable.
0	Systems out-of-date and no longer supported. Systems unstable.
CAPABILITY TO MAINTAIN AND OPERATE EMIS (SCORE 0–5)	
Technical skills are required to understand the system, to modify system configuration when adding new plant/ new meters.	
Score	**Qualifying performance**
5	Widespread skills available to maintain and operate system. Skills updated regularly to maintain pool of capable people.
4	Good internal skills can cope with all requirements, but limited to one individual. Skills would be lost if this person were unavailable.
3	Internal skills available for routine changes. External skills required for involved changes. Training and development in place to improve skills.
2	Internal skills available for routine changes. External skills required for complex changes.
1	Very limited internal skills set. Able to call on external resources.
0	Technical skills no longer available. System unsupported.
TECHNICAL SKILLS AVAILABLE TO ANALYZE DATA AND SET TARGETS (SCORE 0–5)	
Technical skills required to analyze data and to set new targets and generate new reports.	
Score	**Qualifying performance**
5	Internal skills available for routine changes. External skills required for complex changes. Training and development in place to upgrade skills.
3	Internal skills available for most requirements but limited to 1-2 people.
1	Very limited internal skills set. Able to call on external resources.
0	No internal skills.

A4 EMIS Audit Checklist

EMIS Audit Checklist *If you can tick all the boxes the audit site work is complete*	
❐	There is mutual agreement as to the purpose for the EMIS.
❐	The objectives for implementing a new EMIS or improving an existing EMIS have been agreed to and can be clearly articulated.
❐	Energy Account Centres have been identified.
❐	Existing metering has been assessed and any changes to the metering determined.
❐	All new meters have been identified and approximate locations determined. This should include approximate sizing of fluid meters for budgeting purposes.
❐	The utility driver data required for analysis has been determined and any new required meters or sensors defined.
❐	The existing data capture and storage systems have been assessed and any changes determined.
❐	The interface between data capture and storage and data analysis has been considered and a solution identified.
❐	The requirements for data analysis have been assessed and the frequency of analysis defined.
❐	Key stakeholders and the processes for setting targets have been identified.
❐	Energy reporting needs have been identified.
❐	Management systems and procedures have been assessed and the relationship between the EMIS and either the existing energy management program or any other continuous improvement program identified.
❐	Sufficient information from the site has been obtained in order to estimate the benefits of the EMIS, in both financial and non-financial terms.
❐	Sufficient information from the site has been obtained in order to estimate the approximate costs for implementation of the EMIS.
❐	Sufficient information from the site has been obtained in order to define the activities and costs for development of the EMIS Implementation Plan.

B5 Stakeholder Engagement and Sign-off Worksheet

Use the following worksheet tool to map out the key stakeholders in the organization who should be involved at different stages of the EMIS Implementation Plan process (Conceptual Design, Detailed Design, Implementation Plan). An EMIS overlaps many organizational levels. A quality design process should involve these levels at key stages to ensure that:

- critical inputs and sign-offs are obtained;
- buy-in and ownership are developed; and
- people develop awareness of the planned EMIS.

EMIS Element	Stakeholders/ Level	Conceptual Design Inputs and Sign-offs	Detailed Design Inputs and Sign-offs	Implementation Plan Inputs and Sign-offs
Business Level Overview and Final Business Case	Corporate	Obtain sign-off on Business Level Overview		
	Plant Manager			
	Production			
Energy Account Centres	EAC Owners	Engage EAC Owners in EAC design		
	Operational Teams	Consult with Ops Teams to gain insights into EAC level drivers		
Metering and Inputs	EAC Owners and Teams			
	Engineering and Instrumentation			
Data Capture and System Integration	IT Department			
	Instrument and Electrical Technicians			
Data Analysis and Reporting	Finance			
	Procurement			
	Plant Managers			
	Operational Managers			
Management Systems: People and Procedures	Energy Management Steering Group			

B6 Energy Account Centre Structure

Use this EAC table as a template for designing a master overview of the EAC structure, EAC Owners, new (N) and existing (E) metering and inputs and calculation elements required for calculating KPIs, performance metrics, and so on.

This table can then be used to:

- quantify meters and input devices for metering take-off purposes;
- ensure the appropriate energy and driver data is being gathered to inform KPI/Performance calculations;
- present the overview of the system and;
- determine tag numbers, and so on, for data capture purposes.

Figure B6-1 EAC Structure Table

Level					Energy Meters			Inputs/Utility Drivers			Calculation Input Requirements
Level-1: Site	Level-2: Department	Level-3: Sub-department	Level-4: EAC	EAC Owner	Elec	Gas	Other	Production	Environment	Other	
Plant	TMP*	Refiners	Refiner 1	Sally	N			E	N		
			Refiner 2	Bob	N			E	E		
	Paper	Paper Machines	PM 2**	John	N		N,N	E	N		

* TMP: Thermo-mechanical Pulp
** PM2: Paper Machines

B7 Data Analysis and Reporting Planning Worksheet

Complete this worksheet at the conceptual design stage of data analysis and reporting.

Who/Level	Report Type	Report Content	Calculations	Input Data	Report Frequency

B8 Energy Management Policy and Framework

Extensive literature exists on how to establish a systematic approach to managing energy. There is no "one size fits all" approach. However, a fundamental organizational commitment to managing energy is a pre-requisite to deploying a successful EMIS. Without this organizational context that drives peoples' "actions," an EMIS will only deliver information. As the purpose in installing an EMIS is to provide information that enables energy improvement actions by people, the organizational context that drives those actions is paramount to its success.

Some elements of the energy management framework to consider include:

- Assess experiences of other companies who have implemented energy management programs;
- Establish a policy related to the management of energy empowering the program;
- Set up a planning function to create a strategy, set goals and targets and establish the program;
- Create an organization to execute the strategy;
- Establish a structure for identifying and implementing capital and operating improvements on an ongoing basis;
- Train people to perform the range of energy management functions;
- Communicate proactively to encourage energy management;
- Set up a reporting system for reporting on effectiveness of the program.

More information on Energy Management Planning is available from Natural Resources Canada's Dollars to $ense Energy Management Workshops (oee.nrcan.gc.ca/industrial/training-awareness/)

B9 Energy Management Systems Methodologies

Most management systems are built around the Plan-Do-Check-Act (PDCA) methodology. When applied to energy management, PDCA can be defined as:

- **Plan:** establish the objectives and processes necessary to deliver results in accordance with the organization's energy policy.
- **Do:** implement the processes.
- **Check:** monitor and measure processes against energy policy, objectives, targets, legal obligations and other requirements to which the organization subscribes, and report the results.
- **Act:** take actions to continually improve performance of the energy management system.

Figure B9-1 Energy Management System (EnMS)

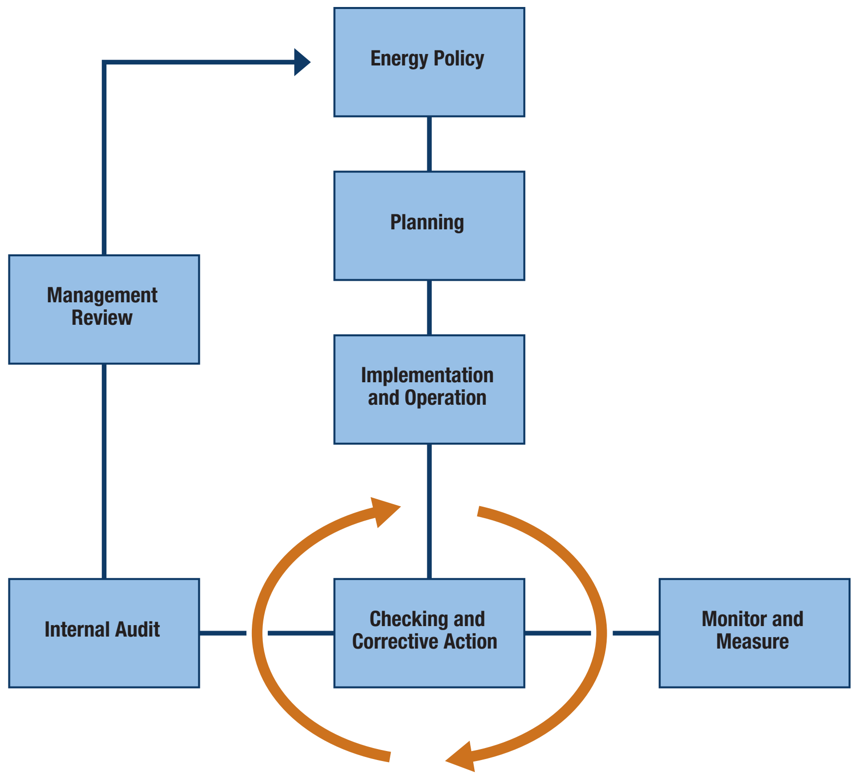


Figure B9-1 shows how PDCA works within the proposed energy management. This model is useful in helping to identify typical roles within an energy management system and hence informing any decisions as to structure.

It is also common to find organizations already using continuous improvement approaches such as:

- **Total Quality Management –** TQM is a business management strategy designed to introduce awareness of quality in all organizational processes. TQM publicized the concept of “Kaizen,” a focus on continual process improvement to make processes visible, repeatable and measurable.
- **Six Sigma –** a business management strategy that focuses on the identification and elimination of the causes of defects in manufacturing or business processes. Significantly, Six Sigma uses statistical methods, such as regression, to analyze business processes and identify root causes of defects. The Six Sigma methodologies include a hierarchy of practitioners, from White Belt through Green Belt to Black Belt, who have increasing expertise in these methods.
- **LEAN –** LEAN is a set of tools whose objectives are to both identify and eliminate waste, leading to improved quality and production time and reductions in costs of production. LEAN is similar in philosophy to the Toyota Production System or TPS.
- **5S –** philosophy and a way of organizing and managing the workspace and work flow with the intent to improve efficiency by eliminating waste, improving flow and reducing process unevenness).

It is important to integrate energy management into existing business systems wherever possible to ensure the sustainability of the initiative and to avoid “islanding” of energy management. In many cases, energy management and an EMIS can best be deployed as part of an existing continuous improvement business system. At a higher level, however, senior management must make a fundamental commitment to manage energy as a variable cost element of the business in order for it to be sustainable.

B10 Allocation of Roles and Responsibilities

Implementing an EMIS at an organization will likely involve new roles for people and, in the case of the steering groups and improvement teams, result in new organizational groupings. These roles will need to be clearly defined in terms of their responsibilities. This is a necessary precursor to identifying the skills and training required. Where new people are to be employed to fill these roles — for example an Energy Management Champion — the role definition can be used as an aid to recruitment.

Figure B10-1 Allocation of Roles

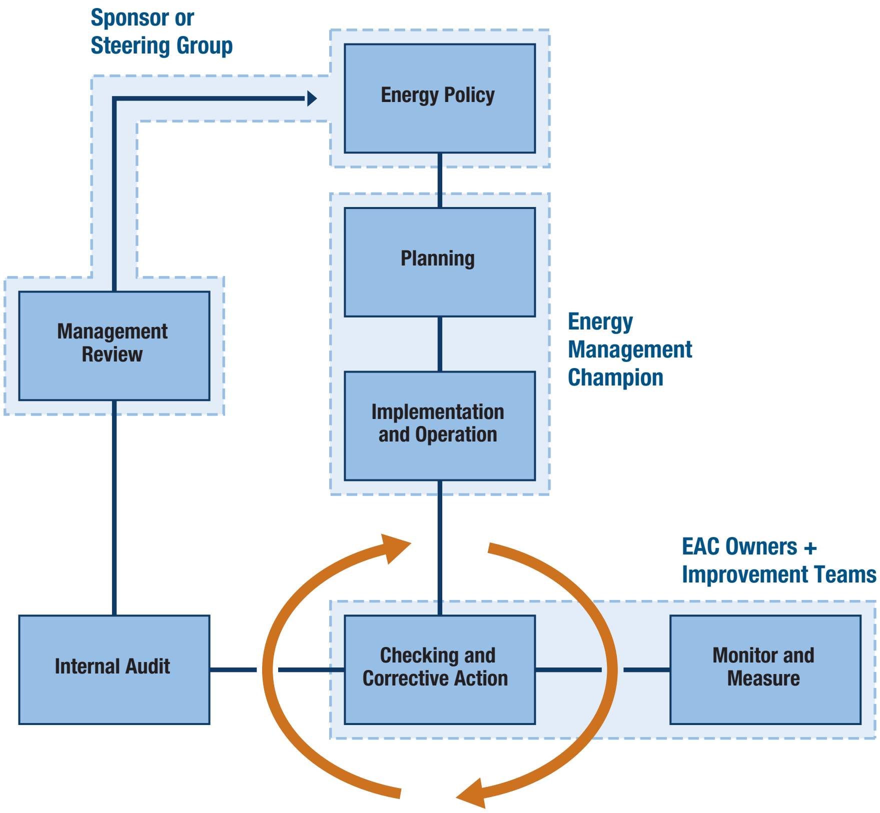


Figure B10-1 shows four generic roles that may be considered within an energy management framework. These are further described as follows:

Sponsor or Steering Group: Typically the Project Sponsor or Steering Group will play a governance role within the Energy Management Information System. To do so, they will define the overall energy policy; set objectives and targets for improvement; ensure the availability of resources to implement; maintain and improve the energy management system. These resources may include human resources, specialized skills, technology and financial resources. The Sponsor/Steering Group should also have sufficient authority within the organization to resolve conflicts and direct activities, although they will not be involved in day-to-day operation. The Sponsor or Steering Group will nominate the Energy Management Champion and may also be involved in decisions relating to participation in the Improvement teams. Steering groups would be used where the EMIS is being implemented at a site level, where the organization's management structure is flat, or where senior management operate collegiate decision-making processes. Project Sponsors are more likely to be used where the EMIS is being implemented on a corporate basis, where management is more hierarchical and where management responsibilities are more clearly defined on a functional basis.

Energy Management Champion: The Energy Management Champion is central to the success of the EMIS and takes responsibility for day-to-day operation of the management system. This means that the EMC will act as the overall project manager for the EMIS during implementation, will work with the Energy Account Centre owners to define the targets for the EACs, and may also act as a focal point for energy expertise within the organization. The EMC will participate in any training activities and will report to the Sponsor or Steering Group on the performance of the EMIS and make any recommendations for improvements.

EAC Owners: An EAC Owner will have process management responsibility for the equipment within one or more Energy Account Centres and will be held accountable to the site or organizational management team for the performance of the EAC.

Improvement Teams: Improvement teams will typically be multidisciplinary teams tasked with process investigation and identification of opportunities for improvement. If accepted, improvement teams may also be tasked with implementation of the opportunities. Although shown as separate from the EAC Owners, it is common to place the EAC Owner as a constituent of the improvement team since they will bring detailed process knowledge to the team. The EMC will coordinate the activities of the improvement teams as part of the responsibility for day-to-day operation of the EMIS.

Within energy management, roles are often characterized by the time allotted to People, Systems, and Technologies. In this Appendix the three generic roles within energy management are defined using the organizing framework of People, Systems and Technology. Remember that role descriptions are generic and must be adapted to the specific needs of each EMIS implementation project.

Energy Management Champion

PEOPLE

- Delivering training to the Sponsor/Steering Group on energy management
- Communicating the need for change to all staff
- Motivating colleagues to contribute to the program
- Developing and implementing a communications program designed to raise awareness of energy consumption within the sites
- Managing and implementing a communications program to raise awareness of activities designed to maintain the engagement of line operators with the overall objectives of energy efficiency improvement
- Providing relevant data and analysis to key internal and external stakeholders concerning energy performance
- Acting as a conduit for knowledge sharing within the site/organization regarding techniques and technologies for energy performance improvement

SYSTEMS

- Developing and implementing an EMIS, including drafting policies and procedures, formulating action plans, securing budgets and ensuring follow-up actions
- Maintaining a high level of knowledge and awareness of best practices in the field of energy management and its information systems; this should include knowledge and awareness of emerging standards for energy management
- Ensuring corporate compliance with all emergent legislation and regulations concerning the environmental impacts of energy consumption
- Responsible for the day-to-day operation of the Energy Management Information System, including the maintenance and evolution of energy performance targets

TECHNOLOGY

- Providing technical leadership on energy efficiency and energy technologies that can be employed within the manufacturing process to reduce the overall energy consumption associated with production
- Performing regular cross site benchmarking exercises on key processes or items of equipment with the aim of identifying those which are performing best in class
- Identifying and implementing cost effective technologies for improving energy performance

Sponsor/Steering Group

PEOPLE

- Communicating the need for change to all staff
- Giving feedback to the Operational Teams and the Energy Management Champion
- Motivating staff to contribute to the program

SYSTEMS

- Defining the goals for the energy management program
- Securing resources for the energy management program
- Monitoring progress against objectives
- Following up on actions agreed to with the Energy Management Champion and the Operational Teams
- Defining and managing communications to both internal and external stakeholders

TECHNOLOGY

- Evaluating proposals for change (technical and non technical opportunities)

Improvement teams

PEOPLE

- Communicating energy performance within the EAC to the EAC Owner and line operators
- Persuading operators to change/improve behaviours to improve energy performance
- Giving feedback to operators on the impact of any changes in behaviour
- Team work to identify root causes of variations in performance
- Promoting awareness of energy savings needs to colleagues

SYSTEMS

- Comparing actual and target performances within each EAC for each utility
- Identifying possible causes of variations
- Defining the investigation necessary to pinpoint the root cause
- Collecting and analyzing additional data from the data historian
- Reporting progress on weekly/monthly basis to Sponsor/Steering Group
- Managing Action Plan – development, budgeting, project management

TECHNOLOGY

- Auditing energy using subsystems to identify opportunities for energy savings
- Estimating the benefits from changes in operational parameters or improved technologies (with the EMC)
- Evaluating the impact of changes

B11 Roles and Skills Assessment Worksheet

Use the following table as a guideline to detail the impact your new energy management organization will have on existing management systems and to determine what new procedures are required.

Energy Management Function	Role	Skills required	Who	Skill Gaps	Management System Issues	New Procedures Required?
Steering Group	The Steering Group provides the strategic leadership for the energy management program		Jill Jack Harold		Establish new incentives Establish direction, set and review targets	
EAC Owner/ Operational Teams	Management of EACs for continuous improvement		Buzz Gerry Anne Don		Work within Six Sigma continuous improvement system	
Energy Management Champion	Oversee effectiveness of operation of Program and EMIS		Monica			Establish and maintain reporting

B12 Evaluating External Bids

In Part A of the Manual, bid evaluation was introduced as a means of choosing between potential suppliers for the EMIS Audit. It consisted of:

- Defining the criteria against which bids would be evaluated;
- Deciding the relative weighting of each of the criteria (this was done by applying a different score to each of the criteria);
- Using multiple assessors to evaluate each bid and score the bids against each of the criteria;
- Dividing the cost of each bid by its evaluation score to give a relative measure of cost/point;
- Going with the supplier that offers the lowest cost, provided that they have achieved a minimum hurdle score on the technical evaluation.

This same technique is recommended when evaluating external bids for each of the packages of work. Each of these tasks is addressed in more detail below.

Criteria Definition

The overall criteria for evaluation will be a mix of technical and non technical criteria:

- **Technical Criteria:** These will relate to the specific technical requirements sent to each of the bidders and described within the technical specification or functional description. This means that when drafting the technical specification or functional description, requirements should be sufficiently succinct and precise that subsequent evaluation is possible. Poorly worded or imprecise technical specifications are likely to result in a range of potential responses that are not comparable, making an evaluation against a common set of standards impossible.
- **Non Technical Criteria:** These criteria will relate to quality control, support, proposed level of staff expertise, or desirable customer service attributes. Again, for purposes of aiding evaluation, the desired levels of non technical attributes should be communicated to bidders with the technical specifications; bidders should be encouraged to address these aspects in their bids.

Relative Weighting

When deciding the relative weighting of each criterion it is important to include as many stakeholders as possible. If not, the overall evaluation will be subjective rather than objective. The critical word here is “stakeholders” — the people included in the decision on criteria weighting must have an interest in the outcome of the evaluation process, for example, as a potential customer of the product or service being evaluated or as someone whose work will be impacted by the procurement of the product or service.

Relative weightings can be determined through discussion between stakeholders, provided that the number of stakeholders is small. As the number of stakeholders increases, so does the difficulty of reaching consensus through negotiation, and other techniques may be required, e.g., adaptations of Delphi techniques. For this, the evaluation scoring sheet would be sent to all stakeholders who would be invited to apply their own relative weightings. The completed sheets are returned to a central co-ordinator who consolidates the responses into an average weighting for each criterion. This is then returned to stakeholders for approval. This allows each stakeholder to submit opinions free of organizational pressure or personal influence.

Another issue to consider in determining the relative weighting is the overall value and importance of the product or service being procured to the overall success of the EMIS implementation. More formal techniques should be used when the product or service is of both high value/importance but can be avoided where the value/importance is less.

Assessment

When evaluating bids it is equally important to include as many of the stakeholders as is practical. In the assessment, evaluators should score each proposal using the relative weightings decided on. If substantial disagreement between evaluators exists, they should be invited to discuss the reasons behind their scoring.

In an ideal world the technical evaluation should be performed separately from the financial evaluation — i.e., evaluators should have no knowledge of the costs of each of the bids when doing the technical evaluation — otherwise there is a risk that this could colour their judgment.

The assessment process should also include agreement on the minimum hurdle scores for each of the criterion, both technical and non technical. The role of the minimum hurdle score is to define minimum acceptable performance for each criterion, with any bids that fail to meet these requirements being rejected or required to resubmit to address these failings.

If this process is respected, then all of the final bids received should attain minimum acceptable performance in all of the criteria.

Deciding

There are two means of deciding between the bids:

- Lowest cost – with all bids achieving acceptable standards, one option is to accept the bid with the lowest cost. This has the advantage of leading to the lowest purchase price but places no value on product or service attributes that go beyond the minimum acceptable performance.
- Best value – in Best Value, financial bids are divided by the evaluation scores; bids can be compared on a cost/point basis. The winning bid is that which scores the lowest cost/point. In some instances this may not lead to the lowest overall cost but does place a value on additional product and service attributes.

B13 Technical Specification Sheets for Metering and Inputs

Use the following general specification sheets for all meter types and track using an instrument list. Collect as much information for each meter as possible and use one copy for each meter. Your local supplier can then help specify and cost out metering requirements.

Complete the Liquid and Gas Meter Specification Table B13-1 below. For guidance, use the reference material below the table.

Table B13-1 Liquid and Gas Meter Specification

LIQUID and GAS METER SPECIFICATION			
			Sheet ____________ of _____________
			Date _____________________ Rev # _____________________
	#	Description	DESIGN SPECIFICATION
General	1	Tag Name	
	2	Location and Description	
	3	Primary Measurement	☐ Mass ☐ Volume ☐ Energy
	4	Required Measurement	☐ Mass ☐ Volume ☐ Energy
	5	Required Up and Downstream Length	Up _______________ Down ________________
Meter Body	6	Line Size	____
	7	End Connections	☐ Flanged ☐ Screwed NPT ☐ Wafer ☐ Weld by Weld ☐ Insertion type
	8	Line Size	____
	9	Orifice Size	____

Fluid Data	10	Fluid	☐ Gas ☐ Liquid Name: ______________
	11	Flow Range	Min. ______________ Max. ______________ Normal ______________
	12	Max. Oper. Pressure	______________
	13	Oper. Temperature	Max. ______________ C Min. ______________ C
	14	Operating Specific Grav.	______________
Transmitter	15	Hardware	☐ Pulse ☐ Analog
	16	Network	☐ Ethernet ☐ Fieldbus ☐ Profibus ☐ Other______________
	17	Serial Data	☐ Serial RS-232 ☐ Serial RS-485 ☐ Protocol ______________
	18	Local Display	☐ Required
	19	Power Supply	☐ 24 VDC ☐ 120 VAC ☐ Other ______________
Accessories	20	Pressure Transmitter	☐ Not required ☐ Range ______________
	21	Temperature Transmitter	☐ Not required ☐ Range ______________
	22	Transmitter Enclosure	☐ General Purpose ☐ Nema 4 ☐ Hazardous area rated
Other	23	Drawing Ref.	
Receiver Instrument	24	Tag Name	
	25	Connection	☐ Channel ______________ ☐ Port # ______________ ☐ Port type ______________
Equipment	26	Model #	Manufacture by: ______________ Model # ______________
Notes:	Orifice meters are usually sized by vendors as a sizing program is required. Attach Orifice sizing as part of specifications.		

Liquid Meter General Requirements

Typical process liquids to be measured are:

- Water, as medium for heating or chilling
- Fuel oils
- Light Hydrocarbons such as Propane or Butane. This class of product is often called LPGs (Liquid Propane Gases).

Table B13-2 lists examples of typical liquid meters

Water

Typical water meter applications are for domestic and process consumption. Utility (billing) water meters vary in design; analogue or pulsed output signals may not be available on existing meters. If not, a new meter should be specified.

Water is also commonly used as a transport medium for heating and cooling loads. In this case an energy calculation is required for the energy cost centre. In addition to the meter, two temperature transmitters are required to measure inlet and outlet water temperatures. Some meters may not be appropriate for hot water because of temperature or high pressure drops.

Fuel Oils

Fuel oils include a range of liquid hydrocarbon fuels such as heavy fuel oil (bunker) and light fuel oil (#2 fuel oil). These fuels are used as primary energy sources for heating applications or for generating process steam. There are a variety of different meters available on the market and costing will vary with the level of accuracy and repeatability specified. Most metering vendors/suppliers have access to comprehensive meter selection software that can be used to specify the appropriate meter for the application. These types of oils are sold based on volume at a temperature of 15°C. When more accurate costing is required, use a temperature transmitter and compensate measured temperature using American Petroleum Institute (API) Table 54b. The fuel supplier can advise you on the product heating value when energy is charged back to the cost centre.

Liquid Propane Gases

Liquid Propane Gas (LPGs) are typically propane and butane based products. These are sold by volume corrected to 15°C. There are a variety of different meters available on the market and costing will vary with the level of accuracy and repeatability specified. Most metering vendors/suppliers have access to comprehensive meter selection software that can be used to specify the appropriate meter for the application. This class of products can be volume corrected from temperature measured to 15°C using API Table TP-25. When metering these products, pressure drop must be considered, as these products will flash in gas.

Table B13-2 Liquid Meter Types

#	Meter Type	Rangeability	Typical usage	Measurement Type
1	Orifice or Flow Nozzle	4:1	▪ Water	Mass, convert to volume using fixed SG
2	Thermal-dispersion	10:1	▪ Water	Mass
3	Vortex	15:1	▪ Water ▪ Fuel Oils	Volume
4	Turbine	10:1	▪ Water ▪ Fuel oils ▪ LPGs	Volume
5	Nutating Disk	10:1	▪ Water	Volume

Gas Meter General Requirements

Gases are measured using a variety of meter types, depending on the metering purpose.

- Compressed air
- Process gases, such as Nitrogen, Oxygen or Carbon Dioxide
- Steam, either saturated or superheated
- Natural Gas or Endothermic Gas (derivative of Natural Gas)

Compressed Air and Process Gas

Compressed air or process gas can, for example, be purchased (for internal cost centre use) based on mass or volume. Process gases are typically sold as a liquid based on mass and then vaporized into a gas. Process gas can be measured as a liquid; however, it is more cost effective to measure the gas since liquid process gases require cryogenic rated equipment.

Cost to generate compressed air could be related to mass or volume. When volume totals are required, additional calculations are necessary to compensate line conditions for pressure, temperature and deviation from perfect gas laws (called supercompressibility).

Steam as Saturated or Superheated

The primary consideration for steam metering systems is the operating conditions of the steam. Any process instrumentation must be rated for both the operation pressure and temperatures of the boiler and related equipment. Consult document design and drawings to find the maximum operating pressure and temperature.

Steam is most commonly measured as mass and then converted to energy total. Energy content of the steam is derived from a steam table. Orifice metering is the most common type of metering for steam applications, although other technologies such as V-Cones are also becoming common since they can be specified for greater turn-downs and minimum equivalent pipe diameters upstream and downstream. Note: In most cases, these primary sensing elements provide a differential pressure measurement and will require a differential pressure transmitter to produce the input signal to your EMIS. Some manufacturers can provide “smart” transmitters with built-in steam tables and pressure compensation.

Natural Gas

Natural gas is typically purchased from the local distribution company based on volume, therefore volume-based measurement is recommended. Volume-based measurement requires a pressure, temperature and deviation from perfect gas law calculation.

Some utilities measure volume and bill energy based on a known or averaged gas heating value. Gas heating values vary based on the gas source and the operation of pipeline delivery systems. It is only practical to measure live gas heating values at the gas transmission pipeline where very large deliveries are made.

Table B13-3 Summary of Meter Types and Applications used on Gases

#	Meter Type	Rangeablity	Typical Usage	Measurement Type
1	Orifice	4:1	▪ Steam ▪ Air, process gas ▪ Natural gas	Mass
2	Thermal-dispersion	10:1	▪ Air, process gas	Mass
3	Vortex	15:1	▪ Steam ▪ Air, process gas ▪ Natural gas	Volume
4	Turbine	10:1	▪ Air, process gas ▪ Natural gas	Volume

Metering notes:

1. Measured mass rates can be converted to volume using the contract or base density (specific gravity).
2. Volumes can be converted to mass rates using the operating conditions for the gas.
3. Orifice metering calculations for mass or volume are done using AGA-3 (American Gas Association) calculations.
4. Turbine or vortex volume calculations are done using AGA-7 calculations.

Complete the Electrical Specification Table B13-4 below. For guidance, use the reference material below the table.

Table B13-4 Electrical Meter Specification

ELECTRICAL METER SPECIFICATION			
			Sheet ____________ of _____________
			Date ______________________ Rev # ______________________
	#	Description	DESIGN SPECIFICATION
General	1	Tag Name	
	2	Location and Description	
	3	Mounting	☐ Base mount ☐ Track TS-32 ☐ Track TS-35 ☐ Other ______________________________
	4	Power Supply	☐ 120 VAC, 60 Hz ☐ 24 VDC ☐ Other ________________ Current Requirement: _____________________________________
Inputs	5	Phases, # Wires	☐ Single ☐ Three ☐ 3–wire ☐ 4-wire
	6	Voltage, VAC	☐ 120 ☐ 240 ☐ 277 ☐ 347 ☐ 480 ☐ 575 (note that 277 and 480 are not commonly used in Canada)
	7	Current, Amps	☐ 5 Amps ☐ Min. ___________ Amps ☐ Max. ___________ Amps
	8	Transformer Type	☐ Wye ☐ Delta direct ☐ Delta
	9	Load Type	☐ Inductive ☐ Resistive
Outputs	10	Hardware Signals	Integrated ☐ Pulse (typically kWh)
	11		Rate ☐ kW ☐ 4-20 madc ☐ Other___________
	12	Data	☐ Serial RS-232 ☐ Serial RS-485 ☐ Ethernet ☐ Protocol ____________________
	13		☐ Rate (kW) ☐ Intergraded (kWh) ☐ Power Factor ☐ kVAR ☐ kVA

Accessories	14	Current Transformers	☐ Ratio ________________ ☐ Not required Model # ____
	15	Voltage (PT) Transformers	☐ Ratio ________________ ☐ Not required Model # ____
	16	Local Display	☐ Required
Other	17	Drawing Ref.	
Receiver Instrument	18	Tag Name	
	19	Connection	☐ Channel ______________ ☐ Port # ____________ ☐ Port type ___________________________________
Equipment	20	Model #	Manufactured by: ______________________________ Model # ____
Notes:			

Electrical Meter General Requirements

Electrical meters or power monitors directly measure electrical energy consumed, similar to household electrical meters. Electrical energy is totalized by measuring the voltage and current supplied to units of total power. The most common billing units are Kilowatt-hours (kWh).

Three phase AC (Alternating Current) voltage systems represent the largest individual energy loads, representing the most likely metering points. DC (Direct Current) metering systems are available but less commonly used.

A number of vendors can supply electrical meters with a variety of feature sets. Simple meters provide only the energy rate (kW). Higher end models can provide power factor, kWh, kVAR, KVA and power logging. It may be necessary to provide a communications network link to a higher-end electrical meter to collect the complete data set. Many vendors offer built-in displays or add-on displays as extras. These can be useful for cross-checking that readings are within expected ranges.

Typically, electrical meters can measure voltages up to 600 VAC without any interface between meter and voltage supply. Above 600 VAC electrical meters require Potential Transformers (often called PTs) to step-down the voltage level. Above 5 Amps current transformers (called CTs) are required to provide a current range of 5 amps (typical) to the full current draw. Once installed, the electrical meter is configured to account for ratios of the PTs and/or CTs if used.

Note: For electrical metering of motors at the EAC level, consider using existing PTs and CTs. For motors with only digital CTs for illustrating On/Off status on the HIM, these devices can be replaced with analogue types and configured as inputs to an algorithm that calculates energy in lieu of a new sub-meter. If motors are equipped with Variable speed drives, consider configuring analogue outputs (in lieu of a new meter) as input to your EMIS.

Electrical installation drawings should show:

- Power source and voltages
- Shunt blocks for current transformers
- Fuses between voltage source and electrical meter
- Wiring direction and mounting of CTs and/or PTs
- Proper ground techniques

Some General Notes and Guidelines

In some cases, Local Distribution Companies (LDCs) such as gas and electrical utilities can offer interfaces to their utility meters. This may eliminate the need for adding a new meter at the billing point, reducing the overall project cost and providing real-time utility billing data. As other sub-metering has no billing requirements, no requirement is made for Measurement Canada approval on meters or systems.

The key to measuring the correct range of flows is to understand the process and consumption ranges (minimum and maximum flows) of the receiving equipment. Metering systems need to be sized based on design of the consuming process. This data can be collected from the nameplate or design drawings/documents.

B14 Preferred Layout for Project Costing

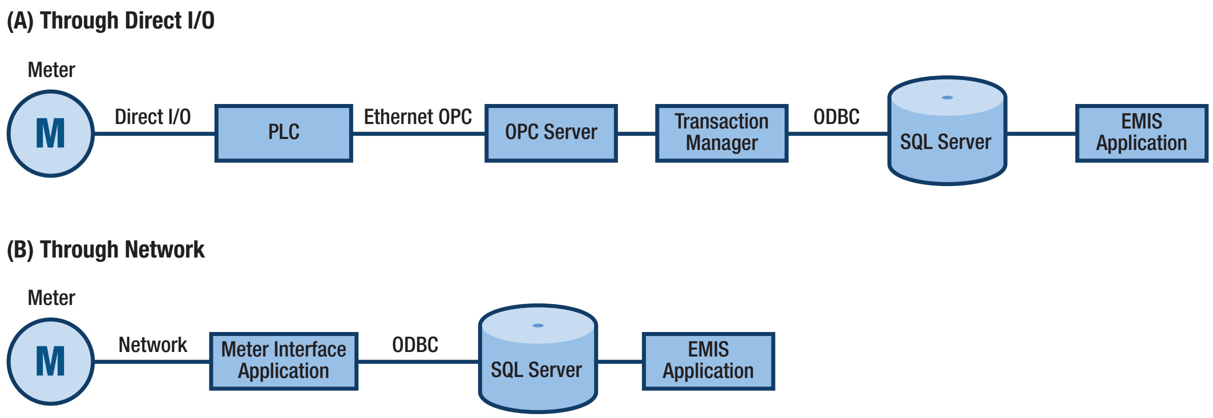
Costs	Year 1			Description	Cost basis			
	Internal Costs	External Costs	Total Estimate		Quoted (Y/N)	Supplier Name	Estimated (Y/N)	Estimator
Hardware								
Utility Meters								
Driver Measurement								
Communications								
Installation								
Hardware Subtotal								
Software								
Software License								
Annual Maintenance								
Installation, Configuration, Training								
Software Subtotal								
Systems Integration								
Hardware								
Installation, Configuration, Training								
Software Support								
Systems Integration Subtotal								
Training								
Energy Management Champion								
Sponsor/Steering Group								
Improvement Teams								
Training Subtotal								
Project Support								
Project Management								
Management Support								
Project Support Subtotal								
Contingency								
Subtotal Cost								
Incentive or Grant Funding								
Net Cost								

B15 Technical Specifications for Data Capture and System Integration

Use the following information on capturing meter readings, database capacity, and hardware specifications to complete your detailed design for data capture and system integration.

Figure B15-1 Capturing Meter Readings

Consider two general paths that meter readings can follow, which begin in the meter and end in the EMIS:



Legend
I/O = Input/Output (hardware signals)
PLC = Programmable Logic Controller
OPC = OLE (Object Linking and Embedding) for Process Control
ODBC = Open Database Connectivity
Network = Ethernet, Profibus, Fieldbus, etc.

Meter Interfaces

Meters provide the physical measurement and an interface to the PLC or database. The most typical interfaces are:

- Hardware signals
- Network interface
- Serial data

Some systems may involve a combination of these. Hardware signals are analogue 4-20 mADC or pulse signals. Many meters offer network data interfaces such as Foundation Fieldbus or Profibus. Network or serial linked meters can offer meter totals, data integrity and audit trail data.

In some cases, meters supply only line process condition data, and further calculations are required to compensate raw meter data for volume or energy calculations. These calculations are done in the plant PLC or, at times, in a Remote Terminal Unit (sometimes called flow computers). A number of vendors offer fixed and programmable RTUs that have built-in natural gas, energy, or temperature-correction calculations of liquid hydrocarbons. These devices should be used whenever possible as they offer labour savings. When raw meter data is compensated, the raw data, along with process inputs and compensated data, is stored in the historical database.

Similarly, customer input is sometimes required for compensation of raw meter data. For example, in a given period, the customer may need to input the energy value of natural gas provided by the gas supplier. In the absence of prohibitively expensive analysis equipment, this method provides the most accurate estimate of true energy usage.

Data Fields

Primary data fields captured from meters include:

- Source or reference ID of the meter
- Timestamp of the reading
- Value of the reading

Additional data fields captured may include:

- Absolute (non-resettable) reading totals
- Meter health and diagnostics

It should be noted that driver (production) data is quite often collected as though it were an absolute meter.

Data Capture Frequency

Consideration must be given to the frequency with which meter data is captured and stored by the EMIS. Factors include:

- Capability to meet minimum requirements for the reporting system, e.g., the shift duration must be evenly divisible by the capture frequency
- Data capture must be frequent enough to identify meter fault conditions
- It must also be frequent enough to identify abnormal process conditions
- Resolution must be fine enough to capture peak meter rates

If individual meter readings are unavailable or questionable, higher resolution allows for more precise interpolation of values.

Meter Diagnostics and Error Checking

Integrity of the EMIS can be increased by encapsulating meter health and diagnostic information in the data stream. This status can flag when there is an issue with the meter itself, generally when the meter is network-enabled.

In addition, meter rollover can be determined either in the database or as a built-in function within the EMIS. Also within the EMIS, error check status can flag when meter readings are out of range, including zero-readings. Power and/or communication issues can be identified by the meter interface.

System Reliability

Reliability of an EMIS is affected in part by the degree of separation between meters and the EMIS server. This statement applies to various layers, including hardware, network, operating system, database, and applications. In general, shorter and simpler means more reliable.

Database Capacity

To determine the disk space required to store meter readings and associated calculations, we begin by identifying the variables that factor into this calculation.

- Total Number of Meters and Associated Outputs
- Import Frequency (assume as number of hours between readings)
- Meter Reading data type (hence storage size)

If we look at storage space required per day for meter readings alone, we find:

$$\frac{\text{Number of Meters} \times \text{24 hrs/day} \times \text{Number of bits/reading}}{\text{Import Frequency (hrs)}} = \text{Bits/day storage}$$

In addition to the storage of readings, we must account for the storage space of calculations performed by the EMIS.

Examples of calculations include:

- Interval values (consumption meters)
- Reporting consumption
- Variable utility cost
- Carbon conversions (CO_2 equivalency)
- Baseline and target consumptions
- Baseline and target costs
- Corporate or enterprise summations

Finally, the EMIS itself consumes disk space. Although exact storage requirements vary by EMIS selection, generally speaking, any EMIS requires storage for:

- Meter configuration (references, alarm limits, multiplication factors, etc.)
- EAC configuration (distributing meter consumptions and costs)
- Driver (production) data configuration
- Organizational structure definition
- User configuration
- Report definition
- Data import configuration

Hardware Specifications

Hardware specifications will vary depending on the EMIS deployed and its underlying calculation engine. Factors that impact the hardware requirements are:

- Number of meters
- Number of EACs (Energy Account Centres)
- Number of driver/production variables
- Number of expected concurrent users
- Data import frequency
- Existing database and network traffic
- Report complexity

B16 Functional Requirements for Data Analysis and Reporting

Below is an example of a functional requirements document completed for a fictitious EMIS. This format should be used when specifying the functional requirements.

Scope of Energy Management Information System

SCOPE INCLUDES
Data analysis from data historian and other data sources to allow allocation of energy consumption to Energy Account Centres. An Energy Account Centre is an area or unit of a plant or facility for which the responsibility for energy consumption can be locally controlled. This analysis should be accomplished over variable and specifiable time periods and on data frequencies as appropriate.
Analysis and targeting of energy consumption of each Energy Account Centre against drivers for consumption, such as production rate, product mix, weather, etc.

SCOPE EXCLUDES
ERP functions, management accounting or other business system requirements.

Assumptions

List and describe any assumed factors (as opposed to known facts) that could affect the requirements. These could include third-party or commercial components that you plan to use, issues around the development, operating environment, company policy regarding hardware procurement or preferences towards specific suppliers. The project could be negatively affected if these assumptions are incorrect or change during the project lifecycle.

ASSUMPTION	IMPACT
SQL will be updated from SQL2003 to SQL 2005	Software compatibility may be affected

Constraints

Constraints are conditions as to how the system must be designed and constructed, such as legal requirements, technical standards, or strategic decisions. Constraints exist because of real business conditions. For example, a delivery date is a constraint only if there are real business consequences that will happen as a result of not meeting the date.

CONSTRAINT	IMPACT
Corporate decision not to invest in new server capacity	Chosen software must be compatible with existing hardware
Personnel in Plant A will not be able to see performance of Plant B	Software security and access must allow user access to analysis: reports to be user specific

Dependencies

Identify any external factors on which the project depends, such as technical resources, that must be in place for the system to operate.

DEPENDENCY	DESCRIPTION
Database administrator	Only available two days per week
Database maintenance	Access to the database server unavailable between 00:00 and 02:00 Sunday mornings

Product Functions

Summarize how the functions are organized so that that they can be easily understood by the reader. For example:

The product resulting from these requirements will:

- Add customers to the Contacts database
- Add, change or delete data
- Calculate and display target and variances
- Report on xyz

FUNCTION	DESCRIPTION
#1	Access or extract data from the data historian and other production databases
#2	Manual data entry must be possible
#3	Be capable of multiple regression analysis to set targets
#4	Calculate and display targets and variances for each EAC
#5	Etc.

Operating Environment

Describe the environment in which the software will operate, including the hardware platform, operating system and versions, and any other software components or applications with which it must coexist. This helps place the system in context from a technical perspective.

User Characteristics

Describe any user group characteristics that might affect system design, such as educational level, experience, technical expertise and geographical location.

User Roles

ROLE NAME	NO. OF USERS	RESPONSIBILITY/ACTIVITY
User	10	View reports, manual data input
Super User	3	As user, set up new reports
Administrator	2	Set up users and passwords, change EAC definitions and calculation equations, set up new reports
Etc.		

Functional Requirements

A number of software aspects should be considered functional requirements for specification. Suggested factors to be considered are:

- Near real-time or next day analysis
- On line data and reporting
- Inclusion of KPIs
- Alarms in case of poor performance
- Analysis and reporting at multiple levels
- Multiple utilities for a node
- Dynamic targets based on production, product mix, etc.
- Applying target between date ranges
- Calculating variance
- Calculating CUSUM
- Calculating cost
- Reports should include traffic lights, graphs, tables, etc.
- Frequency for the data in the report
- Data and reports exportable and printable
- Error checking functions
- Unaccounted calculation
- Operational cost reporting
- Cost allocation reporting

Below is a suggested format for each functional requirement.

Functional Requirement

[REQ #]	TITLE
Priority	1 = High, 2 = Med, 3 = Low
Purpose	The software will…
Input	Describe the inputs to the function, including sources, valid ranges of values, timing considerations, operator requirements, and special interfaces.
Operations	Describe the operations to be performed within the function, including validity checks, responses to abnormal conditions, and types of processing required.
Output	Describe the outputs from the function, including output destinations, valid ranges of values, timing considerations, and considerations for handling of illegal values, error messages, and interfaces required.

Functional Requirement

[REQ #]	TITLE
Priority	1 = High, 2 = Med, 3 = Low
Purpose	
Input	
Operations	
Output	

Functional Requirement

[REQ #]	TITLE
Priority	1 = High, 2 = Med, 3 = Low
Purpose	
Input	
Operations	
Output	

Here is an example for Management Information Reporting:

The analysis and reporting will take place at multiple levels.

The **Energy Account Centre –** the lowest level for analysis and reporting. The EAC will consist of one or more energy meters and one or more production measurements and/or environmental sensors and/or operational parameters. An EAC will have multiple utilities (i.e., electricity, gas, oil, water, etc.).

a. Algorithms use data from production measurements and/or environmental sensors (e.g., ambient temperature, relative humidity, etc.) and/or operational parameters (e.g., set point temperatures, pressures, etc.) to calculate target energy consumption. Algorithms should be editable and should apply between time or date ranges, meaning that the appropriate algorithm is used when recalculating historic data.

*e.g., Target Energy in Period = Constant + (Factor1 * Production Measure) + (Factor2 * Average Environmental Factor in Period) + (Factor3 * Average Operational Parameter in period).*

If the performance is calculated hourly, all other time periods are then the sum of the performance for the hours included in the relevant time period.

In addition to the algorithms used to calculate targets, “Key Performance Indicators” should also be calculated at the EAC level. The KPI will be the energy consumption in the period divided by either the Production measure or the average Environmental or Operational Parameter in the period. The divisor in the KPI calculation should be user defined.

b. Actual energy consumption from the utility meter(s) is then compared against the target to calculate a variance. The actual energy, target energy and variance will provide the core of the reporting. The units for reporting energy consumption should be user defined.

c. When calculating variance, the software must also be able to calculate the cumulative sum of variances (CUSUM).

d. In addition, algorithms should be provided to convert energy consumption values to cost values to allow reporting of actual, target and variance in cost terms as well as energy terms.

The Department – will consist of one or more Energy Account Centres. The performance at the level of the Department is the aggregate of the performance of its individual Energy Account Centres. When reporting at the Department level, aggregate reports (i.e., for the Department as a whole) and disaggregate reports (i.e., split by Energy Account Centre or by Utility and Energy Account Centre) must be provided.

The Site – will consist of one or more Departments. The performance at the Site level will be the aggregate of the individual Departments. When reporting at the Site level, aggregate reports (i.e., for the Site as a whole) and disaggregate reports (i.e., split by Department or by Utility and Department) must be provided.

When reporting, the user must be able to define:

1. The level at which the report is to be run, i.e., EAC, Department, Site.

2. The type of report – i.e., Aggregate or Disaggregated, Graphical or Tabular;

3. The time period for the report – i.e., using data “from” and “to.”

4. The frequency for the data in the report, e.g., hourly, shift based, daily, weekly and calendar monthly summaries. Company X follows the 4-4-5 week period structure for financial reporting within a quarter; the system must be able to work with this breakdown. The “day” at Company X starts at 08:00.

Other Core Features Required

The data in the reports must be able to be exported into a file format readable by Excel; the reports themselves should be able to be exportable into PDF or Word format. The configuration used to define the report should be able to be saved with a unique reference or name so that it can be run subsequently.

The system must have the ability to identify when the flow of data from a meter has stopped and to provide some indication to a system administrator that there may be an issue with the meter or data capture system.

Energy Costs – Two forms of energy cost reporting are envisaged:

- **Ongoing operational costing:** This will use a fixed unit cost for a utility's consumption; it will be updated each year (or more frequently). This will be used to send a cost signal on consumption to the managers of the EACs and Departments. The unit cost should apply during a defined date range so that the appropriate unit cost is used when calculating historic data.
- **Cost Allocation Reports:** At the close of each financial period, a Cost Allocation report will be run that will use the contract structure of the utility suppliers to calculate the cost allocation of each EAC and Utility. For clarification, electricity is offered as an example:

  Monthly Cost for Electricity is:

  a. Consumption

  b. Total consumption for the month in each EAC multiplied by a unit charge. The unit charge is fixed for the year.

- **Demand:** At the end of the period (4 weeks, 5 weeks or one calendar month) the system will need to look at the Main Incoming electricity meters and determine the 15-minute interval with the highest demand and note the time. The demand of the meters in the individual EACs for the same time slot should be identified to determine the contribution of each EAC to the overall site maximum demand, with any difference assigned to Unaccounted.

  The utility company uses an algorithm to determine the chargeable demand, which is:

  The greatest of:

  c. the monthly maximum kW demand

  d. 90% of the monthly maximum kVA demand

  e. 90% of the contracted reserve (a fixed figure of 10 800kW)

  f. 90% of the monthly maximum demand recorded in the current year excluding April through November

  g. 90% of the lesser of the average of the monthly maximum demands recorded through the previous calendar year or the previous calendar year excluding April through November.

The demand charge for each EAC is then its contribution to the site maximum demand (%) multiplied by the chargeable maximum demand multiplied by the cost per kW of demand, which is fixed for the year.

- **Unaccounted:** Not all of the site's energy consumption is captured by the sub-meters. A separate department called Unaccounted is foreseen. The consumption allocated to "Unaccounted" should be the consumption of the Main Incoming meters less the total consumption of the individual Departments/EACs. The costs of the unaccounted consumption (including demand) will be allocated to each Department based on the consumption of the department in the period.

Adding new meters to EACs: The system must allow for the addition and removal of meters within EACs. This function should be reserved for specific classes of users only (e.g., system administrator).

Hardware Requirements

Hardware Functionality

Describe the hardware's requisite capabilities, e.g., support multiple operating systems.

[REQ #]	HARDWARE FUNCTIONALITY
Req #	The hardware will…
Req #	The hardware will…
Req #	The hardware will…

Hardware Characteristics

Describe the hardware's characteristics.

[REQ #]	HARDWARE CHARACTERISTICS
Req #	The hardware will…
Req #	The hardware will…
Req #	The hardware will…

User Requirements

Describe the requirements of the system, user or business, with consideration given to all major user categories. Provide the type of security and other distinguishing characteristics for each set of users.

User requirements often use a numbering system that is separate from functional requirements. For example, you can label the requirements with a leading "U" indicating user requirements.

[REQ #]	TITLE
Req #	The software will allow the user to…
Req #	The software will allow the user to …
Req #	The software will allow the user to …

Input and Output Requirements

Describe manual and automated input requirements such as data entry and data extracts from other applications.

[REQ #]	INPUT REQUIREMENTS
Req #	The software will…
Req #	The software will…
Req #	The software will…

Describe output requirements for the software product, such as printouts, reports, files, etc. that the system will process and produce.

[REQ #]	OUTPUT REQUIREMENTS
Req #	The software will…
Req #	The software will…
Req #	The software will…

Communications Requirements

Describe the system's communication requirements. Specify the desired response times where appropriate. Provide a diagram of the system's communication requirements, including type and peak data volumes.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

Communications Hardware

Describe communication hardware requirements, such as storage devices, input devices, and printers.

[REQ #]	TITLE
Req #	The communication hardware will…
Req #	The communication hardware will…
Req #	The communication hardware will…

Non-Functional Requirements

Non-functional requirements are those not covered by functional requirements. They specify criteria that judge a system's operation rather than its specific behaviours. Typical non-functional requirements include Availability, Performance, Response Time, and Throughput.

Availability

State the time periods during which the system must be available to users, for example, "The system must be available Monday through Friday between 06:00 and 18:00 GMT."

> If the application will be available in several time zones, state their earliest start and latest stop times. Consider daylight savings time. Identify peak times, i.e., when system unavailability is least acceptable.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

Capacity Limits

Specify the system's capacity requirements in relation to the maximum number of transactions, concurrent users, and other quantifiable information. List the required capacities and expected volumes of data in business terms.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

Data Retention

Quantify the length of time data must be retained and the requirements for its archiving and destruction. For example, "The system will retain information for 10 years." Identify different forms of data: system documentation, audit records, and database records.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

Performance

Describe specific performance requirements for the system and subsystems. Provide details of requirements such as the number of events that must be processed, response times, maximum data volumes to be stored, number of inputs and outputs connected, number of transactions to be processed in a specified time, etc.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

Security Requirements

Provide a list of security requirements by considering the following:

- Identify the type(s) of security required, such as physical security and access by user role or types.
- Identify security classification, protection types, and controls for user access.
- Identify security requirements for PC, server, network, dial-up access etc.
- Identify the consequences of the following breaches of security: loss of data; disclosure of sensitive information or privacy information; corruption of software; introduction of viruses, etc.
- Identify access control requirements by data attribute. For example, user group A has permission to view an attribute but may not update it, while user group B has permission to update or view it.

State whether certification and accreditation of the security measures is required.

[REQ #]	TITLE
Req #	The software will…
Req #	The software will…
Req #	The software will…

B17 Background Information: Data Analysis and Reporting Software

The implementation plan looks at specific data analysis and reporting requirements, whether for modification of existing systems or implementation of new systems. The plan should detail the changes to be made in order to implement an EMIS in sufficient detail for a third-party supplier to be able to specify against and to highlight the benefits of putting the recommended measures in place.

The implementation plan should specify:

- What data is to be collected and from where;
- The relationship between each meter and imported variable. This should include distribution diagrams and metering trees;
- Characteristics of the data, such as units, frequency etc.;
- What basic fields are to be calculated for each meter and Energy Account Centre? Fields should include consumption, cost, target, baseline;
- Specifying how targets are set and how target setting process is completed;
- What analysis and reporting is required by each user group, reporting deadlines, detail and presentation style;
- Types of graphical and tabular reports to be produced;
- Availability of reports and access to change the analysis and reporting (security access);
- Compatibility of reports and analysis with other packages, such as the ability to export reports as PDFs, to Excel or in e-mail format.

Data analysis and reporting should also specify where an existing EMIS has been audited and the date a new system is being recommended.

Specifying Data Analysis Changes

Data Collection

When supplying an EMIS, suppliers will need to know:

- The number of meters or data point imports needed;
- Data frequency;
- Amount of historical data to be imported and analyzed.

  Note: The auditor should specify the data to be collected. The number of data points to be collected should be set to allow for future system modification. When implementing an EMIS, an organization goes through a learning curve. After a number of months' experience, an organization may wish to add meters or additional drivers.

The number of meters and amount of data can significantly affect software cost and hardware performance.

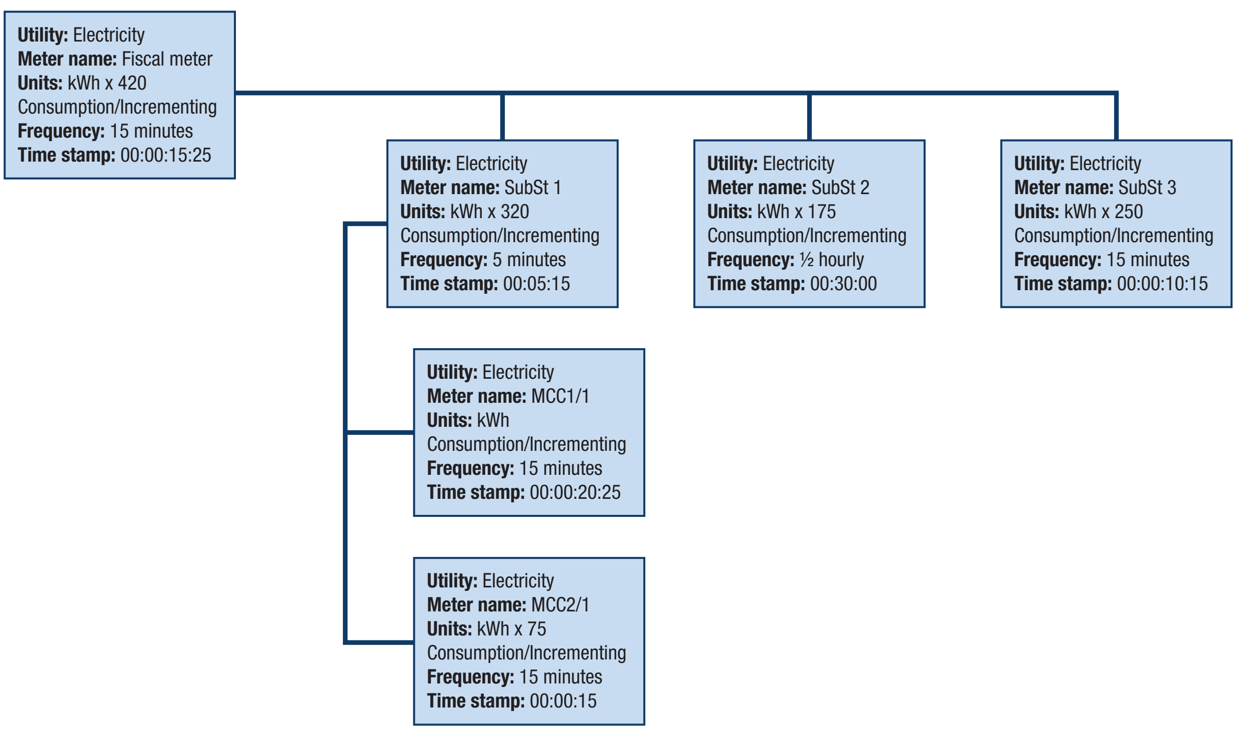
Metering Structure

The metering structure and interrelationship must be defined prior to any data analysis to ensure that like numbers and units are being used in each calculation and that no double counting of consumption occurs.

A utility distribution diagram will show the location of each meter and indicate what is and is not being metered. For each utility a metering tree should be presented showing the details of each meter and how they interrelate. Of particular importance are:

- Units of measure (e.g., kWh, BTU, m^3): A meter multiplication factor may be required to convert meter reading to consumption.
- Consumption or incrementing: A consumption meter gives the consumption in a given period (e.g., kWh over a 1-hour period), whereas an incrementing meter gives incrementing consumption from a time when the meter reading was zero.
- Data frequency: Meaningful reporting can only be done if the data on meters used in the calculation is on a similar frequency.
- Time stamp of each meter reading for each meter: it may be necessary to interpolate to get consumption over the same reporting period or frequency, e.g., one meter has hourly data on the hour while another meter has 30 minute data at 15 minutes past and 15 minutes to the hour.

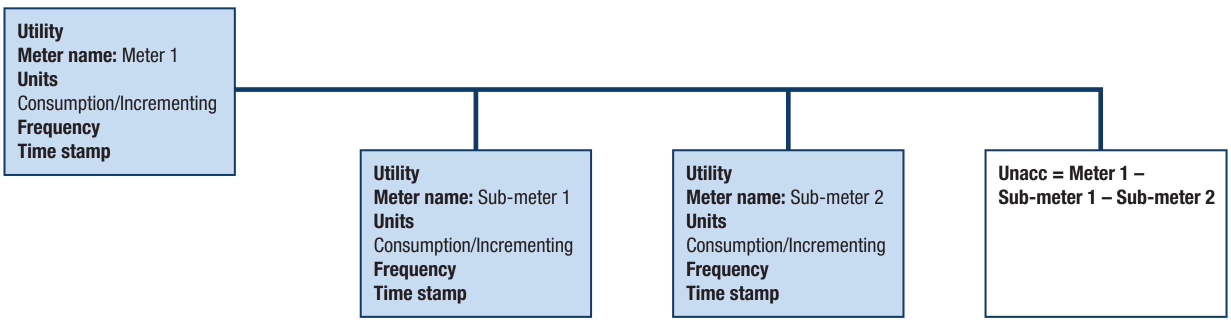
Figure B17-1: Metering Tree Example



Errors in metering structure can lead to double counting of consumption or portions not being accounted for.

Most metering systems do not meter everything. Even if everything is metered, due to metering error, the sum of child nodes is unlikely to equal the parent node. The unaccounted consumption calculation should be specified; this is the difference between the parent meter and the sum of all child nodes, as illustrated in Figure B17-2.

Figure B17-2: Unaccounted Consumption



Where existing metering or EMIS installations are being audited, checks also need to be done to make sure that any recommended changes in metering structure or data analysis are handled, so as to maintain analysis validity (see Table B17-1).

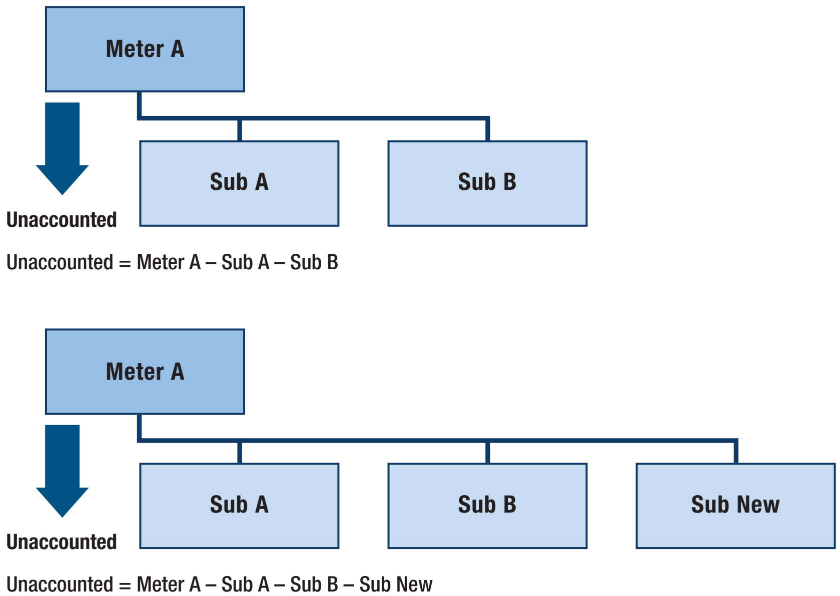
Table B17-1 Data Checklist

Check or Change to be specified	Comment
Define change to metering	Specify where new meter is to be imported into the EMIS, its location and function
Check meter multiplication factor	Change criteria for meter lapping, if necessary
Check meter multiplication factor	Change in calculations and analysis, if necessary
Check meter units	Convert new imported data to consistent units
Check meter type	Change consumption analysis equation as required for new meter type
Check effect of metering structure on meter and Energy Account Centre calculations	Revise analysis and calculations to take into account relocated and additional meters
Record changes	

When additional meters are imported into the EMIS, a meter type or specification is changed, or a meter is moved within the metering structure, the impact on data analysis and reporting should be considered and any acceptable impact agreed on before the EMIS structure or data import is changed. Considerations include:

- Number of digits in the meter reading (meter lapping calculation)
- Meter multiplication factor (many meters require multiplication by a meter multiplication factor to get a consumption value. Changing the meter could change this factor, which must then be changed in the calculation from the exact time the new meter readings are imported.)
- Meter units (change of units will change calculations and conversion factors needed, e.g., m^3 gas to MMBTU or kWh)
- Consumption, incrementing, absolute or rate meter (will change the way consumptions are calculated)
- Addition of meter or change of meter position in tree (if analysis is performed on all meters below a particular node, moving a node will change this calculation)
- Implication on calculations (new meters will change analysis and calculation). New meters can also make historical data comparison difficult.)

Figure B17-3: Impact of New Meters on Unaccounted Consumption



Data Characteristics

For all imported and calculated fields specify the units, number of meter digits and frequency. This will ensure correct calculation of consumption and will enable meter lapping to be handled correctly. In addition, in order to calculate equivalent carbon dioxide emissions and costs, tariff rates and conversion factors must be used.

Change of conversion factor/tariff

There are changes made to conversion factors (such as GWP (Greenhouse Warming Potential)) and cost tariffs for utilities. Agreement is required between all users of the analysis and reporting as to what basic costs and conversions are to be calculated (see Table B17-2).

Conflict of calculated costs and variances between an EMIS and in-house accounting can result in devaluing EMIS results if the differences in calculation are not agreed on and understood beforehand.

Table B17-2 Changes of Conversion Factor or Tariff

Check or Change to be specified	Comment
Define conversion factor or tariff change	Data sources can change as the system develops (e.g., production rate from ERP system or in line measurement).
Validity of comparison with historical data	Inconsistencies in utility costs and savings value may result from changes in tariff rates. Agreement is needed on whether to use historical costs, actual costs or costs based on budgeted fixed rate.

Data Migration and Importing/Analysis of Historic Data

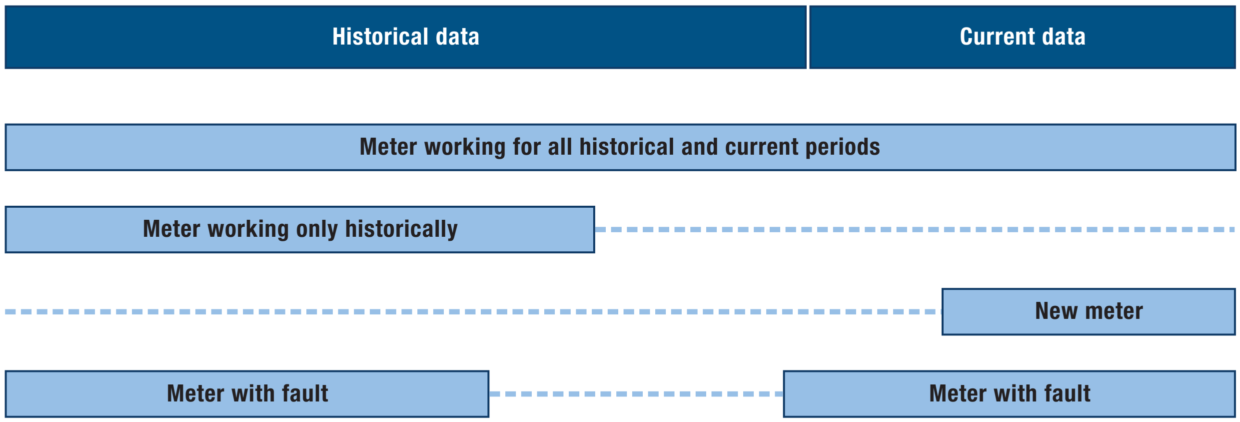
Data manipulation and restructuring may be required by some EMIS during data migration from the data historian and other databases. In other systems, the data is only accessed as reports are generated. This second method demands less computer storage; however, there is the risk of changes, archiving or deletion of historical data in other systems, which would make data unavailable to the EMIS. Some motor monitoring based data historians hold only three months' worth of data, after which it is archived or discarded. The data storage requirements for some systems with data migration and storage of calculated values can be very large, requiring specialist high capacity servers. An EMIS should be capable of accessing up to five years of historical data, either through data migration or through existing databases.

On initial set up of an EMIS, it is good practice to import one year of historical data if available. This would be used for a baseline calculation. However there are risks and pitfalls in using historical data. The auditor should check for inconsistencies in the historical data before using it for target setting or as baseline data.

Missing data

In most cases, prior to an EMIS Audit, data collection from meters will have changed, with meters being gradually added as needed. It is also possible that some meters stopped working for a period or were repaired. As a result, the available meters and metering data to be used in analysis could change, depending on the period selected. For example, equations developed to analyze performance during the audit may not be valid for historical data if meters or data is missing, and vice versa.

Figure B17-4: Impacts of Missing Data



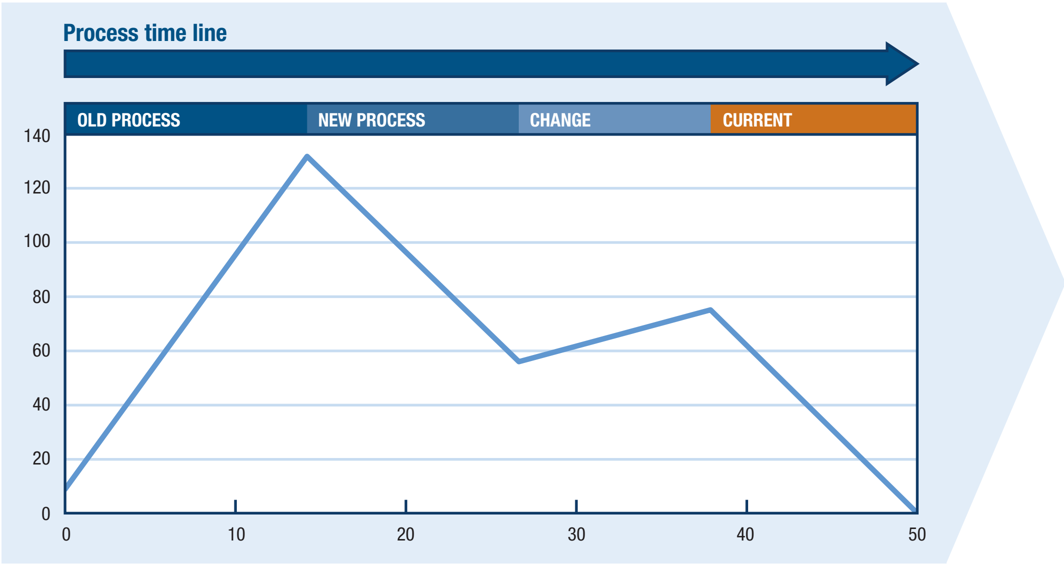
Data Consistency

The basis for energy driver data must be checked for consistency over the historical and current data period. Production accounting methods can change, making direct comparison between current and historical data invalid (production volumes on as produced basis, net of wastage, based on standard batch sizes, etc.).

Process Changes

When setting a baseline to use as a comparison for current data, the process and plant configuration must be comparable. Significant process changes can be pinpointed by interrogation process records or by CUSUM analysis, as shown. Significant process changes will show up as changes in the CUSUM slope. In the example shown, it would be impossible to use the entire period of historical data for basing targets, as the process operation is neither representative nor consistent.

Figure B17-5: Impacts of Process Changes



Periods with similar slope on the CUSUM present similar energy performance and consistent operation. Significant changes in slope indicate process changes. It may not be possible to use a data segment as a baseline if it contains significant process changes.

Data Source

Upon specification, any EMIS data may be captured from a data historian, existing management and engineering system, or directly from a meter. To import data from any source, access to the data sources is required. Each data source may have its own update frequency and data format. A register should be kept to show the source of each data item, the format, and frequency of access/import.

If a data source is to be changed the impact on the imported data and subsequent calculations must be taken into consideration (see Table B17-3).

Table B17-3 Changes to Data Source

Check or Change to be specified	Comment
Define new data source	Data sources can change as the system develops. (e.g., production rate from ERP system or in line measurement)
Check new data source integrity and consistency with previous source	Data source should measure same parameter

A change in a meter or variable's data source will affect data analysis if that data format is inconsistent with the one used previously. If the data source is changed, checks must be made to ensure the data is consistent and that the new data source measurement frequency is adequate for analysis.

Calculated Fields

For each node in an EMIS, the fields to be calculated must be defined, whether for a meter, variable or Energy Account Centre. A spreadsheet should be compiled on which every node is listed along with the fields to be calculated. These should include:

- Consumption
- Cost
- Carbon
- Target
- Baseline

Systems from some suppliers will calculate all of these values and store them in a database; others will only calculate when a report is required. Either way the calculation method for each required field should be defined.

A calculation frequency for reporting must be defined. Reports may be required on an annual, monthly, weekly, daily and even shift-by-shift basis.

Target Setting

Target setting is done after installation of an EMIS. If a new system is being specified, the desired target setting capability should be outlined. On existing systems, the audit may show that the system is adequate but that a more detailed target setting is required. On existing systems whose targets have remained static for a period, targets may need to be refreshed. This will require further change in the management process.

Target setting capability can either be built into an EMIS or be achieved by downloading data to a spreadsheet or statistical analysis package. For most users, an integrated target setting tool is advantageous in that the EMIS is then self-contained. However, some organizations using a Six Sigma or LEAN Manufacturing program may prefer to use their own statistical tools. This should be decided during the audit and the appropriate capability specified (see Table B17-4).

Table B17-4 Specification of Target Change

Check or Change to be specified	Comment
Base data for target	Define time period and data frequency
Record target equation before and after change	
Date range during which new target applies	Targets should be set to cover consecutive time periods
Target comparison	Compare result given by old and new target equation
Agree to change target with EAC responsible	Target ownership lies with the EAC responsible. not the consultant, so agreement as to its change must be decided beforehand
Check effect of changed target on reports	Reporting period featuring two targets can result in inconsistency Consider changing report to show just new target

As energy performance improves or circumstances change it is normal to revise targets. All target changes must be documented and communicated to those concerned.

Tightening energy improvement targets without warning can demoralize teams; the apparent rate of achievement made prior to a target change could be reduced or disappear altogether.

It is good practice to define a baseline performance. This is the performance achieved historically before implementing an EMIS. The baseline provides a performance measure against starting conditions, while a target drives improvement.

With a simpler EMIS there is the risk that unless the requirement for calculation fields is defined up front, the installed system may not have the capability to include additional fields retroactively.

Graphical and Tabular Reports

The aim of an EMIS is to indicate energy performance and provide a tool for improvement. Highly complex data analysis may interest a project engineer or system designer but does not necessarily result in clearer performance or increased savings.

Each EMIS user group will have different requirements. An overview of reporting requirements for each group will be available from the EMIS Audit (see Figure 2-12), but it is in using an EMIS that these requirements are likely to develop.

Availability and Security

An audit should clearly reveal how the user intends to use an EMIS in production and improvement meetings. Inclusion of the reports and data for these meetings will determine when data imports are required and deadlines for related calculations. The system's planned usage should be communicated to potential vendors. Availability depends not only on user requirements but also on hardware configuration, network configuration and specification of servers. Recommended requirements for the EMIS should be discussed prior to the purchase of any hardware. Access to some reports may have to be restricted to a limited group of users. The number of user groups and their required access should be indicated.

B18 Data Analysis and Reporting Evaluation Grid

Criteria	Weight	Supplier 1	Supplier 2
Near Real Time Analysis			
Provision of data to the line operators' SCADA panels			
Trend Lines of Consumption - Single or Multiple meters			
Key Performance Indicators (KPIs)			
Alarms/Indications if KPI moves beyond preset tolerance range			
Analysis and reporting at multiple levels			
An EAC will have multiple utilities (electricity, gas, oil, water, etc.)			
Dynamic targets based on production, environment or operational parameters			
Target applied between date ranges			
KPIs calculated at EAC Level			
Divisor for KPI calculation user defined			
Calculating Variance			
Calculating CUSUM			
Calculating cost			

Criteria	Weight	Supplier 1	Supplier 2
Level at which report is to be run, for example EAC, Department, Site			
Report type (e.g., Aggregate or Disaggregated, Graphical or Tabular)			
Report time period: using data “from” and “to”			
Frequency for report data			
Are data or reports exportable			
Error checking			
Calculations unaccounted for			
Ongoing operational cost reporting			
Cost allocation report - consumption			
Cost allocation report - demand			
Added value functionality offered?			
Ease of configuration			
Ease of modification			
Support available			
Existing client base			
Total bid cost CAD$			
Best value assessment CAD$ point			

B19 Change Checklist for Data Analysis and Reporting

If you are planning to use existing software for the data analysis and reporting function, consider the following checklist when planning your system.

EMIS Change checklist for data analysis and reporting	
❒	Number of meters, data frequency and amount of historical data is defined.
❒	Metering diagrams and utility distribution diagrams compiled and checked.
❒	Changes to current meters or metering is defined. Effect on analysis is determined.
❒	Existing metering has been assessed and any required change to metering is determined.
❒	Data characteristics for each data point are defined.
❒	Historical data checked for missing data.
❒	Energy driver source and definition checked for consistency.
❒	Historical data checked for significant process changes.
❒	Calculated field requirements are defined.
❒	Target setting methodology agreed on with EAC owners.
❒	Graphical and tabular reporting requirements are defined.
❒	Report access and security requirements are defined.
❒	Define how reports and analysis are to be used, i.e., live meetings, e-mail, etc.

B20 Training Needs Analysis, Skills Assessment and Training Plan

This section provides guidance on conducting the training needs analysis (TNA), determining skill requirements and producing a training plan

Training Needs Analysis

Role Definition

Energy management roles are often defined by the time allocated within each to people, systems and technologies. Performance deficiencies often result from incompatibility between a role and an individual's abilities and aptitudes with people, systems and technologies. Listing all responsibilities under one of the three categories will provide information on each major role's requirements. A role may belong to an individual (e.g., Energy Management Champion) or a group (e.g., the Steering Group). With the latter, the group's abilities as a *whole* should be examined *(i.e., not everyone needs all of the skills)*.

Step 1 – Describe the main tasks that each role defined in the Conceptual Design phase requires under the following three headings: **People, Systems** and **Technology**. Table B20-1 lists verbs you may find helpful in describing the roles:

Table B20-1 Action Verbs for Role Definition

People	Systems	Technology
advising	accounting	auditing
briefing	analyzing	calculating
communicating	balancing	controlling
consulting	brainstorming	designing
coaching	budgeting	estimating
facilitating	collecting	evaluating
following through	comparing	investigating
giving feedback	compiling	installing
guiding discussions	computing	measuring
influencing	creating	
initiating	forecasting	
instructing	imagining	
interviewing	interviewing	
managing	organizing	
mentoring	planning	
motivating	problem solving	
negotiating	researching	
persuading	retrieving info	
public speaking	systematizing	
selling		
sponsoring		
supervising		
teaching		
training		

Complete the worksheet for each role defined within the energy management framework.

People Worksheet for Training Needs Analysis – Role Definition

PEOPLE:

SYSTEMS:

TECHNOLOGY:

Step 2 – Once role definition has been clearly articulated, each role can be defined in terms of required skills. The skills must be assessed, both in terms of required level and priority (i.e., relevance to the role's overall objectives). Table B20-2 provides guidance as to the differences between levels.

B20-2 Skill Level Descriptions

Level	General description of attainment
1	Beginner level. The person has had no skills-related training and is unfamiliar with underlying technologies or techniques.
2	Intermediate Level. The person has received training but requires additional coaching to be considered competent.
3	Competent level - Familiar with skill but requires additional training to be able to apply the skill without supervision or control.
4	Advanced Level – Able to apply the skill without any supervision. Fully conversant with underlying technologies or techniques.
5	Expert Level – At this level the person is able to train others at least to Level 4.

The difference between a job's perceived current skills and its required skills helps to define individual or group training requirements.

Step 3 – Based on the tasks above, define the skills required below. In the level fields define the current skills on a scale from 1-5 where 1 is" non-existent" and 5 is "expert". In the Importance field rate the skill in terms of its relevance to the overall objectives for the Energy Management System where 1 is "Optional" and 3 is "Essential".

Step 4 – After completing Steps 1-3, a training needs analysis can be produced (see Table B20-3).

Table B20-3 Training Needs Analysis Overview

Skills	Level (1–5)		Importance		
	Required	Current	1	2	3
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐
			❐	❐	❐

Step 5 – Based on gaps identified in the training needs analysis, a skills requirement assessment can be developed. For each skills gap, the following aspects should be addressed:

- Whether the gap can be addressed through training or other means (with expert support during 'on-the-job' experience, a self-study package, etc.)
- Risks and benefits of training/not training
- Skill complexity – as skills become more complex, training is likely required
- Collectivity – If the skill requires coordination between individuals, it will inform how the training should take place

Step 6 – Based on the evaluation in Step 5, the skills assessment report can be prepared and should cover:

- Copy of gap analysis developed as part of the EMIS Audit;
- Copy of training needs analysis report (Step 4);
- **Statement of Training Goals:** What organizational goal is driving this training? What is the desired outcome? What is the skill gap? What competencies (knowledge, skills, or attitudes) will this training deliver? What evaluation will be used to measure the goal achieved?
- **Target Population:** Who will be trained? What is the estimated class size? How many classes will there be? How long will training last? What are the knowledge and skill prerequisites?
- **Type of Training Required:** What type of program is required? What media can be used?
- **Training Project Planning:** i.e., timeframe during which training should occur.

Step 7 – Qualified service providers should be contacted to submit proposals for all or some components of the training. Training topics to consider include:

- General energy management
- Advanced energy management
- Target setting
- Energy data analysis
- Interpreting energy performance
- Energy auditing
- Energy reporting
- Data analysis and action planning

Step 8 – After obtaining proposals and selecting qualified service providers the training plan component of the report can be completed.

Here is a suggested structure for the training plan:

Goals

1. What organizational goal is driving this training?
2. What will the desired outcome or ROI be?
3. What is the skill gap?
4. What competencies (knowledge, skills, or attitudes) will this program deliver?
5. What factor or evaluation will be used to measure the goal achieved?

Target Population

1. Who will be trained?
2. What is the estimated class size?
3. How many classes will there be? How long will this training last?
4. What are the knowledge and skill prerequisites?

Type of Training

1. What type of program is being proposed?
2. What media will be employed?

Alternatives

1. What will happen if we do not deliver the training?
2. What are the restrictions or limitations to delivering a program?
3. What alternatives can be used to reach the goal (limitations and advantages)?

Project Planning

1. Estimated timeline
2. Estimated budget
3. Personnel or resources required

B21 Developing a Communications and Awareness Plan

The communications plan developed during implementation should address:

- The organization's objectives and targets;
- Opportunities that exist for individuals to contribute both during implementation and ongoing operation;
- Current energy use and trends within the organization and their impact on overall profitability;
- Opportunities for improvement, both organizationally and individually;
- Expected benefits from EMIS Implementation — this should cover both financial and other benefits (environmental, social, etc.);
- Contact person(s) for additional details.

Communications processes should be two-way. It is not enough for the organization to simply inform employees on energy performance; processes should be implemented that will encourage and facilitate employees' proposals for improvement and provide feedback to the Energy Management Champion (EMC), Sponsor or Steering Group.

Submitted proposals and comments should be reviewed and answered promptly.

Processes defined for communication should include:

- Who has the responsibility for internal communications regarding the energy management system? Is this a role assigned to the EMC or should this be the responsibility of an internal marketing department?;
- Relevant information on the implementation and operation of the energy management information system;
- Proposed means of communicating information (internal meetings, staff magazines, intranet, e-mail, energy boards, and/or awareness campaigns etc.);
- How employee proposals and comments are to be reviewed and answered.

A final issue is the need for any external communication, e.g., volunteer efforts, presentations, etc. If the organization commits to such external communication, the plan should identify those responsible for collating the information and the approval process for its external communication.

EXCEL SPREADSHEETS

E1 EMIS Audit Assessment Tool

The EMIS Audit Assessment Tool contains five main worksheets: a generic sheet used to capture data about a site's annual energy consumption, a sheet to generate graphical representations for the audit report, and three sheets dedicated to EMIS Audit scoring and commentary, plus one summary table and graph.

This workbook consists of six tabs:

- Introduction;
- Annual Energy Consumption – captures data on energy consumption and creates pie charts;
- Utility Meters, Utility Drivers and Data Capture and Storage Assessment Criteria – adds scores and compares them against ideal score, provides tables;
- Data Analysis and Reporting Assessment Criteria – adds scores and compares them against ideal score, provides tables;
- Management Systems and Procedures Assessment Criteria – adds scores and compares them against ideal score, provides tables;
- Summary – summary table and gap assessment graph.

E2 EMIS Business Case Tool

The EMIS Business Case Tool is used to create a simplified business case for EMIS implementation and can be used at the audit stage for estimating probable costs and benefits from the EMIS. The Business Case Tool can be updated at the implementation stage when the plan's costs and timescales are known.

The EMIS Business Case Tool has four visible spreadsheets and one graph under the following tabs:

- Analysis Assumptions is used to enter the overall assumptions (energy spending, cost inflation, estimated savings potential from the regression analysis, etc.) and chosen discounted cash rate;
- EMIS Implementation Costs is used to enter the costs for EMIS implementation, including software and support;
- Other Costs and Savings are used to enter any other identifiable costs or benefits from EMIS implementation (metering and data infrastructure costs, productivity gains, etc.). The Cash Flow Chart shows the overall cash flow position.
- The Summary will present the information entered from a cash flow perspective over three, four, or five years.

PART D - REFERENCE MATERIAL

Energy management Information Systems - Achieving Improved Energy Efficiency: A handbook for managers, engineers and operational staff, published in 2003 by the Office of Energy Efficiency of Natural Resources Canada.