Knowledge and Skills Needed to Implement Energy Management Systems in Industry and Commercial Buildings

Multi-Country Analysis and Recommendations

Global Superior Energy Performance Partnership
Energy Management Working Group

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Background on the Global Superior Energy Performance Partnership

The **Global Superior Energy Performance Partnership** (GSEP) is one of 13 ongoing initiatives of the Clean Energy Ministerial (CEM), a high-level global forum for facilitating the transition to a global clean energy economy. The aim of GSEP is to significantly cut global energy use by encouraging the industrial and commercial buildings sectors to continually improve their energy efficiency.

Within GSEP, 11 countries participate in the **Energy Management Working Group** (EMWG) to advocate for wider adoption of **energy management systems** (EnMS) or ISO 50001. The 11 countries in the EMWG are Australia, Canada, Denmark, European Commission, India, Japan, Mexico, Republic of Korea, South Africa, Sweden, and the United States.

To pave the way for wider adoption of EnMS, the EMWG recognizes the need to help countries design programs that better prepare their workforces to successfully implement and manage these systems. Successfully implementing an EnMS requires a committed and knowledgeable energy team drawn from all relevant divisions across an organization, including management. For example, an energy team might require members with such diverse areas of expertise as communications, financial management, information systems, procurement, energy management, sustainability, energy efficiency, or measurement and verification. To better understand the full range of workforce knowledge required to effectively implement an EnMS, the EMWG has compiled this comparative analysis of current energy efficiency workforce programs in five of the 11 EMWG countries: Australia, Japan, the Republic of Korea, South Africa, and the United States. These descriptions of workforce programs for building energy assessment and management expertise in the industrial and commercial buildings sectors should enable the EMWG to identify similarities, gaps in knowledge or skills, best practices, and opportunities for multinational collaboration to improve workforce development. Ultimately, the analysis is designed to expedite the successful use of EnMS around the globe to continuously improve energy performance.

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1. Introduction

Energy management represents a significant opportunity for organizations to reduce their energy use while maintaining or boosting productivity. The industrial and commercial sectors jointly account for approximately 60% of global energy use.[1] Organizations in these sectors can reduce their energy use 10% to 40% by effectively implementing an energy management system (EnMS).[2]

The EnMS concept builds upon the Plan-Do-Check-Act (PDCA) cycle of management developed by Dr. W. Edward Deming and used as a basis for many management systems and standards throughout the world. Figure 1 illustrates how continued use of the PDCA process leads to continuous improvement.

An EnMS is a collection of processes, procedures, and tools designed to engage staff at all levels within an organization in managing energy use on an ongoing basis. An EnMS allows industrial plants; commercial, institutional, and governmental facilities; and entire organizations to systematically track, analyze, and plan their energy use—enabling greater control of and continual improvement in energy performance. Organizations may choose to pursue only certain components of energy management.

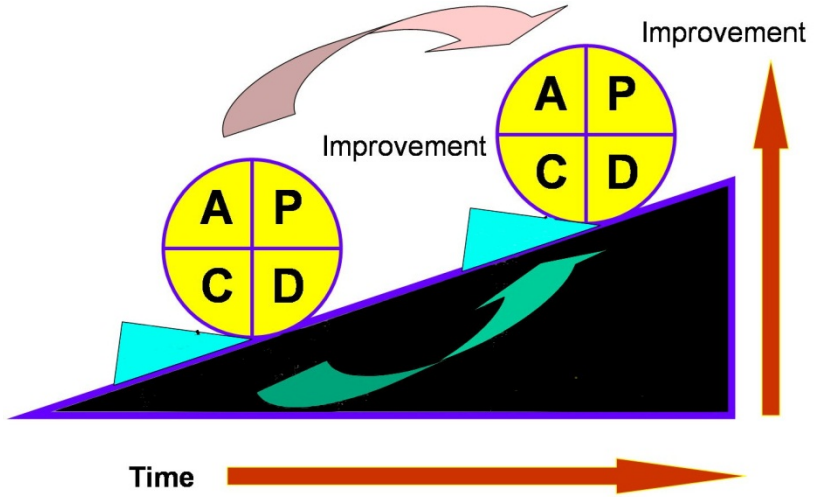

Figure 1: Plan-Do-Check-Act cycle for continuous improvement[3]

Some governments have formulated specifications to define energy management requirements, while others have adopted EnMS standards such as ISO 50001.[4] Regardless of the chosen (or mandated) path, energy management requires specific expertise and skills. Access to the skills of an experienced professional in energy management—whether the individual is internal to the company or an external consultant—will result in more effective implementation of the EnMS and higher energy savings. However, professionals with these skills are not yet widely available in the market. While EnMS implementation expertise is typically concentrated in technical and

[1] Energy Information Administration, *International Energy Outlook 2013*, DOE/EIA (Washington, DC: U.S. Energy Information Administration, 2013).

[2] International Energy Agency/Institute for Industrial Productivity, *Energy Management Policy Pathways* (Paris: International Energy Agency, 2012), 19, www.iea.org/publications/freepublications/publication/policypathwaysindustry.pdf; Carlos Duarte et al., *Prioritizing and Visualizing Energy Management and Control System Data to Provide Actionable Information for Building Operators* (presentation, Western Energy Policy Research Conference, Boise, ID, August 25–26, 2011), http://mhrg.if.uidaho.edu/papers/2011/WEPC11_DuarteAckerKevin_EMSDataVisualisation.pdf.

[3] ISO 14001 Certification home page, International Organization for Standardization, accessed August 27, 2013, http://iso14001certification.com/.

[4] International Energy Agency/Institute for Industrial Productivity. (2012)

engineering positions within an organization, a variety of non-technical personnel also exert significant influence on energy decision-making (e.g., executive staff, accountants, and financial managers). While these non-technical staff members need not be knowledgeable in all aspects of energy management, they are included in this analysis since they can be critical to the success of an EnMS within their organization.

Many long-standing professional training or credentialing programs cover some skills or knowledge areas relevant to EnMS implementation, but most fall short of providing the entire spectrum of skills and expertise needed to implement an EnMS effectively. Workforce development programs that focus specifically on EnMS implementation in response to the 2011 publication of ISO 50001 are still in the early stages of development or release, and most do not provide training for the broader range of personnel involved in instituting energy management at the organizational level.

The GSEP EMWG seeks to facilitate effective implementation of energy management in the industrial and commercial buildings sectors by recommending to workforce development programs a broad set of foundational knowledge and skills for professionals engaged in energy assessment and management. This analysis identifies knowledge and skills that are unique and noteworthy as well as those that are common across existing energy assessment and management programs in Australia, Japan, the Republic of Korea, South Africa, and the United States. In addition, this report contains job-specific knowledge and skills for key positions that can influence energy management within a company and specifies the most relevant knowledge and skills for each job type. As examples, some of these key positions include the following:

- Chief Financial Officers
- Sustainability Officers
- Accountants and Financial Professionals
- Environmental, Health, and Safety (EH&S) Professionals
- Engineers: Industrial, Mechanical, and Electrical
- Technicians and Tradespeople

Finally, this report identifies some common professional development models and ways in which GSEP member countries are using these models to build energy management capacity in their workforces.

The recommended knowledge and skills in this report may impart guidance to workforce programs under development, generate opportunities for collaboration among developing or expanding training programs, facilitate greater consistency among existing professional programs, and increase awareness about the energy efficiency potential that can be achieved through skills programs. Ultimately, building skills in the workforce will help countries achieve their national energy efficiency goals. Advancements in training and credentialing offer only part of the solution for improving effectiveness; supporting policies and national systems are also critical components. Although this report does not analyze such policies, it acknowledges their vital role in improving workforce programs and work quality.

1.1 METHODOLOGY AND SOURCES

During 2012 and 2013, representatives of five countries participating on the GSEP EMWG provided documents describing the training programs used to prepare their workforces to meet energy assessment and management needs. This analysis is based on the documents submitted by those five countries: Australia, Japan, the Republic of Korea, South Africa, and the United States.

The GSEP EMWG compiled the knowledge and skills collectively recommended or required by the training programs. For each phase of EnMS implementation, representatives identified the key knowledge and skills most needed (see country lists in Appendix A).

Representatives also identified the six job positions deemed most instrumental to EnMS implementation at a typical industrial company or commercial building, then identified the knowledge and skills recommended or required for individuals in those positions (see country lists in Appendix B). This document integrates these findings; future versions may incorporate additional countries and workforce programs. The documents provided by the five countries include reports identifying required or desired skills (needs analyses) and overviews of existing training (noted in Appendix C), and the existing legislation related to energy management (Appendix D). Appendix E lists other sources used for this document.

1.2 HOW TO USE THIS REPORT

This report is intended to provide initial guidance for refining or accelerating the development of workforce programs in the fields of energy assessment and management in the industrial and commercial building sectors. This information may help professional workforce programs to develop key program products—curricula, training, and exams—and to identify appropriate professional development models. Key audiences for this report include the following:

- **Governmental energy departments or ministries**
- **National education departments or workforce training programs** (may incorporate energy assessment and management into other workforce programs)
- **Universities** developing professional training programs
- **Professional associations and industry associations**
- **The private sector** (corporations, building property owners)

This report identifies suggested topic areas for training and organizes this information in different ways for flexible access. The content is structured as follows:

1. An analysis of the knowledge and skill areas needed in each major aspect of implementing an EnMS
2. An overview of the most relevant knowledge and skill areas for six selected positions in an organization
3. An overview of the professional development models used to deliver workforce training in EnMS
4. Next steps

These sections and the appendices also list information resources that provide a more complete understanding of the suggested topic areas.

2. Knowledge and Skill Areas for Energy Management System Implementation

Based on the resources provided by Australia, Japan, the Republic of Korea, South Africa, and the United States, the EMWG assessed the similarities and noteworthy differences among the knowledge and skills sets required or recommended by various programs. As listed in Appendixes A and B, the EMWG mapped these knowledge and skills areas to the steps in which they are needed during implementation of an energy management system:

1. **Initiating an Energy Management Program:** Understanding basic concepts and requirements; getting organization leadership commitment; establishing an energy team; developing an energy policy
2. **Conducting an Energy Review:** Collecting energy data; analyzing energy consumption and costs; identifying major energy uses; conducting energy assessments; identifying potential opportunities
3. **Energy Management Planning:** Setting a baseline; determining performance metrics; evaluating opportunities and selecting projects; developing action plans
4. **Implementing Energy Management:** Obtaining resource commitments; providing training and raising awareness; communicating to all stakeholders; executing action plans
5. **Measurement and Verification:** Including the knowledge and skills required to monitor, measure, verify, track, and document energy use and savings
6. **Management Review**: Reviewing progress; modifying goals and action plans as needed

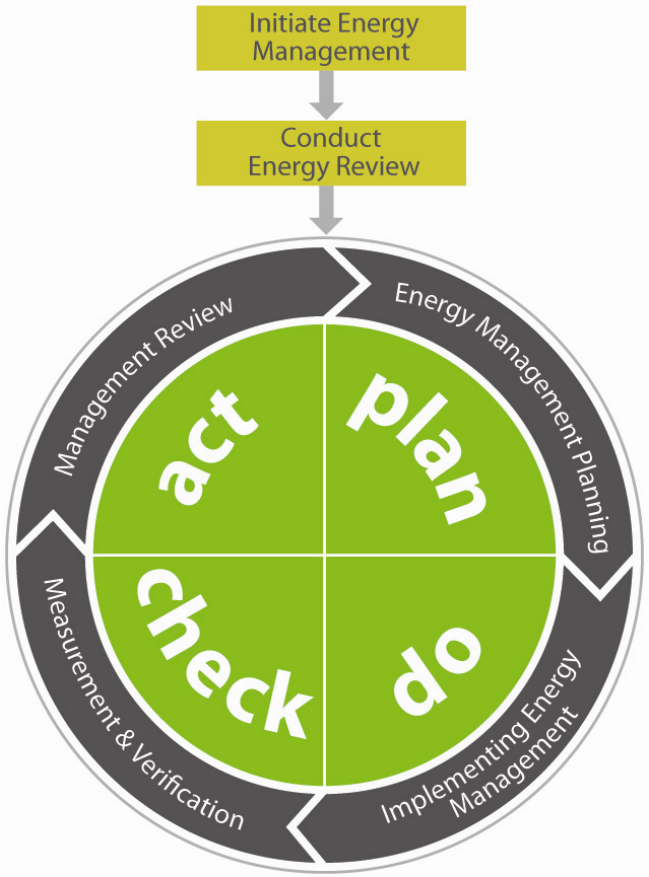

Figure 2: Steps within Energy Management Systems

These steps are embedded in the Plan-Do-Check-Act cycle, as represented in Figure 2. In addition to these common knowledge areas, the EMWG identified ancillary knowledge and skills that will enhance understanding of key energy management topics.

2.1 INITIATING AN ENERGY MANAGEMENT PROGRAM

To succeed, any corporate energy management program will need to obtain the commitment of top management to provide the resources needed for a sustained effort. An energy team is usually responsible for implementing the EnMS and ensuring energy performance improvements, but the composition and size of the team will vary by organization. To obtain top management support, the energy team should present the business case articulating the positive long-term impacts that the program will have on key business objectives, such as financial performance, business growth, environmental performance, and social responsibility.

Forming a committed, multidisciplinary energy team is crucial to the success of an EnMS. Typically, the organization will designate an energy leader or energy champion to head the team. A small organization's team may have only a few members, while a large organization may have multiple layers of teams. The energy team should include members responsible for the common operational areas shown in Figure 3. In smaller organizations, one person may represent multiple operational areas and business units, as long as the team member has cross-functional knowledge and decision-making authority. An energy team may also include outside personnel, such as utility representatives, suppliers, or trusted consultants.

After obtaining the commitment of top management, the energy team should develop a plan for implementing the energy management program and create a structure that facilitates documentation and recordkeeping. Some of the fundamental tasks involved in initiating an energy management program include the following:

- Developing the business case
- Determining internal and external audiences and their roles in supporting energy management
- Engaging stakeholders
- Developing multidisciplinary teams

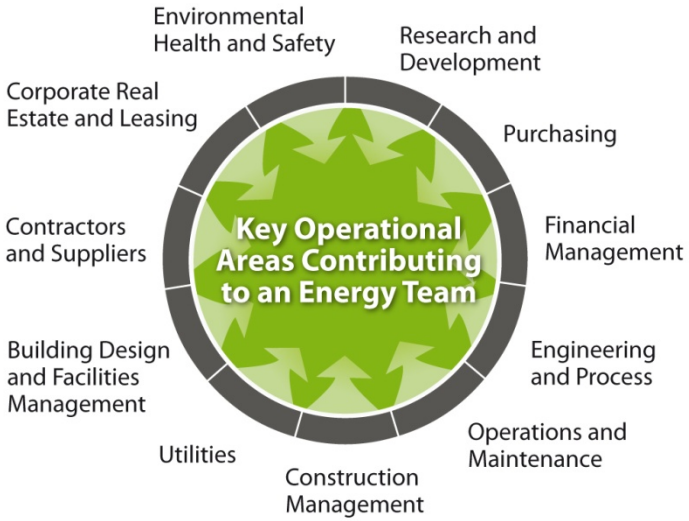

Figure 3: Example operational areas to include in an energy team[5]

[5] Energy Star, *Teaming Up to Save Energy*, Document No. 430-K-05-007 430-K-05-007 (Washington, DC: U.S. Environmental Protection Agency, n.d.), www.energystar.gov/buildings/tools-and-resources/teaming-save-energy.

Implementing Energy Management Example

Samsung SDI, a manufacturer based in the Republic of Korea, initiated an EnMS program for its global facilities in response to stakeholder requests and as a means to comply with South Korea's climate change policy. Samsung SDI was already familiar with the management systems approach to business improvement through its use of the ISO 14001, ISO 9001, and other standards. The company formed a corporate-level EnMS Task Force, consisting of representatives from the production technology, equipment purchasing, and manufacturing departments, to work with energy teams at individual sites as they pursue ISO 50001 certification.

Source:
www.bsigroup.com.au/upload/Case%20Studies/BSI%20Samsung%20SDI%20Case%20study.pdf

TARGET EMPLOYEE CATEGORIES

While the personnel needed to initiate an energy management program will vary according to the expertise of personnel within an organization, the following staff should typically be involved:

- Chief Executive Officer and senior management
- Chief Financial Officer
- Sustainability Officer
- Facility Manager
- Other energy team members

COMMON KNOWLEDGE AND SKILLS

Multiple workforce training programs reviewed in this analysis recommend or require common knowledge and skills pertaining to initiating an energy management program. No single person on the energy team is expected to be proficient in all areas of energy management, but members of a successful team should collectively possess the following knowledge and skills:

- **Management skills**
  - Business decision-making fundamentals
  - Business improvement skills
  - Organizational and leadership skills
- **Knowledge of regulations, standards, and best practices**
  - Federal, state, and local energy legislation and policies
  - National energy reporting systems
  - Federal, state, and local green building standards and programs
  - Environmental regulations
  - Energy management system concepts (e.g., ISO 50001)
- **Financial and accounting skills**
  - Financial decision-making processes
  - Risk management
  - Economics of energy management
- **Technical knowledge**
  - Facility and industrial processes
  - Energy fundamentals
  - Energy metrics
  - Energy measurement and verification techniques and protocols
- **Other knowledge and skills**
  - Communication and interpersonal skills

NOTABLE KNOWLEDGE/SKILL RESOURCES

In addition to the common knowledge and skills represented in multiple training programs (identified above), the GSEP EMWG recommends the following resources as beneficial when initiating a management system.

Australia:

- The Chartered Institute of Management Accountants provides a report that is unique in its coverage of the role that accounting professionals can play in energy management and the broader topic of climate change mitigation: *Accounting for Climate Change: How management accountants can help organisations mitigate and adapt to climate change* (2010)

United States:

- A U.S. Department of Energy on-line resource, the DOE eGuide for ISO 50001, includes guidance on the following activities involved in initiating an energy management program:
  - **Management skills**
    - Business decision-making fundamentals
    - Business improvement skills
    - Organizational and leadership skills
    - Business case development
    - Determining stakeholder roles
    - Stakeholder engagement
    - Developing multidisciplinary teams
  - **Regulatory, standards and best practices**
    - Energy management system concepts (e.g., ISO 50001)
  - **Other knowledge and skills**
    - Communication and interpersonal skills
- U.S. Environmental Protection Agency on-line resource, Guidelines for Energy Management
- *Certified Practitioner in Energy Management Systems* (training, certification)
- *Job/Task Analysis for an Energy/Sustainability Manager* (report)

RELEVANT TRAINING AND QUALIFICATION PROGRAM RESOURCES

Australia:

- *Energy Efficiency Opportunities Program – Industry Guidelines* (guidebook)

Japan:

- *Japan Energy Conservation Handbook 2011* (guidebook)

Korea:

- *Training Course for Energy Practitioners* (training)
- *EnMS Package Guideline for SME (software and guidebook)*

2.2 CONDUCTING AN ENERGY REVIEW

To manage energy, a company must gain a complete understanding of its energy use and demand. This understanding should be based on a comprehensive energy review, which consists of analyzing all energy use and consumption, determining the significant energy uses, and then identifying and prioritizing potential opportunities for improvement. An energy review is an essential element of energy management planning and should be performed by personnel with a broad range of knowledge and skills. An energy review requires the collection of energy consumption data from utility bills, energy meters, and other sources. The data must be analyzed and interpreted within the context of the various sites, facilities, processes, business units, and equipment in the organization. This analysis requires personnel that not only understand buildings, processes, energy-using equipment, and other factors but also

possess the knowledge and skills necessary to identify viable improvement opportunities.

Some of the fundamental tasks involved in conducting an energy review include:

- Data logging and collection
- Metering, monitoring, measurement, and verification
- Facilitating and managing the process for identifying energy efficiency opportunities

TARGET EMPLOYEE CATEGORIES

While the personnel needed to conduct an energy review will vary by organization and based on the expertise of personnel within the organization, the following personnel should typically be involved:

- Engineers
- Technicians and Tradespeople
- Other energy team members
- Consultants and other outside expertise as needed to provide energy assessments and identify opportunities for improvement

COMMON KNOWLEDGE AND SKILLS

Multiple workforce training programs reviewed in this analysis recommend or require common knowledge and skills pertaining to conducting an energy review.

- **Building and facility knowledge**
  - Energy measurement and verification techniques and protocols
  - Building construction techniques
  - Building envelope
  - Facility and industrial processes
  - Energy fundamentals
  - System optimization fundamentals
  - New and existing energy-related technologies
  - Operation of energy-using equipment and systems
  - Efficient use of energy in buildings
  - Efficient use of energy in processes, systems, and equipment
  - Operations and maintenance practices and requirements
- **Technical knowledge**
  - Mechanical and electrical engineering principles
  - Facility and industrial processes
  - Operation and maintenance practices and requirements
  - Awareness and understanding of new and existing technologies
  - Building automation and interoperability
  - Instrumentation and controls
- **Analysis**
  - Energy mass balance diagrams and models
  - "Whole-of-systems" analysis
  - Identifying "out-of-box" solutions
  - Identifying significant energy uses
- **Energy assessment and opportunity identification**
  - Assessment/audit skills
  - Factors influencing energy use or waste
  - Cost implications of wasting energy
  - Building energy rating, simulation, and simulation methodologies
  - Implementation costs
  - Life cycle cost analysis
- **Regulations, standards, and best practices**
  - Federal, state, and local building regulations and codes
  - National energy regulations and laws

- Heating, ventilation, and air conditioning (HVAC) and indoor air quality standards

NOTABLE KNOWLEDGE/SKILL RESOURCES

In addition to the commonly recommended knowledge and skills for conducting an energy review (identified above), the GSEP EMWG identifies the following resources as beneficial.

Japan:

- An established an energy management qualification program that requires knowledge in the following areas relevant to conducting an energy review:
  - **Building and facility knowledge**
    - Basics of thermodynamics, fluid engineering, and heat transmission
    - Electricity and electronics theory
    - Automated control and information processing
    - Fuel and combustion (optional)
    - Heat utilization equipment (boilers, steam distribution, heat exchangers, heat recovery, chilled water systems) and management thereof (optional)
    - Electrical equipment and appliances (optional)
    - Electric power applications – motor systems, lighting, air conditioning, electrical heating, electrochemistry (optional)
  - **Analysis**
    - Electrical measurement and data analysis
  - **Energy assessment and opportunity identification**
    - Energy efficiency opportunities identification process
  - **Regulations, standards, and best practices**
    - Laws and ordinances related to energy use

United States:

- ANSI/ASME System Assessment Standards for steam, process heating, pumping, and compressed air systems (standards)
- U.S. Department of Energy's 24 university-based Industrial Assessment Centers provide hands-on assessment experience to engineering students.
- U.S. Department of Energy and the National Institute of Building Sciences: Job Task Analyses (JTAs)[6] for the following job types[7]:
  - Commercial Building Energy Auditors
  - Commercial Building Energy Modelers
  - Commissioning/Retro-Commissioning Authorities
  - Energy/Sustainability Managers
  - Facility Managers
  - Operating Engineers/Building Technicians

  Portions of the JTAs for each of these job types relate to conducting an energy review:
  - **Building and facility knowledge**
    - Facility and industrial processes
    - Building construction techniques
    - Building envelope
    - Operations and maintenance processes and requirements
    - Building trades
    - Electrical systems
    - System optimization fundamentals
    - Energy fundamentals
  - **Analysis**
    - Data logging and collection

[6] JTAs are under revision. The Energy Manager JTA will be revised with content related to energy management systems and ISO 50001.
[7] The U.S. Department of Energy is collaborating with the National Institute of Building Sciences to finalize the JTAs.

    - Metering, monitoring, measurement, and verification
  - **Energy assessment and opportunity identification**
    - Assessment/audit skills

RELEVANT TRAINING AND QUALIFICATION PROGRAM RESOURCES

Australia:

- *Functional Skills for an Energy Efficiency Assessment* (report)
- *Leadership & Change for Energy Efficiency in Accounting & Management: Training Needs Analysis* (report)
- *AS/NZS 3598 Energy Audits (2000)* (standard)
- *Energy Savings Measurement Guide* (guidebook)
- *Energy Efficiency Opportunities Program – Industry Guidelines* (guidebook)
- *Energy Efficiency Opportunities Program – Assessment Handbook* (guidebook)

South Africa:

- *Needs Analysis for Training of Energy Auditors, Energy Managers and M&V Professionals in the Building Sector* (report)
- *Green Skills: Baseline Overview for Skills Development for Renewable Energy and Energy Efficiency* (report)

United States:

- *ASHRAE Building Energy Assessment Professional Certification* (certification)
- *BOMA (Building Owners and Managers Association, Intl.) Building Energy Efficiency Program* (training)
- Energy Management Diploma Program, North Carolina State University (training)
- Energy Management Certification, Northwest Water and Energy Education Institute (training)

Korea:

- *Energy Auditor* (credential)
- Building Energy Assessor (training and credential)
- Korea Voluntary Emission Reduction Project Verifier (training and credential)
- GHG Reduction Verifier (training and credential)

2.3 ENERGY MANAGEMENT PLANNING

Energy management planning entails defining—and refining, as necessary--the organization's objectives to meet defined goals, strategies, and action plans for improving energy performance. The energy team and other members of the organization who have roles in planning or implementing energy management must possess the knowledge or skills appropriate to their roles (i.e., energy fundamentals, energy optimization techniques, analysis of energy data, and energy performance metrics). Knowledge of renewable energy and on-site generation options will be helpful for certain organizations. Strong planning capabilities and interpersonal skills are also desired. At times, internal training of non-technical staff on energy fundamentals will be advantageous, as will training of technical staff on such areas as communication and organizational skills. Some of the tasks common to energy management planning at any type of organization include the following:

- Stakeholder engagement

- Facility planning
- Project planning and management
- Developing energy intensity indicators
- Energy data analysis
- Developing energy mass balance diagrams and models
- Integrating energy management into operational procedures and key performance indicators (KPIs)

TARGET EMPLOYEE CATEGORIES

While the personnel needed to conduct energy planning will vary by organization and will reflect the expertise of personnel within the organization, the following staff should typically be involved:

- Chief Financial Officer
- Sustainability Officer
- EH&S Professionals
- Engineers

> ***Energy Management Planning Example***
>
> *U.S.-based manufacturer 3M implemented the ISO 50001 EnMS at its facility in Cordova, Illinois. The company learned the value of energy management planning in achieving success. The structure provided by a management system proved to be valuable in helping set objectives and targets, increasing the visibility of the activity, and demonstrating to management the value of an EnMS in meeting organizational goals.*
>
> *Source: www.superiorenergyperformance.net/pdfs/3M_WEEC_2012.pdf*

- Facility Managers
- Other energy team members

COMMON KNOWLEDGE AND SKILLS

Multiple workforce training programs reviewed in this analysis recommend or require common knowledge and skills pertaining to energy management planning.

- **Management skills**
  - Organizational and leadership skills
- **Energy management knowledge**
  - Energy fundamentals
  - Energy metrics
  - Energy optimization fundamentals
- **Analytical skills**
  - Identifying "out-of-the-box" solutions
  - "Whole systems" analysis
  - Benchmarking
  - Life cycle cost analysis
- **Other knowledge and skill areas**
  - Communication and interpersonal skills
  - Critical thinking skills
  - Renewable energy
  - Combined heat and power

NOTABLE KNOWLEDGE/SKILL RESOURCES

In addition to the common knowledge and skills on energy management planning identified above, the GSEP EMWG recommends the following resources as beneficial.

Australia:

- *Leadership & Change for Energy Efficiency in Accounting & Management: Training Needs Analysis* (report)

- *Accounting for Climate Change: How management accountants can help organisations mitigate and adapt to climate change* (report)

Japan:

- Energy Conservation Decision Criteria for Business Operators

United States:

- A U.S. Department of Energy on-line resource, the DOE eGuide for ISO 50001, includes guidance on energy management planning. The knowledge and skills discussed in this resource include:
  - **Management skills**
    - Organizational and leadership skills
    - Project planning and management
  - **Analytical skills**
    - Identifying "out-of-the-box" solutions
    - "Whole systems" analysis
    - Other knowledge and skill areas
  - **Communication and interpersonal skills**
    - Integrating energy-efficiency projects and goals into cross-business operational plans, procedures, and KPIs
- *Certified Practitioner in Energy Management Systems* (training, certification)

2.4 IMPLEMENTING ENERGY MANAGEMENT

Once energy management plans are in place, the next phase is implementing actions and individual projects. Implementation requires obtaining the appropriate capital resources and personnel, ensuring that personnel are properly trained, and communicating the energy management program goals and objectives to all levels of the organization. Some of the typical tasks involved in implementing energy management include:

- Integrating energy management into operational procedures and KPIs
- Organizing improvement activities
- Facility planning
- Project planning and management
- Contract development

TARGET EMPLOYEE CATEGORIES

While the personnel needed to implement energy management will vary by organization and will reflect the expertise of personnel within the organization, the following staff should typically be involved:

- Chief Financial Officer
- Accounting and Financial Professionals
- Engineers
- Technicians and Tradespeople
- Facility Managers
- Training Specialists
- Public Affairs or Communications Specialists
- Other energy team members

COMMON KNOWLEDGE AND SKILLS

Multiple workforce training programs reviewed in this analysis recommend or require common knowledge and skills pertaining to implementing energy management.

- **Management skills**
  - Organizational and leadership skills
  - Change management skills
  - Contract management
- **Financial and accounting skills**
  - Risk management
  - Economics of energy management
  - Financing options, alternative financing
- **Energy management knowledge**
  - Energy fundamentals
  - Energy optimization fundamentals
- **Technical knowledge**
  - Mechanical and electrical engineering principles
  - Facility and industrial processes
  - Operation and maintenance practices and requirements
  - Awareness and understanding of new and existing technologies
  - Building automation and interoperability
  - Instrumentation and controls
  - Commissioning principles
  - Recommissioning
- **Other knowledge and skill areas**
  - Communication and interpersonal skills
  - Energy procurement
  - Performance contracting
  - Implementation costs
  - Product and service procurement

NOTABLE KNOWLEDGE/SKILL RESOURCES

In addition to the common knowledge and skills for implementing energy management (identified above), the GSEP EMWG recommends the following resources as beneficial.

Australia:

- *The Business Case and Beyond* (web resource)

2.5 MEASUREMENT AND VERIFICATION

Monitoring, measurement, and verification are vital to successful energy management. Expertise in these areas is needed to track progress over time and to document energy savings. Implemented energy projects must undergo robust metrics review; however, since all organizations are dynamic and constantly evolving, monitoring, measurement, and verification activities should also regularly focus on other aspects of the energy management program, such as significant energy uses, action plans, and energy performance indicators.

Tasks typically undertaken as a part of measurement and verification include:

- Identifying factors influencing energy use or waste
- Developing and implementing data management, tracking, and reporting systems
- Metering, monitoring, measurement, and verification
- Data logging, collection, and use
- Internal auditing for conformance to EnMS standards

TARGET EMPLOYEE CATEGORIES

While the personnel needed to measure and verify an EnMS will vary by organization and according to the expertise of personnel within the organization, the following personnel should typically be involved:

- Engineers
- Technicians and Tradespeople
- Other energy team members
- Consultants and other outside expertise in measurement and verification of management systems

M&V Example

General Dynamics' Ordnance and Tactical Systems manufacturing facility in Scranton, Pennsylvania, achieved certification for the ISO 50001 energy management systems standard and, using the measurement and verification protocols of the U.S. Superior Energy Performance (SEP) program, became SEP Gold certified in 2013. The facility reduced its annual energy costs by over $500,000 USD in the first year after implementing the EnMS.

Source:

www1.eere.energy.gov/manufacturing/resources/army_general_dynamics.html

COMMON KNOWLEDGE AND SKILLS

All or some of the programs included in this analysis recommend or require the following knowledge and skills related to implementing measurement and verification:

- **Energy management knowledge**
  - Energy fundamentals
  - Energy optimization fundamentals
  - Industry scorecards and dashboards
  - Key energy efficiency program requirements
  - EnMS internal audit components and planning
- **Technical knowledge**
  - Facility and industrial processes
  - Operation and maintenance practices and requirements
  - Energy metrics

- Commissioning principles
- Instrumentation and controls

- **Regulations, standards, and best practices**
  - Federal, state, and local building regulations and codes
  - National energy regulations and laws
  - Energy measurement and verification guides and protocols
  - HVAC and indoor air quality standards

RELEVANT TRAINING AND QUALIFICATION PROGRAM RESOURCES

Australia:

- *A Best Practice Guide to Measurement and Verification of Savings* (guidebook)

South Africa:

- *South African National Standard 50010: measurement and verification of energy savings* (standard)
- *South African National Accreditation Systems (SANAS): inspection bodies: energy efficiency measurement and verification* (training, certification)

United States:

- Superior Energy Performance program's Performance Verifier certification training
- *Superior Energy Performance Measurement and Verification Protocol for Industry* (protocol)

2.6 MANAGEMENT REVIEW

An organization's top management conducts reviews at planned intervals to assess the effectiveness of the energy management system or program. Findings from these reviews help the energy team to modify its energy goals to insure relevance and adjust its plans to ensure persistent improvements in energy performance. In addition, management review provides an opportunity to recognize successes and key contributors. Typical activities and tasks within the management review include:

- Assessing organizational barriers
- Stakeholder engagement
- Writing and presenting energy management reports

TARGET EMPLOYEE CATEGORIES

While the personnel needed to participate in a management review will vary by organization and may reflect the expertise of personnel within the organization, the following staff should typically be involved:

- Chief Executive Officer and senior management
- Chief Financial Officer
- Accounting and Financial Professionals
- Sustainability Officer

- Other energy team members

COMMON KNOWLEDGE AND SKILLS

The following knowledge and skills relevant to management review are recommended or required by all or some of the programs included in this analysis.

- **Management skills**
  - Organizational and leadership skills
  - Change management skills
- **Energy management knowledge**
  - Energy fundamentals
  - Energy optimization fundamentals
  - Industry scorecards and dashboards
- **Analytical skills**
  - Business decision-making fundamentals
  - Problem-solving skills
  - Risk management skills
  - Business improvement skills
  - Critical thinking skills
  - Benchmarking
- **Other knowledge and skills areas**
  - Communication and interpersonal skills

2.7 ANCILLARY KNOWLEDGE AND SKILLS

In addition to the energy management-specific knowledge areas addressed earlier in this report, personnel will benefit from a comprehensive understanding of related topics, such as electricity and fuel markets, greenhouse gas and carbon emissions programs, renewable energy, recycling and waste management, and water management.

TARGET EMPLOYEE CATEGORIES

While the personnel needed to provide other key areas of knowledge and expertise will vary by organization and topic, the following staff should typically be involved:

- Sustainability Officer
- EH&S Professionals
- Other energy team members
- Consultants and other outside expertise in the knowledge and skill areas identified below

COMMON KNOWLEDGE AND SKILLS

The following ancillary knowledge and skills are recommended by all or some of the programs included in this analysis.

- **Regulations, standards, and best practices**
  - Local sustainability codes and requirements
  - Sustainability standards and best practices
  - Environmental regulations and standards (e.g. ISO 14001)
  - Climate change-related regulations
  - Water management best practices
- **Greenhouse gases/carbon**
  - Carbon markets, carbon finance, and carbon project development process

- National greenhouse gas reporting systems
- Reducing risks associated with climate change
- Calculating greenhouse emissions and carbon footprints

- **Other knowledge and skills areas**
  - Corporate social responsibility
  - Renewable energy fundamentals
  - Economic regulation of utilities
  - Utility contracts, rate structures, tariffs
  - Local recycling and waste management operations
  - Greening office space (recycling, cleaning, supplies, transport and commuting)

NOTABLE KNOWLEDGE/SKILL RESOURCES

Australia:

- National Greenhouse and Energy Reporting System (NGERS) Act (legislations, guidelines)

Japan:

- Law Concerning the Promotion of Measures to Cope with Global Warming

RELEVANT TRAINING AND QUALIFICATION PROGRAM RESOURCES

Japan:

- Law Concerning the Promotion of Measures to Cope with Global Warming
- Electricity Business Act

South Africa:

- Energy Efficiency Tax Incentives

United States:

- ASHRAE HVAC and indoor air quality standards
- U.S. Green Building Council: Leadership in Energy and Environmental Design (green building certification)

3. Job-Specific Knowledge and Skills

The GSEP EMWG aims to help workforce programs tailor their energy assessment and management training courses to key personnel within a company. The EMWG identifies six key positions that are commonly represented on the energy team or otherwise influence energy management decision-making and implementation in many organizations. Personnel in these positions typically drive energy management system planning and implementation within their organizations. This section identifies the energy assessment and management skills most relevant to these positions:

- Chief Financial Officers
- Environmental, Health, and Safety Professionals
- Engineers: Industrial, Mechanical, and Electrical
- Tradespeople and Technicians
- Sustainability Officers
- Accountants and Financial Staff

These are not the only positions within organizations that may impact energy management or EnMS implementation, but the EMWG identifies these positions as having the highest initial impact. Some organizations have a Corporate Energy Manager or other individual dedicated to energy management or energy efficiency, but this position is not as common at many small- and mid-sized organizations. Regardless of whether an organization has a dedicated energy manager, other key personnel at the organization can influence energy management planning, review, and implementation (see Figure 4).

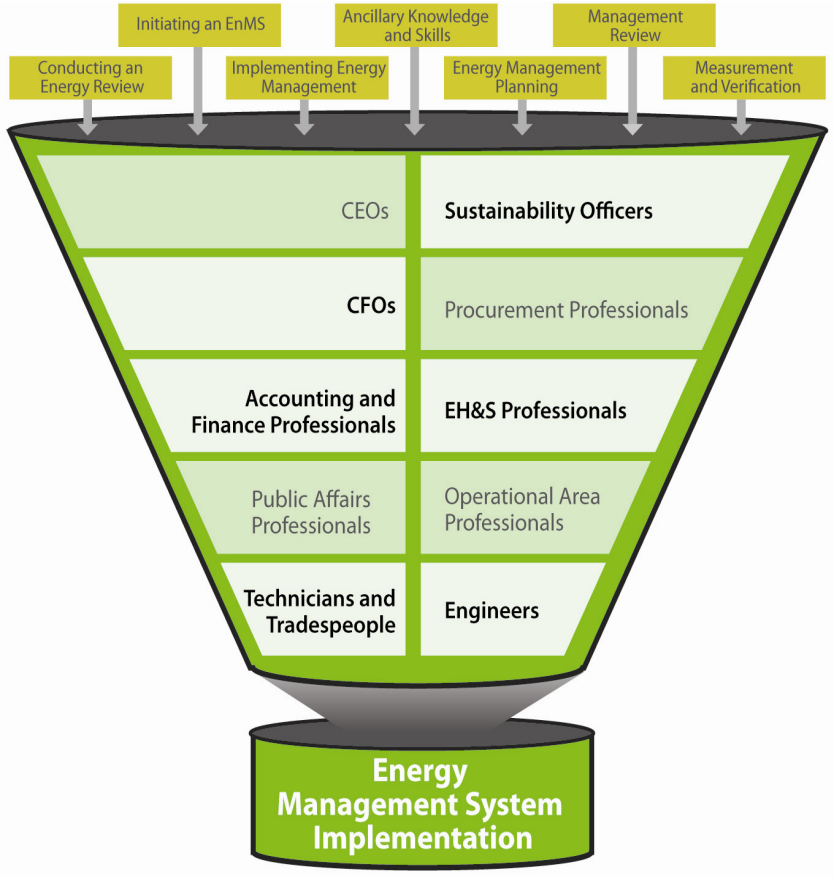

Figure 4: Organization staff commonly engaged in energy management system planning and implementation (positions addressed in this section are indicated by lighter shading)

This section lists the key knowledge and skills needed for various types of personnel that can influence decision-making or implementation of energy management within a corporation. These lists include the primary knowledge and skills essential to these key personnel for both understanding energy management systems and contributing to the organization's energy management efforts. The lists also include secondary knowledge and skills areas that can enhance their contributions to energy management, but are not as critical as the primary areas. These lists do not detail the level of proficiency needed for each knowledge or skill area for each position. The proficiency level needed will vary by position and by organization. For example, a Sustainability Officer should understand the capabilities of building energy modeling but is not expected to be a skilled energy modeler.

3.1 CHIEF FINANCIAL OFFICER

The Chief Financial Officer (CFO) plays a variety of roles within an organization, including some that affect corporate energy management. Six such key CFO roles are summarized in Figure 5.

CFOs are responsible for ensuring that capital investments are based on sound financial criteria (roles 1 and 4 in Figure 5). Implementation of an EnMS may lead to identification of capital projects, requiring the CFO to make capital investments based on a foundation of financial principles and using a range of potential financing options for these types of investments. Risk management skills are essential when companies consider long-term fuel procurements and energy service contracts, for example.

CFOs should also be capable of establishing policies and leading key new initiatives related to the financial aspects of energy management (roles #3 and 5 in Figure 5). The CFO should be able to provide leadership to the energy team as it develops financial analysis methodologies that equalize comparisons of energy investments relative to other capital investments. Environmental, maintenance, and other factors must be properly considered.

Typical tasks for a CFO related to EnMS implementation may include:

- Business case development
- Integrating energy-efficiency projects and goals into cross-business operational plans, procedures, and KPIs
- Conducting financial analyses, such as simple payback and rates of return
- Conducting cost-benefit analysis, including evaluation of environmental and social benefits
- Interpreting forecasts

The GSEP EMWG identifies the following knowledge and skills areas that a CFO should possess to assist in energy assessment and management. Duties will vary among organizations and among personnel within the Finance department, but these areas are broadly relevant to these professionals.

- **Management skills**
  - Change management
  - Innovation

- **Financial and accounting skills**
  - Economics of energy management
  - Energy accounting and analysis
  - Financing options, alternative financing
  - Energy efficiency tax incentives
- **Analytical skills**
  - Identifying "out-of-box" solutions
- **Procurement knowledge**
  - Electricity markets
  - Utility contracts, rate structures, tariffs
  - Energy procurement
  - Performance contracting

3.2 SUSTAINABILITY OFFICERS

Many large organizations now designate a senior-level executive to hold broad responsibilities for improving the sustainability of the organization. Job titles vary and may include Chief Sustainability Officer, Sustainability Manager, Vice President for Sustainability, or similar labels. The definition of sustainability and the roles of these positions continue to evolve and vary by company according to their priorities. Key responsibilities typically include:

- Energy management
- Environmental compliance
- Waste management
- Water conservation
- Carbon management
- Environmentally preferred purchasing
- Supply chain engagement

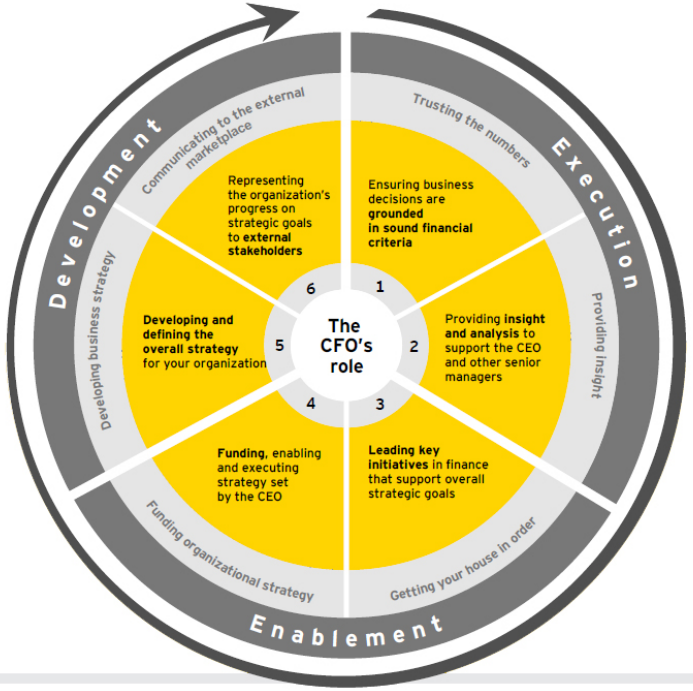

Figure 5: CFO skills and knowledge relevant to EnMS

Source: Ernst & Young, www.ey.com/GL/en/Issues/Managing-finance/The-DNA-of-the-CFO---perspectives-on-the-evolving-role---The-CFO-s-contribution, retrieved in 2012

As a senior-level executive, the Sustainability Officer may also engage in the following tasks related to energy assessment and energy management:

- Business case development
- Determining internal and external audiences and their roles in supporting energy management
- Stakeholder engagement

- Developing multi-disciplinary teams
- Assessing organizational barriers
- Financial analyses such as simple payback and rates of return
- Cost-benefit analysis including evaluation of environmental and social benefits
- Energy management policy and planning
- Building an energy performance awareness program
- Facility planning
- Integrating energy management into cross-business operational plans, procedures, and KPIs.
- Report development

The Sustainability Officer may not be involved in energy management on a daily basis if the company has a designated Corporate Energy Manager. However, the Sustainability Officer will need to understand all aspects of energy management and the effects of energy decisions on the organization.

When appointing a Sustainability Officer, companies typically seek someone who understands the organization's operations, structure, culture, and products. Successful candidates are usually selected from within the organizations and have several years of experience there. The knowledge areas and skills required largely fall into the following broad categories:

- Communications – ability to educate, persuade, and facilitate culture change
- Technical understanding of energy use and other sustainability issues
- Quantitative skills – ability to baseline, benchmark, and set goals based on data
- Financial skills
- Innovation skills
- Engaging the supply chain
- Understanding the operations, structure, and culture of the organization

The GSEP EMWG identifies the following energy assessment and management knowledge and skills as relevant to Sustainability Officers. Organizations may define the role of Sustainability Officers differently, but common competencies are listed below:

Primary areas:

- **Management skills**
  - Facilitation and negotiation
  - Culture and behavioral change management
  - Communications and engagement plans
  - Project management, project planning
  - Contract development, contract management
- **Financial and accounting skills**
  - Economic analysis techniques
  - Economics of energy management
  - Energy accounting and analysis
  - Financing options, alternative financing
  - Cost control and budgeting
- **Analytical skills**
  - Identify "out-of-the-box" solutions
  - Life cycle cost analysis
  - Benchmarking
  - Interpreting forecasts
- **Energy management knowledge**
  - Energy fundamentals
  - Energy project planning
  - Energy review and analysis

    - Energy metrics
    - Energy intensity indicators
    - Data management, tracking, and reporting systems
    - Energy data analysis
    - Cost implications of wasting energy
    - Energy efficiency program requirements
    - Energy optimization
- **Technical knowledge**
    - Building functions, operations and systems, interoperability
    - New and emerging technologies
    - Operation and maintenance practices
    - Whole-system and services analysis
    - Energy auditing
    - Efficient use of energy in buildings
    - System optimization fundamentals
    - Building energy modeling
- **Regulatory, standards and best practices**
    - Federal, state, and local energy legislation and policies
    - Building codes
    - Federal, state, and local green building standards and programs
    - Energy conservation laws and policies
    - Environmental regulations
- **Other knowledge and skill areas**
    - Communications
    - Interpersonal skills
    - Personnel motivation techniques
    - Utility contracts, rate structures, tariffs
    - Energy procurement
    - Information management principles

Secondary areas:

- **Greenhouse gases/carbon**
    - Reducing risks associated with climate change
    - GHG and carbon footprint emissions calculation protocols
    - Carbon markets, carbon finance, and the carbon project development process
- **Regulations, standards and best practices**
    - Local sustainability codes and requirements
    - Sustainability standards and best practices
    - Water management best practices
- **Other knowledge and skill areas**
    - Corporate social responsibility
    - Economic regulation of utilities
    - Building commissioning
    - Policy interventions to promote renewable energy value chains
    - Local recycling and waste management operations
    - Greening office space (recycling, cleaning, supplies, transport and commuting)

3.3 ACCOUNTING AND FINANCIAL PROFESSIONALS

Accounting and financial professionals provide critical skills affecting the success of an energy management program at an organization—including quantifying the economic costs and benefits of energy optimization measures. These professionals also maintain direct lines of communication to top management and can convey the importance of energy-related expenditures. As the importance of energy management, sustainability, and corporate social responsibility (CSR) grows, accounting and financial professionals will need to expand their expertise in these areas. They will need to understand the basics of EnMS, energy optimization strategies, and energy accounting; they will also need to relate energy projects to risk management, life cycle cost analysis, and business case development.

Accounting and financial professionals are likely to engage in the following activities related to EnMS implementation:

- Business case development
- Assessing organizational barriers
- Stakeholder engagement
- Financial analyses, such as simple payback and rates of return
- Cost-benefit analysis, including evaluation of environmental and social benefits
- Integrating energy management into operational procedures and KPIs

In addition, these personnel are often expected to communicate effectively within the organization and contribute to annual reports, CSR reports, and other documents.

The GSEP EMWG identifies the following energy assessment and management knowledge and skills as relevant to accounting and financial professionals.

Primary areas:

- **Financial and accounting skills**
  - Economics of energy management
  - Energy accounting and analysis
  - Financing options, alternative financing
  - Cost control and budgeting
- **Analytical skills**
  - Statistical modeling
  - Life cycle cost analysis
  - Cumulative sum control charts
- **Other knowledge and skill areas**
  - Communication and interpersonal skills
  - Organizational skills
  - Energy metrics and implementation costs
  - Cost implications of wasting energy
  - Energy procurement
  - Performance contracting
  - Information management principles

Secondary areas:

- Understanding ISO management systems
- Energy management basics
- ISO 50001 concepts
- System optimization fundamentals
- Energy economics fundamentals

3.4 ENVIRONMENTAL, HEALTH, AND SAFETY (EH&S) PROFESSIONALS

The roles of Environmental, Health, and Safety (EH&S) professionals vary based upon the type and size of the organization. Some organizations place energy management responsibility within the EH&S department.

EH&S professionals need to understand federal, state, and local environmental regulations and reporting relevant to their organization's processes as well as the regulatory implications of energy optimization projects (e.g., boiler system replacement). These professionals should also understand and assess the built environment within their organization, such as the impact of heating, ventilating, and air conditioning renovations on indoor air quality. Other typical EnMS implementation activities for EH&S professionals include:

- Developing multi-disciplinary teams
- Creating communications and engagement plans
- Cost-benefit analysis, including evaluation of environmental and social benefits
- Financial analyses, such as simple payback and rates of return
- Facility planning
- Integrating energy management into operational procedures and KPIs
- Report development

In addition, EH&S professionals may be expected to collaborate across departments and communicate to all levels of personnel in the organization.

Over time, EnMS such as ISO 50001 are expected to increase the overlap of energy- and environmental-related duties and responsibilities. Professionals using the ISO 14001 framework for environmental management are more likely to assume responsibility for implementing ISO 50001 or other EnMS standards.

The GSEP EMWG identifies the following energy assessment and management knowledge and skills as relevant to EH&S Professionals. Duties will vary among organizations and among personnel within EH&S departments, but these areas are broadly relevant to these professionals.

Primary areas:

- **Management skills**
  - Organizational and leadership skills
  - Project planning and management
  - Bridging organizational barriers
  - Cultural and behavioral change management
- **Analytical skills**
  - "Whole-systems" analysis

- Identifying "out-of-the-box" solutions

- **Technical knowledge**
  - Systems optimization
  - Energy-using systems
  - Indoor air quality control
- **Regulations, standards, and best practices**
  - Federal, state, and local environmental regulations
  - National energy reporting systems
  - HVAC and indoor air quality standards and best practices
- **Other knowledge and skill areas**
  - Communications
  - Personnel motivation methods
  - Information management

Secondary areas:

- **Greenhouse gases/carbon**
  - Carbon markets, carbon finance, and carbon project development process
  - National greenhouse gas reporting systems
  - Reducing risks associated with climate change
  - Calculating GHG emissions and carbon footprints
- **Regulations, standards, and best practices**
  - Sustainability statutes, codes, and requirements
  - Sustainability standards and best practices
  - Water management best practices
- **Other knowledge and skill areas**
  - Corporate social responsibility
  - Local recycling capabilities
  - Local waste management operations

3.5 INDUSTRIAL, MECHANICAL, AND ELECTRICAL ENGINEERS

Industrial, mechanical, and electrical engineers working in commercial and industrial facilities must possess a variety of technical skills and understand the operation of several systems as well as the effects of operation on production, energy use, and EH&S issues. Engineers are often responsible for measuring and monitoring building and industrial processes. They perform analyses of the collected data to identify maintenance, reliability, and safety issues and to identify energy optimization opportunities. Other typical EnMS implementation activities for engineers include:

- Stakeholder engagement
- Facility planning
- Project planning and management
- Cost-benefit analysis, including evaluation of environmental and social benefits
- Energy project planning
- Data collection and recording
- Data management, tracking, and reporting
- System assessments and planning
- Building energy modeling
- Electrical systems evaluation

As the complexity of organizations and facilities grows, it is increasingly important that engineers be able to communicate effectively with other personnel within their organization, such as

facilities managers, EH&S professionals, and corporate decision-makers.

A significant portion of the workforce training programs in this analysis focus on skills and knowledge areas needed by industrial, mechanical, and electrical engineers, clearly indicating the central role of these personnel in the successful implementation of energy management systems:

Primary areas:

- **Financial and accounting skills**
  - Economics of energy management
  - Energy accounting and analysis
- **Analytical skills**
  - Statistical analysis, including regression analysis
  - "Whole-system" analysis
  - Identifying "out-of-the-box" solutions
- **Energy management knowledge**
  - Energy fundamentals
  - Energy review and analysis
  - Energy metrics
  - Establishing energy performance indicators
  - System optimization
  - Energy mass balance diagrams and models
  - Building energy rating, simulation, and simulation methodologies
  - Industry scorecards and dashboards
- **Technical knowledge**
  - New and emerging technologies
  - Operations and maintenance practices
  - Systems interoperability
  - Systems optimization
  - Metering, monitoring, measurement, and verification
  - Power systems analysis
  - Thermodynamics and heat transfer
  - Commissioning principles
  - Combined heat and power
- **Regulations, standards, and best practices**
  - Federal, state, and local building regulations and codes
  - National energy regulations and laws
  - Energy management systems
  - Energy measurement and verification guides and protocols
  - HVAC and indoor air quality standards
  - Federal, state, and local green building programs
- **Other knowledge and skill areas**
  - Communication and interpersonal skills
  - Problem-solving

Secondary areas:

- Renewable energy fundamentals
- Indoor air quality control
- Sustainability standards and best practices
- Water management best practices

3.6 TECHNICIANS AND TRADESPEOPLE

Technicians and tradespeople, such as electricians, HVAC technicians, and maintenance personnel, are responsible for the daily operation of energy-using equipment and processes. For organizations with energy management systems in place, these individuals are responsible for optimizing equipment operation and processes. It is crucial that maintenance personnel understand the impacts of maintenance on system efficiency and reliability. At many small and medium-sized facilities, a technician may assume responsibilities that an energy manager would hold at a larger facility, so a broad range of skills is especially critical. Typical responsibilities and tasks for technicians and tradespeople include:

- Equipment and systems operation
- Energy data measurement and collection
- Managing energy demand
- System assessments and planning
- Energy project cost estimating
- Identifying significant energy usage
- Establishing energy performance indicators
- Developing and implementing data management, tracking, and reporting systems
- Identifying, facilitating, and capturing energy-efficiency opportunities
- Energy savings calculation
- Manage energy efficiency opportunity implementation

The role of technicians and tradespeople is evolving, mainly due to the increasing penetration of building and facility automation. The operation of buildings and facilities is becoming more complex, and technicians need to operate sophisticated computerized energy monitoring systems, electrical distribution systems, HVAC systems, and metering equipment. At many facilities, these personnel must be familiar with local, state, and federal regulations, including those related to environment, health, and safety.

In addition to technical skills, technicians and tradespeople must possess communication skills because they are in regular contact with equipment operators or office staff. They can have a significant role in creating awareness of the benefits of energy management as well as in facilitating a culture change within the organization. Finally, as technicians' responsibilities grow, the need for critical thinking and problem-solving skills also grows.

The following areas are relevant to technicians and tradespeople. Due to specialization, such as electricians or HVAC technicians, not every type of technician or tradesperson will need to be knowledgeable in all of these areas.

Primary areas:

- **Technical knowledge**
  - Understanding of facility and industrial processes
  - New and emerging technologies
  - Energy fundamentals
  - Operations and maintenance practices and requirements
  - Building construction techniques
  - Building envelope
  - Energy metrics
  - Energy metrics

- Metering, monitoring, measurement, and verification
- System optimization fundamentals
- Efficient use of energy in buildings
- Building automation and interoperability
- Instrumentation and controls
- Electrical and power systems
- Power factor control
- Combined heat and power (CHP) systems
- Domestic water systems

- **Regulations, standards, and best practices**
  - Building regulations and codes
  - Energy regulations and codes
  - Energy measurement and verification
  - HVAC and indoor air quality standards
- **Other knowledge and skill areas**
  - System operating costs
  - Organizational skills

Secondary areas:

- **Technical knowledge**
  - Commissioning principles
  - Thermal energy storage systems
- **Regulations, standards, and best practices**
  - Environmental regulations
  - Indoor air quality
  - Plumbing systems and codes
  - Water management best practices
- **Other knowledge and skill areas**
  - Communications
  - Interpersonal skills
  - Information management principles

4. Professional Development Models

Workforce and professional development programs will vary in structure and mode of delivery, depending on the market needs or regulatory requirements in a particular country. This section describes different types of awareness-raising efforts and educational offerings that can build professional expertise—from networking events, to stand-alone training, to formal courses and credentialing processes. This section references some programs within GSEP EMWG countries and provides examples of government involvement. These examples illustrate how these types of models are applied, but they are not representative of all workforce programs in these countries.

4.1 AWARENESS-RAISING EFFORTS

Many organizations and some government programs offer periodic, stand-alone, awareness-raising efforts that are not connected to an exam or credentialing process. These efforts can serve multiple purposes, including raising awareness about the latest market and industry trends, sharing best practices and case studies, or introducing tools or products. The format and duration of these sessions will depend on the target level of engagement for the intended audience. For example, in-person regional gatherings and networking events can be effective for introducing the value of energy management to corporate officers and decision-makers. Topical workshops and webinars may be more effective in reaching audiences that seek a deeper awareness of specific aspects of energy management.

Training sessions are a common and effective way to economically raise awareness or disseminate best practices at a large scale. Many organizations offer training sessions to maintain engagement with their stakeholders or customers. While formal classes or credentialing processes ensure that participants grasp the content, stand-alone training outreach may be a solution for workforce programs hoping to interact with large numbers of participants or reach broad audiences.

Workforce programs seeking to introduce or create awareness of EnMS implementation across a broad section of the workforce may choose to deploy training sessions through established training organizations. A key advantage of this approach is the ability to reach a larger population of potential attendees through the training organization's existing client base. In addition, workforce programs can broaden their reach by engaging training organizations that serve different types of audiences (i.e., not only those that primarily focus on energy).

EXAMPLES

Initiatives led by GSEP member governments

Canada: Dollars to $ense workshops

Korea:

- Training courses for energy practitioners
- EnMS Package for small and medium enterprises – web resource (software and guideline)

United States:

- U.S. Department of Energy eGuide for ISO 50001

- U.S. Environmental Protection Agency Guidelines for Energy Management

Initiatives led by GSEP member governments, in partnership with non-government organization

United States: BOMA Energy Efficiency Program (BEEP)

4.2 CONTINUING EDUCATION

Companies may offer a variety of apprenticeships or on-the-job training opportunities to train their own employees or enhance their skills. Alternatively, existing professionals interested in updating skills in their current field, or in changing careers, may seek opportunities through continuing education programs or vocational training at community colleges, trade schools, and training organizations.

Continuing education programs offer classes as part of a structured course of study but are generally less comprehensive than degree programs. Continuing education units or certificates are available following successful completion of the program. Professionals who enroll in continuing education programs generally work in fields with changing best practices, technologies, or processes.

Workforce programs could consider creating a continuing education course on EnMS implementation for industry or commercial buildings personnel, or they could create classes that could be integrated into existing programs on related topics. Government-developed continuing education programs were not analyzed in this report, but continuing education is another option for workforce programs that may be exploring deployment options to complement more formal education.

4.3 FORMAL EDUCATION

To build EnMS implementation expertise in individuals before they begin their professional careers, energy management can be integrated into education courses for credit at colleges and universities, vocational schools, or trade schools. Some community colleges offer Associate degrees in energy management, while other education programs may provide credit toward higher degrees. Though many workforce programs may prioritize training of the existing workforce in the near term, developing expertise in students will prepare the workforce of the future.

EnMS concepts may be easily integrated into courses for engineering or technical students, as their curricula should already include many energy-related topics. In addition, workforce programs may find value in incorporating EnMS concepts into coursework for accounting and business management students, since energy-related responsibilities are expanding across many divisions within companies. An innovative program in Australia develops energy efficiency knowledge and skills in accounting and business management students. Australia's *Leadership & Change for Energy*

Efficiency in Accounting & Management project is one of the first of its kind and could serve as a model for countries interested in developing EnMS expertise in future financial or business leaders.

EXAMPLE

Initiatives led by GSEP member governments

Australia: *Leadership & Change for Energy Efficiency in Accounting & Management: Training Needs Analysis*

4.4 PROFESSIONAL CREDENTIALING

Professional credentialing or certification involves evaluation to ensure that individuals possess advanced skills, knowledge, and competencies in a particular field. Credentials and certifications are commonly used to signal the credibility of certain types of professionals, such as energy managers.

National governments may need to develop and deploy personnel certification programs in response to regulatory requirements. For example, Japan's Energy Conservation Law requires companies that are large energy consumers to appoint an energy manager. In response, the Japanese government created a training program, exam, and certification process for different types of energy managers. The government also deploys the program and certifies these professionals to ensure compliance with the law.

Governments that do not establish credentialing systems may engage non-governmental organizations in the market to issue certifications. For example, the U.S. government is partnering with the National Institute of Building Sciences and commercial buildings experts to develop Better Buildings Workforce Guidelines: voluntary national guidelines for commercial building energy efficiency credentials in five key occupations: Energy Auditor, Commissioning Authority, Building/Stationary Engineer, Facilities Manager, and Energy Manager. For each occupation, the guidelines will contain an industry-validated Job-Task Analysis that can be adopted by professional certification bodies, labor unions, training providers, or career-technical education programs. Qualified certification bodies can license these guidelines to develop certification exams and confer a nationally recognized professional certification.

Workforce programs that seek to maintain consistent personnel certification may require personnel certification bodies to seek accreditation under standards that govern credentialing or certificate programs. Examples of these standards include the Interstate Renewable Energy Council Standard 14732, which specifies requirements for U.S. certificate programs in the renewable energy and energy efficiency fields, and the ISO/IEC 17024 standard, which specifies structure and governance for bodies that certify personnel internationally. As one example, to help companies gain expertise in implementing an EnMS, such as ISO 50001, the U.S. government collaborated with industry to create the Certified Practitioner in Energy Management Systems program. The government owns the training curriculum and licenses use of the materials to two teams of

organizations that provide the training. In addition, the government worked with personnel certification experts in the market to establish a non-governmental personnel certification body to create and administer the certification exam. In accordance with ISO/IEC 17024, the personnel certification body operates independently from any training organization to avoid any conflict of interest in the certification of personnel.

Many non-governmental organizations, such as industry associations, also create energy-related credentialing programs for specialized types of professionals. Examples of these programs in the United States include the credentialing programs administered by the Association of Energy Engineers, ASHRAE, and the International Facility Management Association. The reputations of these organizations in the market help create recognized value for these certification programs.

EXAMPLES

Initiatives led by GSEP member governments

Japan: Qualified Energy Manager, required by Energy Conservation Law.

Korea: Korea Voluntary Emission Reduction Project Verifier (Training and Credential)

Initiatives led by GSEP member governments in partnership with non-government organizations

United States: ANSI-accredited Certified Practitioners in Energy Management Systems

Initiatives led by non-governmental organizations

- Association for Energy Engineers Certified Energy Manager
- ASHRAE Building Energy Assessment Professionals
- IFMA Facility Management Professional credential
- IFMA Sustainability Facility Professional credential
- Northwest Energy Efficiency Council Building Operator Certification

Korea

- Energy Auditor (Credential)
- GHG Reduction Verifier (Training and Credential)
- Building Energy Assessor (Training and Credential)

5. Next Steps

ISO 50001 and similar EnMS standards enable organizations to engage staff at all levels to assess and better manage energy on an ongoing basis. GSEP recognizes inadequate workforce knowledge and training as potential barriers to successful EnMS implementation. Through GSEP, member countries share their experiences and collaborate on efforts to strengthen national workforce capacity to implement EnMS. Collectively, these efforts will help countries foster continual energy improvement in the industrial and commercial buildings sectors and help meet national energy and climate mitigation goals.

As a first step in these efforts, this report highlights six activities central to energy management systems. Personnel who participate in these activities can influence energy decision-making within an industrial facility or commercial building. The EMWG thus identifies a number of specific knowledge and skill areas recommended or required for each of these activities as well as several ancillary knowledge and skill areas needed. Workforce development programs are encouraged to apply these recommendations to better prepare individuals to facilitate continual improvement in energy performance. In addition, this analysis should raise awareness that a variety of employees need to be engaged to create institutional change and meaningfully impact energy efficiency within an organization.

The EMWG will use this analysis to identify collaboration opportunities to address any gaps in the collective knowledge and skills areas, explore certain expertise areas in more detail, or develop more comprehensive job position descriptions in terms of energy management. In addition, this work will enable EMWG countries to identify strategies or policy options that could facilitate more effective deployment of workforce program.

Future versions of this report may include additional workforce programs from other countries and reflect further recommendations from the EMWG's collaboration efforts. The creation and use of JTAs will also be addressed.

Appendix A: Major Knowledge and Skills Areas for Professionals Involved in Energy Management, by Country

Entries for each of the five contributing countries are organized as follows:

A. Initiating an Energy Management Program

a. Understanding basic concepts and requirements

b. Getting organization leadership commitment

c. Establishing an energy team

d. Developing an energy policy

B. Conducting an energy review

a. Collecting energy data

b. Analyzing energy consumption and costs

c. Identifying major energy uses

d. Energy assessments

e. Identifying potential opportunities

C. Energy management planning

a. Setting a baseline

b. Determining performance metrics

c. Evaluating opportunities and selecting projects

d. Developing action plans

D. Implementing Energy Management

a. Obtaining Resource Commitments

b. Training and Awareness

c. Communication

d. Executing action plans

E. Measurement & Verification

F. Management review

a. Review progress

b. Modify goals and action plans as needed to ensure continual improvement

c. Recognize successes and key contributors

G. Ancillary Requirements & Skills

Australia	Korea	Japan	South Africa	United States
A. Initiating an Energy Management Program				
• Business improvement skills • Understand financial decision-making processes	• Energy planning	• Energy Management	• Energy Management	• Organizational and leadership skills • Business decision-making fundamentals • Financial principles and management • Understanding key energy efficiency program requirements
B. Conducting an energy review				
• Factors influencing energy use or waste • Energy data analysis • Energy mass balance diagrams and models • Whole system and services analysis skills • Understanding and analysis of process, site, or sector • Awareness and understanding of new and existing technologies • Identify "out-of-box" solutions • Energy and other data collection skills, and setting analysis boundaries	• Energy efficiency techniques for equipment • Heat Balance	• Analytical skills: ○ Identifying significant energy use ○ Establishing energy performance indicators ○ Evaluating energy ○ Performance improvement • Energy data analysis • Buildings Systems • Industrial Plant Systems and Best Practices • Equipment energy efficiency	• Building Energy Audits • Cost implications of wasting energy • Energy optimisation • Data collection and data service • Efficient use of energy in buildings • Identifying inefficiencies in building systems • Water heating • Lighting systems • Power systems analysis and design • Industrial energy systems: pumps, conveyors, winders, crushers, mills, furnace, etc. • Thermodynamics and heat transfer	• Internal audit/assessment skills • Energy review • Data collection and use • Energy fundamentals • Energy review, analysis, energy balance • Energy accounting & analysis • System optimization fundamentals • Energy-using equipment & systems operation (boilers, steam, motors, drives, pumps, lighting, HVAC, etc), industrial & facility processes • Instrumentation and controls, building automation • Building functions, operations & systems, interoperability • Building construction techniques, building envelope • O&M processes & requirements • Building trades • Electrical systems • Power factor • Combined Heat & Power Systems • Thermal energy storage systems • Domestic water systems • Load factors • Managing energy demand
C. Energy Management Planning				
• Cost-benefit analysis including evaluation of environmental and social benefits • Building energy rating, simulation, and simulation methodologies	Not available	• Analytical skills: ○ Identifying significant energy use ○ Establishing energy performance indicators ○ Evaluating energy ○ Performance improvement • Energy intensity • Recommendation for energy savings and costs (payback period)	• Basics of energy modeling • Assessing the role of the main drivers and parameters of energy modeling • Economic aspects of effective energy management • Designing and implementing Rate of Return methodologies • Life cycle cost analysis	• Industry scorecards and dashboards • Benchmarking • Building energy modeling • Energy metrics • Implementation costs • Economic analysis techniques • Accounting principles, energy accounting • Modeling techniques – including basic statistics, cumulative sum control charts, process models, identifying model inputs and outputs, relationships between components and systems[2] • Life cycle cost analysis • Financing options, alternative financing

Australia	Korea	Japan	South Africa	United States
D. Implementing Energy Management				
• Change management • Innovation skills • Risk management skills • Facilitation & negotiation • Culture & behavioral change management • Statistical analysis, incl. regression analysis • Assessing organizational barriers • Report, document & present key data & findings • Communicate to influence; esp. energy benefits in context of broader business benefits • Collaborative & cultural change skills • Understanding of energy optimization and energy economics by non-technical staff; e.g. accounting, procurement professionals • Understanding and analysis of design, procurement, commissioning, operational & maintenance practices • Undertake and apply specific techniques for process optimization	Not available	• Organizational skills	• Technical aspects of effective energy management • All levels of engineering: modeling and planning of energy systems, deterministic and stochastic. • Statistics, regression analysis, ARMA and fractional order modeling • Financial analysis, investment, electricity market	• Problem-solving skills • Critical thinking skills • Personnel motivation techniques • Statistics -- including identifying independent linear variables, testing for linearity, calculating significance & p-value, regression analysis, and projecting future energy use related to operations • Analytical skills • Communication skills • Interpersonal skills • Information management principles • Commissioning principles • Affinity laws • Mechanical and electrical engineering principles • Procurement, energy procurement • Contract management • Cost control and budgeting • Recommissioning • Performance contracting
E. Measurement & Verification				
Not available	• Monitoring and measurement	Not available	• Measurement and verification • Sampling and monitoring plan for M&V and CDM projects • Metering and monitoring	• Testing and measurement, test equipment operations
F. Management Review				
• Business improvement skills • Change management • Cultural change skills • Risk management skills	Not available	Not available	Not available	• Business decision-making fundamentals • Problem-solving skills • Critical thinking skills • Contract management
G. Ancillary Requirements and Skills				
• Understanding of energy markets, pricing and tariffs	• GHG emissions calculations • New and renewable energy	Not available	• Energy Efficiency Tax Incentives • Sustainability in residential settings • Basics of photovoltaics • Basics of wind energy • How to design and implement PV and wind systems • Overview of most significant renewable energy resources, concepts, and technologies to overcome climate challenge and other sustainable development goals • Solar thermal technologies for generating electricity from sunlight • Determining the carbon footprint for a large corporation • Carbon markets, carbon finance, and the carbon project development process • Policy interventions to promote renewable energy value chains • How to reduce risks associated with climate change • How to be green in the office (recycling, cleaning, energy efficiency, supplies, transport and commuting) • Indoor air quality control	• Utility contracts, rate structures • Utility rebates • Renewables • Water management best practices • Local recycling capabilities • Local waste management operations • Carbon footprints, GHG accounting • Corporate social responsibility • Renewable energy credits • Indoor air quality, indoor environmental quality

Appendix B: Tasks for Professionals Involved in Energy Management, by Country

Australia	Korea	Japan	South Africa	United States
A. Initiating an Energy Management Program				
• Stakeholder engagement • Business case development • Develop multi-disciplinary teams • Determine stakeholders and their roles	Not available	Not available	• Using financial structuring tools to attract investors • Putting together a business case for economic justification of all types • Energy management strategies and solutions for managing electricity consumption	• Creating an energy management policy & plan
B. Conducting an energy review				
• Develop energy efficiency assessment plan • Facilitating and managing energy efficiency opportunities identification process	• Collecting and analyzing data • Calculating energy saving • Conducting Economic cost-benefit analysis	• Data collection and recording • Data assessments by FEMS and BEMS • Develop energy mass balance diagrams and models	Not available	• Data logging
C. Energy Management Planning				
• Develop energy intensity indicators • Ability to calculate energy savings – simple payback and/or other relevant financial analysis • Develop & implement data management, tracking & reporting systems	Not available	• Organizing improvement activities	Not available	Not available
D. Implementing Energy Management				
• Develop & implement communications & engagement plan • Develop & manage ongoing communication with stakeholders • Integrating energy management into operational procedures and KPIs. • Manage energy efficiency opportunity implementation	• Writing an effective energy management report	• Organizing seminars and communication • Controlling implementation schedule	• Interpreting forecasts correctly	• Building an energy performance awareness program • Facility planning • Project planning and management • Contract development
E. Measurement & Verification				
• Assess, install, and use appropriate measurement and monitoring equipment	Not available	Not available	Not available	• Data logging
F. Management Review				
• Undertake statistically valid assessments of similar energy using sites, operations or processes • Assessing organizational barriers	Not available	• Evaluating achievements	Not available	• Contract development
G. Ancillary Requirements and Skills – Not available				

Appendix C: Standards, Certification Programs, and Guidance for Energy Management, by Country

Australia	Korea	Japan	South Africa	United States
A. Initiating an Energy Management Program				
Not available	• EnMS certification program • Interpretation of ISO 50001	Not available	• ISO 50001, the Energy Management System standard • South African National Standard 10400-XA • Green Building Standard • South African National Standard 50010: measurement and verification of energy savings	• Apply energy management systems in context of ISO 50001 • Understanding of M&V and other standards and models • Third party certification requirements • ASHRAE HVAC and indoor air quality standards • Green buildings, LEED, Energy Star program
B. Conducting an energy review – Not available				
C. Energy Management Planning – Not available				
D. Implementing Energy Management				
• Industry Guidelines	• Understanding ISO management systems	• Qualified person (Nationally recognized qualification: exam/training)	• Certified Energy Audit (CEA) Certificate • Certified Measurement and Verification Professionals	• ISO 50001 concepts
E. Measurement & Verification				
• Energy Savings Measurement Guide • A Best Practice Guide to Measurement and Verification of Savings	Not available	Not available	• South African National Standard 50010: measurement and verification of energy savings • South African National Accreditation Systems (SANAS): inspection bodies: energy efficiency measurement and verification	• Understanding of M&V and other standards and models
F. Management Review – Not available				
G. Ancillary Requirements and Skills				
	• Understanding of Standards (Energy Saving Design, Building energy efficiency labeling) and Energy Performance Indicator(BEA)			• Sustainability standards and best practices

Appendix D: Regulations, Laws, and Codes for Energy Management, by Country

Australia	Korea	Japan	South Africa	United States
• Energy Efficiency Opportunities Act (with related EEO Program – Industry Guidelines) • National Greenhouse and Energy Reporting System (NGERS) Act • Various pieces of state-level legislation	• Energy conservation laws and policies	• *Energy Conservation Law*: Energy management techniques and practices • Knowledge of *Energy Conservation Law* • Energy Conservation Law: Sectoral Benchmarks • Energy Conservation Law: Top Runner Program • *Energy Conservation Law*: Standard of Judgment for Factories, Business Offices and Other Business Places including: 1. Management 2. Measurement and recording 3. Maintenance and inspection 4. Measures when installing new facilities and equipment • Energy Conservation Law (Article 10) "Duty of Energy Manager" including: 1. Maintenance of energy consuming equipment and facilities 2. Improvement and monitoring of the way of using energy 3 Preparing a periodical report 4. Preparing a medium and long term plan • Energy Conservation Law (Article 10) "Duty of Energy Manager" including: 1. Maintenance of energy consuming equipment and facilities 2. Improvement and monitoring of the way of using energy 3 Preparing a periodical report 4. Preparing a medium and long term plan • Law Concerning the Promotion of Measures to Cope with Global Warming • Electricity Business Act	• National Energy Efficiency Strategy • National Building Regulations and Building Standard Act of 1977 • Economic regulation of utilities	• Regulatory aspects of effective energy management • Regulatory requirements, federal regulations • Building codes • Environmental regulations • Model Energy Code • International Electrotechnical Commission and IECC Codes • Energy & sustainability statutes, requirements • Local sustainability codes & requirements Plumbing systems and codes

Appendix E: Workforce Program Sources

Australia	Korea	Japan	South Africa	United States

• *Australian Functional Skills for an Energy Efficiency Assessment*
• *Leadership & Change for Energy Efficiency in Accounting & Management: Training Needs Analysis*
• *Accounting for Climate Change: How management accountants can help organisations mitigate and adapt to climate change*
• *The Business Case and Beyond (web resource)*
• *AS/NZS 3598 Energy Audits (2000)*
• *Energy Savings Measurement Guide*
• *Energy Efficiency Opportunities Program – Industry Guidelines*
• *Energy Efficiency Opportunities Program – Assessment Handbook*
	• *Training course for energy practitioners*
	• Energy Management System Package *for SME-web resource*
	  ○ Implementation Guideline (guidebook),
	  ○ EnMS Data Analyzing Tool,
	  ○ M&V Protocol and Software Manual
	  ○ Efficiency management protocol for main equipment
	• *Energy Auditor (credential)*
	• *Building Energy Assessor-BEA- (training & credential)*
	• *GHG reduction verifier (training & credential)*
	• *Korea Voluntary Emission Reduction Project Verifier (training and credential)*
		• *Energy Conservation Law*
		• *Japan Energy Conservation Handbook 2011*
		• *Qualified Energy Manager according to Energy Conservation Law, Japan – December 6, 2012 presentation by Keiichi Komai to GSEP Qualified Workforce Task Force*
			• *Needs Analysis for Training of Energy Auditors, Energy Managers and M&V Professionals in the Building Sector*
			• *Green Skills: Baseline Overview for Skills Development for Renewable Energy and Energy Efficiency*
				• *US Draft CP for EnMS blueprint*
				• *US DOE draft JTA for energy/sustainability manager*
				• *US DOE draft JTA for a Facility Manager*
				• *Study guide for AEE-CEM*
				• *ASHRAE Building Energy Assessment Professional Certification Exam Outline*
				• *ASHRAE Operations & Performance Management Professional Certification Exam Outline*
				• *BOMA Energy Efficiency Program (BEEP) Curriculum outline*
				• *BOMI International Facilities Management Certificate course requirements*
				• *IFMA Facility Management Professional credential course outline*
				• *IFMA Sustainability Facility Professional credential*

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