IFMA's Sustainability Course

Student Guide

IFMA™

Acknowledgments

IFMA's professional development courses – including our world-class credential programs, the FMP®, SFP® and CFM® – are the cornerstone of our industry-leading offerings for career advancement. The contribution of IFMA volunteer members is critical to the relevance and value of our educational programs. The result of their global input is learning for facility managers, by facility managers. We would like to acknowledge the cumulative hours and expertise our members have contributed to educational content development and review, from design through delivery, ensuring that IFMA's Sustainability Course accurately reflects the body of knowledge and skills required of facility managers in today's global business environment.

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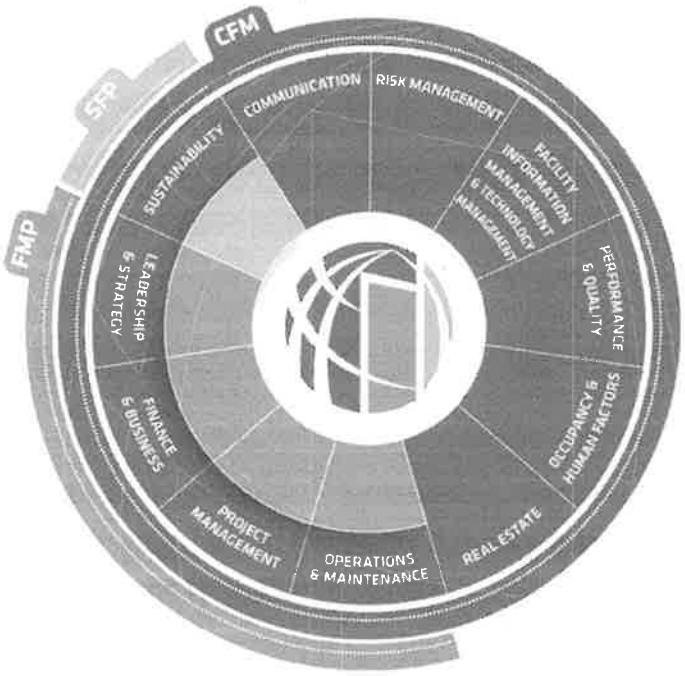
IFMA Credentials

About IFMA Credentials

After analyzing the work performed by facility managers, we have defined 11 competency areas. Our three world class FM credentials, — Facility Management Professional™ (FMP®), Sustainability Facility Professional® (SFP®), and Certified Facility Manager® (CFM®) — are based on these competencies.



1. The FMP® is the foundational credential for FM professionals and industry suppliers looking to increase their depth-of-knowledge on the core FM topics deemed critical by employers.
2. The SFP® is the leading credential for all FM and like-minded professionals with an interest in the development of sustainable FM strategies.
3. The CFM® is the premier certification for experienced FM professionals. A comprehensive exam assesses knowledge, skills, and proficiency across all FM competency areas.

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IFMA's Core Competency Courses

IFMA's 11 core competency courses, developed from IFMA's Global Job Analysis (GJTA), comprise the body of knowledge for facility managers. IFMA continuously refreshes the courses to align with global industry standards for FM knowledge, skills, and tasks. The courses provide practical knowledge and examples to help you improve your performance.

IFMA's Core Competency Courses include the following:

Communication: develop the skills you need to be an effective liaison between external and internal stakeholders.

Participants will be able to:

- Create and deliver the right message for the intended result.
- Develop an FM communication plan.
- Identify and share relevant information to the appropriate audience.

Risk Management: address the role of the facility manager in supporting or leading risk management planning; emergency preparedness, response and recovery; facility resilience and business continuity.

Participants will understand how to:

- Respond appropriately to emergencies affecting the facility.
- Meet the organization's business continuity goals.

Facility Information Management and Technology Management: understand how to leverage modern tools and techniques for today's workplaces and occupants.

Participants will be able to:

- Understand secure, efficient data collection supports decision-making processes to meet core business objectives.
- Conduct technology needs assessments and anticipate the impact of new technologies.
- Understand decisions are made to keep, update, augment, or replace technology.

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Occupancy and Human Factors: grow your ability to support organizational and individual occupant performance, while leading the FM team to develop and implement practices necessary to achieve success.

Participants will be able to:

- Create an environment where motivation, productivity, and retention are the norm.
- Blend safety and security with innovation.
- Negotiate service level agreements.

Real Estate: understand real estate principles and practices and how they contribute to achieving the core business strategy.

Participants will be able to:

- Develop and implement a real estate strategy to support the core business including assessing, acquiring, and disposing of real estate, and space management.
- Understand project management principles for managing new construction and other major projects.

Performance and Quality: define and make relevant what it means to capture fitness for the intended purpose, embrace a continuous improvement mindset, and satisfy stakeholders' needs.

Participants will be able to:

- Determine the needs and expectations of stakeholders for the facility and related service requirements.
- Understand and describe what comprises a comprehensive quality management system for FM.
- Measure the FM organization's performance to make continual improvements.

Sustainability: define the basics of five areas of sustainability and make relevant what it means to embrace sustainability.

Participants will be able to:

- Understand the management basics of:
  - Energy
  - Water
  - Materials and Consumables
  - Waste
  - Workplace and Site

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Welcome

Course Introduction

Welcome to IFMA's Sustainability Course!

Participant Introductions

- → Your name
- → Company name and/or job responsibilities
- → Reason(s) for taking this course — expected outcome(s)
- → Your experience in FM — years and work responsibilities over your career

Expectations

Learner responsibilities:

- → Be prepared – complete class pre-work
- → Take part in class discussions and activities
- → Follow the rules of common courtesy
- → Provide feedback to the instructor and IFMA

Course Audience

Welcome to IFMA's Sustainability Course! This course is designed for persons interested in developing knowledge and skills in IFMA's FM Core Competencies and who wishes to gain practical knowledge to enhance FM industry professional development.

Course Chapters

There are six chapters in the Sustainability core course.

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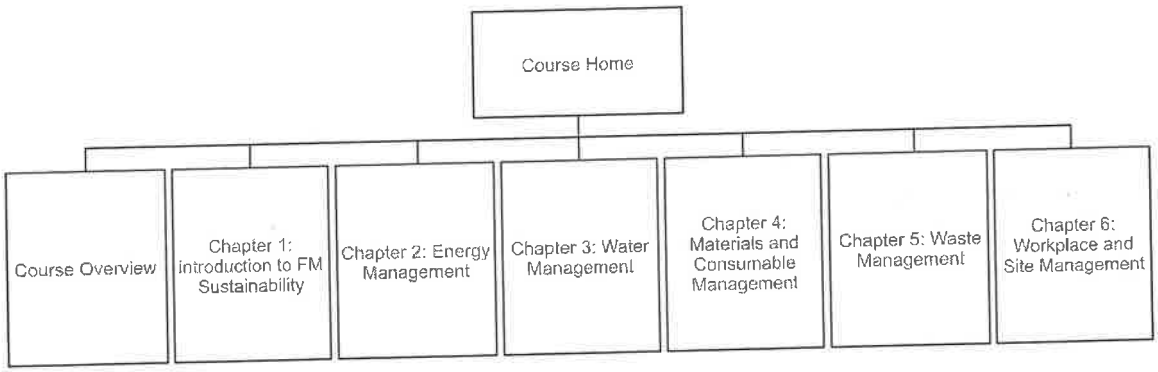

Course Goals

The goals for this course are as follows:

- Understand the sustainability domain competencies.
- Discuss the following: energy management, water management, materials, and consumable management, waste management, and workplace and site management.

Course Overview

Decisions taken today have a long-term impact on the health of the planet. Environmental issues are not something future generations should solve, they are important and need to be addressed urgently. Decisions that facility managers make can have an impact if sustainability is embraced.

Christopher Hodges, a facilities and engineering professional at George Mason University states, "With over five million commercial buildings in the United States, the potential for greening our building stock is tremendous. The requirement to do so is critical. The energy savings, productivity increases, reduction in waste stream, water conservation and other sustainable facility benefits in existing buildings far outweigh the potential benefits from sustainable new construction." Hodges continues to say, "Facilities managers control the operating costs of the facility, and have the greatest amount of influence on the productivity of the workforce. Workforce costs are the greatest expense to an organization, about 10 to 15 times that of the facility cost. Small improvements in workforce productivity can overcome the cost of facility improvements. Facility professionals manage about 25 to 60 percent of an organization's hard assets and have a large influence over the productivity of the workforce by influencing the comfort, health, and safety of the workplace."

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Mark Vidler of the UK-based environmental recruitment firm Allen & York states, "The evidence of growing interest in sustainability is impressive. A survey of a thousand CEOs from 43 countries by PriceWaterhouseCoopers indicated that 79% of these CEOs believe that sustainability is vital to the profitability of any company. The reason for increased interest is clear. Sustainable practices are profitable because they can reduce risk, make business and consumers more efficient, and advance them technologically while reducing environmental and social concerns."

Data indicates that customers care about sustainable products. A NielsonIQ survey shows that 73% of millennials are willing to pay more for sustainable goods, with 66% of global customers saying the same.

Sustainability Competencies in FM

Outlined below are the competencies and the performance standards that a facility manager should know regarding sustainability, energy management, water management, materials and consumables management, waste management and workplace and site management.

Given the usage of energy by a facility and its occupants, a competent facility manager manages energy in a manner that:

- The built environment uses energy-efficient devices and systems.
- The built environment uses energy-efficient operational processes.

Given the usage of water by a facility and its occupants, a competent facility manager manages water usage in a manner that:

- The built environment is designed and operated to minimize the unnecessary utilization of potable water.
- The built environment utilizes methods to reduce water waste.

Given the usage of materials and consumables by a facility and its occupants, a competent facility manager manages the usage of materials and consumables in a manner that:

- The built environment utilizes renewable resources to protect endangered species and slow-growth natural resources.
- The built environment efficiently uses all materials and minimizes the use of substances that are harmful to health and the environment by use of natural alternatives and biodegradable materials.
- The purchasing of materials and resources is done in a manner that promotes ethical behavior and corporate social responsibility.

Given the production of waste by a facility and its occupants, a competent facility manager manages waste in a manner that:

- Procurement activities lead efforts to reduce consumption of materials to appropriate minimums.
- The built environment recycles waste and follows local waste management guidelines designed to protect the natural environment.
- The built environment disposes of waste in ways that do not harm the natural environment.

Given the need to oversee sustainability efforts, a competent facility manager directs and supports the sustainability practices of a workplace and site in a manner that:

- The impact on the natural environment is minimized when expanding the built environment.
- Architectural designs specify sustainable products and have minimal negative impact on the natural environment.
- The operation of the built environment complies with laws and regulations.
- Elements of the built and natural environments that have historic value are identified.
- Practices of tenants, customers and users that may harm the built and natural environments are identified.
- Policies and practices designed to preserve, protect, and restore buildings, grounds, wildlife habitats, and the environment are promoted and implemented.
- Decisions about if and where to invest in restoration/remediation or demolition include consideration of environmental impact.
- Criteria for evaluating an asset's life cycle include environmental impact.
- Facilities comply with generally accepted sustainable building principles.
- Impact to indoor environmental quality is evaluated.

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Chapter 1: Introduction to FM Sustainability

Lessons

- Objectives
- Lesson 1: Triple Bottom Line
- Lesson 2: Aligning Organizational Strategy with Sustainability

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Objectives

Chapter 1: Objectives

On completion of this chapter, you will be able to:

- Summarize the aspects of the triple bottom line.
- Understand the importance of aligning the FM sustainability strategic plan with the demand organization's strategic plan and state three benefits of doing the alignment.

Sustainability is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Filho et al., 2019). Sustainability is now a significant obligation and expectation across many businesses. Commitment to sustainability initiatives from key stakeholders (e.g., governments, consumers, and competitors) is driving organizations to implement their own sustainability agendas.

Economic, social and environmental factors like climate change and limitation of energy resources give FM professionals more to address in terms of sustainability for their organizations.

The highest level of management within the demand organization has the ultimate responsibility for sustainability. Still, FM professionals should take the lead in integrating sustainable practices into their operational and management activities (Shah 2007; Elmualim et al. 2009).

Lesson 1: Triple Bottom Line

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Summarize the aspects of the triple bottom line.

Introduction

The triple bottom line refers to the balance and harmony between the built environment, the natural environment, and society. To create and preserve that harmony, organizations and individuals strive to achieve a balance between the social, environmental, and economic aspects of sustainability.

- The **social bottom line** focuses the facility manager's attention on areas such as community involvement and occupant well-being. This translates into goals such as:
  - Monitoring all vendors for fair labor practices (i.e., child labor, exploitation) and environmentally sound business practices.
  - Practicing fair labor relations, such as paying fair wages, requiring regular working hours.
  - Creating a safe, comfortable and productive work environment for the people of the organization.
  - Contributing to the community in a positive way (i.e., sponsorships, donations of time or money) and avoiding exploiting or harming the community.
- The **environmental bottom line** focuses on avoiding harm to the environment and preserving scarce resources for future generations. This translates into goals, such as:
  - Managing the consumption of energy and resources.
  - Reducing waste.
  - Recycling or reusing.
  - Decreasing the organization's carbon footprint.
  - Decreasing or eliminating hazardous waste.
  - Creating building processes that abolish toxic material to support a healthy environment.

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- The **economic bottom line** focuses facility managers on the value of sustainable actions to the organization's financial well-being. This translates into goals, such as
  - Lowering operating cost.
  - Increasing asset value.
  - Delivering a high return on investment (ROI).
  - Delivering increased efficiency.
  - Providing long-term savings.

Actions Must Have Balance

Actions to achieve benefits in one category cannot begin without looking at the impact on the other categories and even within the same category. For example, replacing a working incandescent lamp with a compact fluorescent will save energy and contribute to creating a comfortable work environment. However, it will also create toxic waste because the incandescent lamp contains toxic heavy metals. Deciding to save energy by replacing the lamp has a positive impact on the economic and social bottom line. It also harms the environmental bottom line.

FM touches all three aspects of the triple bottom line. Many of the environmental indicators for sustainability – e.g., energy usage, waste generation, occupant well-being – are under the direct control of the facility manager. Facility managers can use the triple bottom line to generate ideas for policies and programs and to report on the facility's sustainability strategy.

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Lesson 2: Aligning Organizational Strategy with Sustainability

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Understand the importance of aligning the Facility Management sustainability strategic plan with the demand organization's strategic plan and state three benefits of doing the alignment.

Three Aspects of Sustainability

Each of the three aspects of sustainability (social, environmental, and economic) is about making choices. When making a decision that focuses on one of these aspects, the organization should weigh the impact of that decision against the other two aspects of the triple bottom line. Each decision should be bearable, viable, and equitable.

Bearable is the balance between the environmental and social aspects of the triple bottom line. Does an action that has a positive effect from the ecological perspective negatively affect occupants' productivity? The solution must have a better-than-neutral impact on the occupants; it must improve things somehow. For example, if the set temperature point is too high, and the occupants are not comfortable, then the occupants are no longer productive. The negative impact on productivity may outweigh the energy savings on heat or air conditioning.

For example, an organization may want to implement a recycling program for fluorescent lamps. To make this program viable, the facility manager needs to:

- Make sure space is available for collection.
- Allocate task labor.
- Ensure the collection can be done safely.
- Ensure a disposal site is available that can handle toxic metals.

Viable is the balance between the environmental and economic aspects of the triple bottom line. A viable action ensures the long-term survival of both the environment and the organization.

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For example, if the organization implements a recycling program for facility fluorescent lamps, the program will be viable only if the facility can ensure:

- Collection can be done without sacrificing significant amounts of space or requiring significant additional labor
- Collection can be done safely, without breakage that would expose the environment and occupants to toxic metals
- A disposal site is available to handle the waste in a sustainable manner.

Equitable is the balance between the social and economic aspects of the triple bottom line. When determining if something is equitable, the organization must ask if the social benefits will outweigh the cost of the initiative.

For example, adding daylighting for occupants has economic costs, including reconfiguring workstations, adding sunshades to windows and adding skylights. When weighed against the potential benefits – increased user productivity, reduced emissions, and reduced operating costs – are these costs equitable?

Sustainability Policies

A sustainability policy is a high-level working document that serves two purposes:

- Focusing the organization on sustainable issues that relate directly to its vision and strategy.
- Ensuring that decision-makers throughout the organization consider appropriate sustainable goals in matters large and small, throughout the organization, including FM.

If no sustainability policies currently exist, any new sustainability program should include policy development. Once in place, the sustainability policy can drive and shape subsequent sustainability initiatives.

A sustainability policy should be clear and straightforward. The main parts of a sustainability policy include:

- **Vision.** A sustainability vision has a global point of view: How is the world enriched or diminished by what is done? What are the major impacts on society? How does the overall business strategy reflect those impacts? What does our sustainable organization look like when fully successful? Typically, it is a one- or two-sentence, a well-crafted statement that gives employees and stakeholders a set of broadly stated principles against which the efforts can be measured. A sustainability vision should show how to incorporate an emphasis on environmental, social, and economic prosperity into every decision made throughout the organization and to think about how this would take hold at the operating level.

- **Scope**. Scope, or key issues, can be determined by completing a matrix like the one shown below on each tab. Each matrix lists issues under the triple bottom line aspects and then indicates their relationship to and influence on the organization's sustainable strategy.

Key:

DH = direct relation/high influence
DL= direct relation/low influence
IH=Indirect relation/high influence
IL= Indirect relation/low influence

The table below shows the relationships between the Social Sustainability Issues and Elements

	Sustainability Elements					
Sustainability Issues **(Social)**	Energy	Waste	Water	Purchasing	Travel	Community
Lifestyle	IH	IH	IL	IH	IH	DH
Safety/Health	IL	DH	DH	DH	IH	DL
Comfort	IL	DH	DH	IH	IH	DH
Awareness	DH	DH	DH	DH	DH	DH
Knowledge	DH	DL	DH	DH	IL	DH
Public Service	DH	DH	DH	IL	IL	DH
Community	DH	DH	DH	IH	IL	DH

Table 1 Social Sustainability Issues and Elements

The table below shows the relationship between the Environmental Sustainability Issues and Elements

	Sustainability Elements					
Sustainability Issues **(Environmental)**	Energy	Waste	Water	Purchasing	Travel	Community
Emissions	DH	DH	DH	DH	DH	IL

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Biodiversity	IL	DH	IL	DH	IL	DL
Landfills	IL	DH	IL	DH	DH	DI
Research and Development	DH	DH	DH	DH	IL	IL
Awareness	DH	DH	DH	DH	DH	DH
Legislation	DH	DH	DH	DH	DH	DH

Table 2 Environmental Sustainability Issues and Elements

The table below shows the relationship between the Economic Sustainability Issues and Elements

	Sustainability Elements					
Sustainability Elements **(Economic)**	Energy	Waste	Water	Purchasing	Travel	Community
Supply chain	DH	DH	DH	DH	DH	DH
Capital costs	DH	DH	DH	DH	IL	DH
Productivity	IL	IL	IL	DH	DH	DH
Research and Development	DH	DH	DH	DH	IL	IL
Brand recognition	DH	DH	DH	DH	DH	DH
Liability	IH	IH	IL	IH	IL	DH
Retention	DH	DH	DH	DH	DH	DH

Table 3 Economic Sustainability Issues and Elements

- **Performance metrics.** Performance metrics determine the standards used to measure the success of the policy.
- **Procedures and strategies.** Procedures and strategies are defined in terms of the social, economic and environmental aspects of a policy. You should assign responsibility for specific strategies.
- **Time period.** Time period refers to both the timeline for achieving all aspects of the sustainability policy and timelines for achieving various milestones within the policy.
- **Responsible party.** The sustainability policy should have accountability at the highest level within the organization.

Rules to Live By

Since policy development is a strategic function, it usually starts at a high level in the organization. Because of their influence and the importance of facilities to the value of the organization, facility managers are in a good position to steer policy development. Here are some rules to help focus the goals:

- Seek the buy-in of senior management. Any issues that arise will escalate to upper management, so having at least one or two champions keeps the cause moving in the right direction.
- To maintain consistency throughout the organization, be sure to use the organization's best practices when creating a policy.
- Educate occupants and use their excitement for the program to build momentum. To further build and maintain momentum, promote the results of the program. Sharing success stories is an excellent way to promote both the policy and the organization.

Example: A Sustainable Leasing Policy

A good example of a sustainability leasing policy is a practice called "green leasing", integrating sustainability elements into lease negotiations. These elements could include efficient building design, energy and water efficiencies, equipment, appliances, waste minimization and other sustainability objectives. A sustainable leasing policy gives facility managers guidance on ways to increase the energy-efficient operation of a building, improve the property's indoor environmental quality, or decrease the amount of materials used and discarded in the buildout process.

Green leases are marked by:

- **Lease structures that provide mutual incentives.** This is not always the case in conventional leases. For example, in gross leases (in which tenants do not pay operating costs), the landlord, not the tenant, gets the economic benefit from tenant efficiency. Net leases (in which tenants pay operating costs and receive direct benefit of improved efficiency) do not give landlords any incentive to make capital improvements. A green lease should be structured so that both parties have incentives to make sustainable choices.
- **Transparency.** Regular, complete, and candid sharing of information about building performance is necessary in a green lease. This is particularly important if tenants expect to be rewarded for increased efficiency or if the lease terms include stipulations about building performance.

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- **Alignment of interests and compromise.** The tenant and the landlord will each expect concessions, as illustrated in Green Lease Example. The success of the lease will depend on how well the tenant and landlord work together.

Interests and compromises

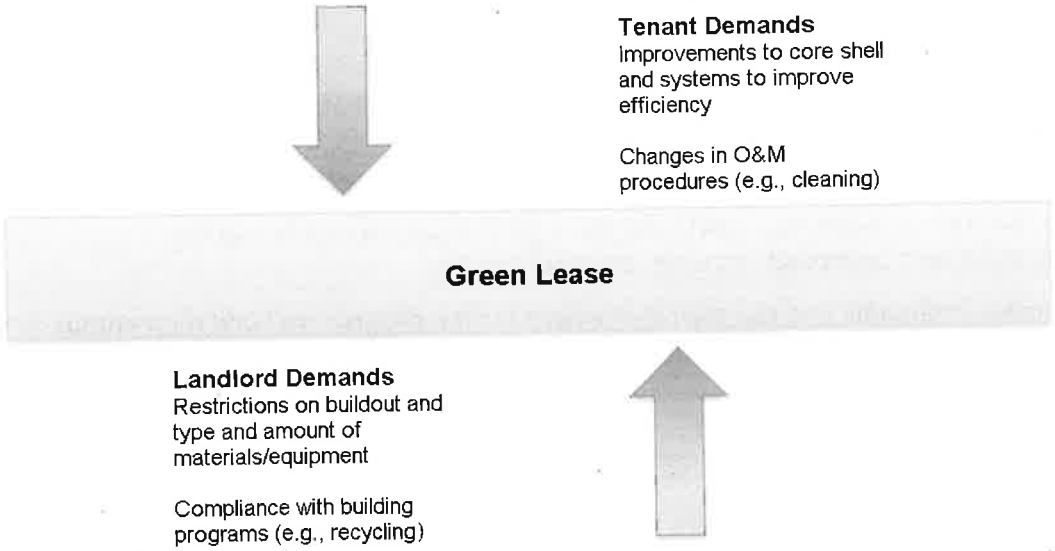

Figure 1 Green Lease Example

Both parties can put their preferences in writing:

- Tenants can develop RFPs (requests for proposal) or RFIs (requests for information) to be used by leasing agents to identify suitable properties. These RFPs or RFIs can incorporate a checklist of sustainable characteristics that the tenant is seeking.
- Landlords can create a green lease contract that includes sustainable lease terms. The work letter can clearly set forth requirements and restrictions on buildout – e.g., the types of materials and lighting that must be used or the manner of disposal for current space materials.

Benefits of a Sustainability Policy

Sustainability policies offer both hard and soft benefits. Hard benefits can be quantified and are usually expressed in terms of monetary units. Soft benefits can also be expressed in monetary terms but are harder to quantify.

Examples of hard benefits include:

- Cost-efficient manufacturing processes or other processes that directly affect cost reduction.

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- Money-saving measures, such as reducing the amount and/or cost of business travel.
- Profit-making activities, such as selling surplus energy to the grid.

Examples of soft benefits include:

- Improved employee morale.
- Increased occupant health, comfort, and productivity.
- Reduced pollution and landfill waste.
- Increased competitive advantage.
- Increased brand strength.

The key to measuring soft benefits is to identify the right person, metric and tool for the job. For example, if you're looking for someone to help assess the impact of employee satisfaction and training on productivity, try the Human Resources director. The HR director has the knowledge and experience to translate an increase in productivity into a monetary benefit.

Selling the Benefits

How should these benefits be sold to the stakeholders within the organization? Through stakeholder management, hard benefits are easy to sell as they are tangible, and their ROI can be easily explained. For this reason, hard benefits have traditionally been the center of any discussion about the economic feasibility of a project.

More can be learned about stakeholder management in IFMA's Project Management course.

Soft benefits, despite being more difficult to measure, have a value and impact that upper management increasingly recognizes. When selling soft benefits to stakeholders, you may need to be more creative and certainly more proactive than when discussing hard benefits.

A well-presented soft-benefit business case can be as solid as a business case presented with financial and technical data. It should be based on solid experience and include examples from projects like those being presented. While focusing on a creative approach, don't try to measure things that are impossible to measure.

Also, let the stakeholders know that soft benefits can be as tangible as hard benefits. An improvement in the building environment can improve staff morale, thereby increasing performance and reducing staff turnover. You can make assumptions. Just be sure to define what the assumptions are and to describe how those assumptions were reached.

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Keep in mind that you may have just one chance to sell the business case to the stakeholders. Since the concept of soft benefits may be unfamiliar, you may have to open some eyes, give some detailed explanations and hold some hands to get the audience through the case. Communicating both the hard and soft benefits clearly and effectively will influence the minds of the decision makers both now and with future projects. Again, be clear on the assumptions made within the business case and be prepared to back up those assumptions with examples from the real world. Finally, be clear and concise in the summaries. Include the full cost, the resulting benefits and the potential risks involved.

Sustainable Plan Development

Developing a sustainability plan requires gathering information and input from a variety of sources. The plan must fit the organization's overall strategy. It must also be workable for the various functions of the organization. In addition, landlords, government authorities, and the community have interests to consider. In developing the sustainability plan, the facility manager will have to balance the impact on all of these.

Aligning Facility Sustainability Plans with Organizational Strategy

The end goal of the facility management strategic plan is to help the organization to meet its sustainability objectives.

- The logic behind the FM plan is transparent (obvious) in how it supports the entire organization's requirements.
- The requirements (staff, resources, access to decision-makers and so forth) to execute the FM strategic plan are appropriate.
- The facility's success measures are linked to satisfying the entire organization's requirements.
- The methods proposed (outsourcing, upgrading technology, subleasing, and so forth) to execute the FM plan support the entire organization's goals and objectives are appropriate.

Assessing the Organization's Position on Sustainability

Before starting the facility strategic planning process, the facility manager must take the organization's sustainability "pulse" by considering:

- **What the company/organization says** – Its vision statement, strategic goals in annual reports, the measures it applies to assess the strategy's success, corporate social responsibility (CSR) reports, sustainability reports, and policies.
- **How the organization operates** – Whether its decisions and actions demonstrate the influence of sustainable principles.
- **The nature of the business** within the facility and how it could be made more sustainable.
- **How sustainability applies to the industry** – Is the organization leading or lagging its competition in this field?

If the organization is committed to sustainability, the facility manager must be prepared to champion the cause and lead the effort. Strategies may include:

- Forming a cross-functional committee.
- Creating smaller project teams for each project.
- Holding an official program launch.
- Using internal formal communication channels to keep the organization informed.

If the organization is not currently committed to sustainability, the facility manager can try to change that position by influencing those with formal and informal authority. You might find a self-appointed leader who has the passion and personal power to start up a program without formal authority or sponsorship. This self-appointed leader may need more creative strategies to get things done, such as:

- Reaching out to those who can contribute to the effort or are concerned about the specific sustainability issue.
- Working on the low-cost/no-cost initiatives first to gain momentum.
- Sharing success stories informally.
- Creating informal discussion groups.
- Inviting sustainability guest speakers to team meetings.
- Networking with other facilities that are making progress in sustainability.

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Internal and External Functions to Promote Sustainability.

Table 1 and Table 2 list internal and external groups that could support a facility manager's efforts to promote sustainability.

Internal Functions	Sustainability could impact. . .
Facility Management (FM)	Day-to-day responsibilities and how the facility manager completes them. This group will feel the greatest impact of a sustainability initiative.
Real Estate	How real estate searches for, bids on, and strategizes about the purchasing or leasing of new properties.
Legal	Contracts with suppliers, contractors and other vendors to include language around sustainability requirements.
Finance/ Accounting	How this group accounts for the use of items as well as the depreciation of assets, grants applied for, rebates given, and tax incentives.
Information Technology (IT)	Information that is tracked, and the systems and infrastructure needed to support sustainability initiatives, such as telecommuting or videoconferencing.
Human Resources (HR)	How HR positions the organization to new employees, benefits provided and services offered to existing employees.
Marketing / Sales	Image of the organization, which in turn impacts any marketing materials and any sales messaging.
Senior Management	Senior management's strategic planning and goal setting for the future.

Table 4 Internal Functions

External Functions	Sustainability could impact. . .
Landlord	How the organization attracts tenants and the landlords' requirements of those tenants.
Tenants	How the organization selects a location and the amenities it requires.
Service providers/suppliers	Whether or not the organization gets a contract. It may also affect reporting requirements.
Governing	Laws around greenhouse gas emissions, carbon footprint, and the

authorities	monitoring and tracking of hazardous waste.
Utility providers	Demand for utilities. Depending on the type of utility, it may also affect any rebates the provider may offer.
Neighboring businesses	Neighboring businesses, who may feel more motivated to pursue their own sustainability efforts.
Community	People living near the facility and in the entire community. The facility's actions may affect their experiences and daily activities in positive and negative ways.
Workplace	The way that work gets done and even transform it.

Table 5 External Functions

Ten Steps to Creating a Sustainability Policy

There are ten steps to create a sustainability policy.

1. **Identify stakeholders.** Recognize, prioritize, and understand those individuals who are the key stakeholders in the organization. If the stakeholders are adequately engaged, they are more likely to see the policy favorably.
2. **Confirm organizational strategy.** The sustainability objectives should enhance those of the demand organization and support the organization's objectives. Agree on a policy that is aligned with the organization's broader corporate strategy.
3. **Agree that sustainability policy meets strategy and expectation.** Gain consensus from the stakeholders on what the sustainability policy is aiming to achieve. Identify the specific links between the sustainability policy and the organization's overall strategic goals.
4. **Get a high-level sponsor.** Having the support of a high-level executive may be beneficial when it is time to present the policy to top-level management. Prepare a business case for the policy and present it to a senior executive who has a desire for sustainability.
5. **Agree on policy boundaries.** When trying to determine what the policy is, it helps to know what it is not. Defining the scope and extent of the policy with the main stakeholders helps identify those boundaries. Having a well-defined policy makes prioritizing objectives easier, allowing for more efficient use of the available resources.
6. **Provide adequate resources.** Assign enough of the right resources to properly execute the action plan. A cost-effective implementation contributes to the success of the sustainability policy. The implementation process should not necessarily demand a capital increase.

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7. **Set targets/goals using the SMART technique.** As a monitoring technique, SMART involves analyzing proposed goals and how they are measured from five different perspectives: Specific, Measurable, Achievable, Relevant, and Time-bound. (For more on SMART goals, refer to the **Leadership and Strategy Course).**
8. **Engage staff.** Since the FM staff is often responsible for carrying out the sustainability policy, it is important to discuss the policy with them.
9. **Communicate success.** Provide timely feedback on the sustainability policy's strengths and weaknesses. This lets stakeholders know what is going on with the timeline and how the implementation is progressing. This also helps everyone involved understand the external aspects of the policy that affect sustainability on a more global scale. This is a form of marketing or promoting FM.
10. **Review and provide feedback.** To make sure everyone involved is allowed to voice opinions, establish a two-way feedback channel. The stakeholders can review and analyze the data then turn that information into action points.

Chapter 1: Progress Check

1. What is the concept of the triple bottom line?

   a. The triple bottom line is the balance between science, religion and politics.
   b. The triple bottom line is the balance and harmony between the built environment, the natural environment, and society.
   c. The triple bottom line is the balance between mother nature, how the mother nature harvests resources and how resources are used.
   d. The triple bottom line is the balance between the company's money, how the company spends the money and how the company profits.

2. Name one goal from the social perspective.

   a. Sound business practices such as fair child labor practices
   b. Managing recycling and waste
   c. Increasing asset value
   d. Creating building processes that abolish toxic waste

3. If an organization is committed to principals of sustainability, how might this look to the public?

   a. The sustainability goals will show in the annual report.
   b. Programs will be announced to the public.
   c. The company will make a press announcement.
   d. The public will see their sustainability goals on their website.

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Chapter 2: Energy Management

Lessons

- Objectives
- Lesson 1: What is Energy Management?
- Lesson 2: Use Energy More Efficiently
- Lesson 3: Energy Management Evaluation
- Lesson 4: Energy Efficient devices
- Lesson 5: Reducing Energy Use
- Lesson 6: Energy-efficient Systems
- Lesson 7: Energy-efficient Operational Processes

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Objectives

Chapter 2: Objectives

On completion of this chapter, you will be able to:

- Describe the basic concepts and principles behind energy management.
- Understand energy pricing factors.
- Understand energy-efficient operational processes that can assist in managing energy use.
- Understand specific terminology related to energy management.
- Explain how devices and systems can be used to increase energy efficiency.
- Describe options to help reduce energy use.

In Chapter One, we introduced you to the concept of the triple bottom line and the importance of aligning the FM strategic plan with the demand organization's strategic plan. In this chapter, we will look at the basics of energy management.

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Lesson 1: What is Energy Management?

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Describe the basic concepts and principles behind energy management.

Three Goals of Energy Management

As a sustainable practice, energy management can be financially rewarding for an organization. The three basic goals of sustainable energy management are:

1. **Use less**
2. **Use more energy derived from renewable sources.**
3. **Use energy in a more socially and environmentally responsible manner.**

Click on the tabs below to learn more:

Use Less

Use Less. You can do this in two ways:

- Reduce energy consumption by decreasing demand.
- Increase efficiency.

This approach addresses two goals of sustainability:

- To reduce the use of finite resources, such as fossil fuels.
- To reduce pollution, including greenhouse gas emissions and other air and water pollutants.

The efficient or productive use of energy is the foundation for a facility's sustainable energy use. A report prepared by the **National Association of Energy Service Companies** noted that:

"Many people think of renewable energy technologies, such as photovoltaics, when they think about green buildings, but energy efficiency is the technical and economic foundation of a green building project. On the technical side, no renewable energy technology is inexpensive or reliable enough to offset inefficient end uses, so a building's energy use must be minimized to make optimal use of renewable energy."

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Use more from renewable sources

- **Use more energy derived from renewable sources.** This reduces pressure on finite resources. You can accomplish this by:
  - Purchasing more energy from renewable sources. This works in both regulated and deregulated markets. Nonrenewable energy use can be offset by purchasing credits.
  - Generating energy on site (e.g., with solar-powered systems) and replacing facility equipment powered by fossil fuels with models that are powered by alternative sources of energy.

Use responsibly

- **Use energy in a more socially and environmentally responsible manner.** Sustainable organizations understand that a facility's actions can either improve or degrade the well-being of its communities. Decreasing pollutants contributes to the health of the general population and protects communities from the effects of global warming. For example, by managing when the facility uses electrical power, a facility can save money while benefitting the community. That practice decreases the need for additional generating plants (whose construction will necessitate increased energy rates) and lowers the risk of brownouts and blackouts caused by excessive demands on the power grid.

Zero Net Energy Buildings

From a design standpoint, the goal is the development of net-zero energy buildings, also known as zero net energy buildings (ZNB). These high-performance buildings are integrated with the grid. By using cutting-edge technologies and on-site generation systems, such as solar power and geothermal energy, they can generate as much energy as they consume.

"In most countries, energy management is dictated at the highest levels of energy policy."

Many countries around the world recognize the issues brought by the ever-growing demand for energy. In some of these countries, the highest levels of government set the energy policy. To avoid the severe and irreversible effects of climate change, they seek to better manage the generation of energy and its use.

The energy practices of any nation impact all others. According to the U.S. Information Administration, in 2017, the U.S. total primary energy consumption was about 98 quadrillion British thermal units (Btu) or about 17% of the total world primary energy consumption of 582 quadrillion Btu. China's energy consumption was growing at a rate of 5.5 percent per year. The industrial sector worldwide consumes 37 percent of the total

delivered energy. (Abdelaziz, E.A., et al. 2010). To address energy concerns, **European Climate Law** proposes a legally binding target of net-zero greenhouse gas emissions by 2050. The EU Institutions and the Member States are bound to take the necessary measures at EU and the national level to meet the targets. Because it has become a worldwide priority, the management of energy may be a primary operational goal. Fortunately, facility managers have many resources available to them.

In many regions, companies that provide energy resources are helping organizations develop efficient energy management practices. In large part, this is an act of self-preservation. Even if the power provider could meet all the demand, they would be unable to provide and maintain the extensive infrastructure to sustain the growing need.

Beyond the energy companies, significant market sectors are focused on providing energy-conserving products. To gain acceptance, these producers have been required to provide verifiable data about the efficiency and estimated life of their products and materials. This information is an excellent resource for facility managers weighing options for energy management products.

For a facility manager, energy management starts with an understanding of the strategic goals of the organization. To get the financial backing of the organization, a business case for an energy management project must address the organization's priorities. With that understanding, the facility manager can lead the organization in the development of energy management standards.

Use Less Energy

Using less energy involves:

- Upgrading the building envelope to decrease infiltration, heat loss, and solar gain.
- Improving the efficiency of core systems.
- Optimizing energy use.
- Use renewable sources.

Upgrading the building envelope

Upgrading the building envelope reduces energy demand and increases system efficiency. Temperatures can be maintained more easily, which allows systems to consume less. Building envelope improvements can also reduce heating and cooling loads, which lead in turn to lower energy bills. This may also allow you to eventually downsize system components.

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Improving the efficiency of core systems

The term "core building systems" refers to installed equipment that is integral to providing common building services:

- Heating, ventilation and air conditioning (HVAC) systems, including:
  - Control systems (thermostats, sensors, building automation systems).
  - Boilers to heat water and generate steam.
  - Heating equipment, such as furnaces, and other heating devices, such as radiant heating, and solar heating systems.
  - Cooling system equipment, such as chillers and cooling towers.
  - Ventilation equipment, including ductwork, fans, fan coils, air-handling units to condition and circulate air, exhausts, and variable-airflow mixing boxes.
  - Other devices, such as variable-speed drives, humidity-control equipment, heat-storage, and heat-recovery units.
- Lighting, both interior and exterior.
- Electrical systems.
- Transport systems, including lifts, escalators, and moving walkways.
- Plumbing, including:
  - Domestic and processed water used for heating and cooling.
  - Pumping and distribution throughout the facility.

Optimizing Energy Use

Facility managers can work to improve building systems through commissioning, energy audits, building automation systems, and energy contracting.

Use Renewable Sources

Renewable energy sources include solar (thermal or photovoltaic), wind, hydro, tidal, wave, geothermal, biomass and biogas (or digester gas, the gas produced by the anaerobic breakdown of organic matter). Electricity is considered a secondary source of energy, produced by converting primary fuels into a more desirable or usable form. The goal is to use electricity generated by renewable sources as much as possible, rather than coal or natural gas.

Upgrading the Building Envelope

Upgrades that affect energy performance focus on increasing insulation and reducing infiltration and solar heat gain. Sustainable activities include the following:

- **Insulation**. Insulate walls and roof areas to a level consistent with the local climate. Consider insulation value when replacing existing doors and windows.
- **Inspection**. Regularly inspect the building exterior. Pay particular attention to, areas around doors and windows, the roof and sub roof structure, any openings in the envelope made for vents or pipes, and junction areas between the foundation and walls, the walls and roof, and conjoined exterior panels. Maintaining the envelope to prevent infiltration also prevents moisture from entering and accumulating inside the facility, damaging structures and potentially elevating mold levels in facility air.
- **Decreasing solar gain**. Solar radiation adds directly to cooling needs. Use low-E windows, window films, and internal and external shading devices. Trees also minimize solar gain through facility windows.

Improving the Efficiency of Core Systems

A few pages back we told you the definition of "core building systems." Here, we will go deeper on some of the core building systems.

HVAC System

HVAC System: During design, scheduled replacement/retrofits, and operations and maintenance activities, you will have opportunities to improve the efficiency of a building's heating, cooling and ventilation. As part of a projected replacement schedule, facility managers can upgrade components or entire systems to increase efficiency. In some cases, savings may justify replacing inefficient equipment earlier than planned. If an organization has been implementing numerous changes to increase the facility's energy efficiency, system replacement is a good time to size the facility's equipment to the new load. You can also better match capacity to actual occupancy rates.

You can use technology to improve efficiency in each component of the HVAC system. Notable technologies include:

- **Variable speed drives**. These electronic devices can be added to motors. They save energy by adjusting the speed of the motor to current load requirements. For example, reducing a fan's speed by 20 percent saves 50 percent of its energy consumption.
- **Demand-controlled ventilation**. Demand-controlled ventilation saves energy by reducing the volume of air delivered to a space that must be heated or cooled. This is done by integrating CO2 sensors and controls with HVAC equipment. The

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amount of unconditioned outside air drawn into a building depends on the concentration of carbon dioxide in occupied areas of the facility.

- **Heat exchange technology**. Devices capture waste heat and use it to preheat water or fresh air. The heat exchange principle is also used in desiccant (drying) cooling/heat enthalpy (measure of heat) wheels.
- **Economizers**. Air-side economizers control dampers to mix cooler outside air with return air, decreasing energy needs for cooling. Water-side economizers use the same principle for cooling towers.

One of the most obvious and effective ways to increase system efficiency is to make sure that pipes and ducts are properly insulated.

Operation and maintenance (O&M) activities can also increase HVAC efficiency. Equipment can be sequenced for greater efficiency. Temperature settings can be adjusted. For example, make sure that heating and cooling systems are not running at the same time. Planned maintenance can predict or identify problems, preventing them from happening. Unplanned maintenance, even in an emergency, can also help the facility achieve greater HVAC efficiency.

Lighting System

Lighting System: Efforts to improve energy efficiency usually include facility lighting. Lighting fixtures consume a lot of energy. Also, the heat emitted by the lights increases the demand for cooling. ENERGY STAR (2008-2016) continues to report that decreasing the lighting load by one watt per square foot in a 100,000 square foot building would result in a chiller capacity reduction. Imagine how much energy savings could be achieved using LED technology. The heat load is very different from traditional lighting, this is discussed further in lesson six.

When modifying facility lighting, occupant needs must be considered. If increased energy efficiency fails to meet the organization's other needs, an upgrade is not sustainable. For example, an organization managing a resort complex may want to decrease its electric bill. At the same time, it wants its housekeeping staff to be able to see what needs to be cleaned. Its guests also must be able to climb stairs safely or use a parking area at night. All occupants must be able to see critical and informational signage. It also needs to support an image that will attract guests.

Sustainable lighting strategies include:

- Incorporating daylight as much as possible.
- Using more efficient sources of artificial light, such as compact fluorescents and LEDS.
- Using more efficient fixtures with electronic rather than mechanical ballasts.

- Combining task lighting with ambient (general or "mood") lighting.
- Installing controls to allow some lights to be turned off.
- Using occupancy sensors to turn off lights automatically.
- Automating lighting control.

Improved maintenance practices can also decrease the amount of energy used in lighting. For example, keep lamps and reflectors free of dust, and replace lamps on a schedule rather than waiting for them to burn out. Lamps become less efficient as they age, so this practice saves energy and maintenance time.

Electrical System

To make the facility electrical system more sustainable:

- Establish a preventive maintenance program. Inspect system components for odors, discoloration, deformation and heat. Manually operate all switches to prevent corrosion. Use infrared thermography to detect overheating in inaccessible areas.
- Implement a predictive maintenance program.
- Add capacitors on problematic loads to correct low power factors. This is known as "power factor correction". The capacitors store reactive power (measured in kilowatts) created by induction motors. They release energy in opposition to create a more balanced load. Facilities with power load issues may require the advice of electrical system experts.
- When the facility expands, check electrical system design and capacity.

Transport System

Transport system: To make lifts or elevators more efficient:

- Switch from hydraulic to traction or magnetic drives.
- Use controls to manage lift routes according to occupant needs.
- Use LEDs for cabin lighting.

Optimizing Energy Use

Facility managers can work to improve building systems through commissioning, energy audits, building automation systems, and energy contracting.

Commissioning

Commissioning is the systematic process of verifying and documenting that all building systems perform interactively as designed and needed. The process should begin with the

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design phase and last at least one year after the construction phase and into the occupancy phase. It should include training of operations and maintenance staff.

Commissioning is labor-intensive process, but it has a good return on investments of time and money. The U.S.-based Lawrence Berkeley National Laboratory researched the benefits of commissioning. They collated and analyzed data from 224 buildings. Commissioning projects produced 15 percent median whole-building energy savings and had a median payback period of 0.7 years. In the study period, the 224 buildings discovered over 7,000 problems during building commissioning.

Post-occupancy inspections are called **recommissioning**. You would measure the systems' current performance against first benchmarks, then make repairs or changes to meet the original building goals. The reinspection should be thorough and revisit all systems. This includes HVAC systems, building controls, lighting controls, irrigation systems and the building envelope.

You can follow this same process for existing buildings that were never commissioned after construction. In this case, it is called **retro commissioning**. Gather data from various sources, including complaints, maintenance reports, utility bills, and original documentation. Review this data to identify performance gaps. Prioritize and address these gaps.

Continuous commissioning is an ongoing process to resolve operating problems, improve comfort, optimize energy use, and identify retrofits. Tools can include building automation system reports and alerts, monthly energy invoices, building information, O&M records, and reports of problems. Continuous commissioning identifies problems more quickly before they cause significant energy loss or wasted consumption or impair occupant comfort.

Energy Site Audits

Energy site audits compare building practices to accepted markers of efficient operation. Utilities or contractors can perform these audits, but facilities can also perform their own audits. Facility managers may draw on inventories that are part of ratings systems, such as Tru.

Only when they produce actual change do energy audits promote sustainability. Facility managers can improve the value of audits by establishing energy use levels before the audit, then measuring and documenting changes to energy efficiency after updating the systems.

Building Automation Systems

Building automation systems (BAS) help facilities become "smart". In a smart facility, certain processes can be automatic rather than manual, improving efficiency. These processes

might include shutdowns of power, lighting or irrigation schedules, adjustments to temperature setpoints, and demand response energy arrangements.

The systems also allow:

- Real-time monitoring and control of the entire system from a central or remote location.
- Alarms when conditions exceed predetermined limits.
- Diagnostics.
- Documenting performance and logging errors. This enables better problem-solving and earlier identification of performance issues. It also allows facility managers to measure the effects of any changes. Facility managers can provide this feedback to management or use it to support applications for sustainable facility certification.

Energy Performance Contracting

Energy performance contracting (EPC) is a risk-based contractual agreement between a customer and an energy service company (ESCO) in which the ESCO promises to deliver specified energy performance for an agreed-upon fee. The ESCO delivers all services and systems in a turnkey (ready-to-go) arrangement. In general, ESCOs improve a facility's energy consumption by improving energy and water efficiency. A smaller part of ESCO business is to install engine/turbine generators, develop on-site renewable energy generation and consult on energy management, including billing and procurement of resources. The goal for an EPC project is to generate enough savings in facility energy costs to pay the full fee plus any charges the customer incurs to finance the project.

Electronic devices and equipment (the plug-in load) used throughout a facility continue to include advances in efficient use of energy.

Facility managers can improve the use of energy-efficient electronics and appliances by:

- **Purchasing energy-efficient electronics and appliances.** Energy efficiency ratings are available for electronics (e.g., computer components, servers, televisions), appliances (e.g., food service equipment, cleaning equipment) and lighting. ENERGY STAR is used in many countries. Energy Saving Trust Recommended labels are used in the United Kingdom (U.K.) to rate the efficiency of appliances and electronics. In Europe, Ecolabel combines efficiency with other sustainability issues. TCO Certification, also in Europe, combines energy efficiency with ergonomics for computer and office equipment.
- **Avoiding standby power loss.** Standby power loss occurs when an appliance or electronic device is not in use but continues to consume electricity. Facility managers can decrease this wasted energy consumption by:
  - Activating power management settings on facility computers.

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- Installing energy-reducing devices, such as occupancy sensors for vending machines.
- Supplying occupants with smart power strips that can power down groups of equipment and can automatically power down idle equipment after a set time.

Renewable Resources

What do you know about renewable energy sources?

Instructions: Match the term with the correct definition by drawing a line from the term to the correct definition.

Solar	Is the system that takes water from a river and diverts into a channel or pipe where it spins turbines to produce electricity.
Biomass	Is the system that produce few emissions, and in some locations, excess electricity may be sold back into the grid.
Geothermal	Is the heat and the light from the sun that technology harnesses.
Wind Turbines	Is the system that capitalizes on the difference between air and subsurface temperatures.
Micro hydro	Is the organic material that comes from plants and animals.

Use Renewable Resources

Renewable energy sources include solar (thermal or photovoltaic), wind, hydro, tidal, wave, geothermal, biomass and biogas (or digester gas, the gas produced by the anaerobic breakdown of organic matter). Electricity is considered a secondary source of energy, produced by converting primary fuels into a more desirable or usable form. The goal is to use electricity generated by renewable sources as much as possible, rather than coal or natural gas.

Sustainable facilities that produce their own electricity on site must be able to make good use of excess electricity. Particularly with solar and wind, the facility may generate more or less than it needs. If the facility can sell excess back into the grid, it avoids the considerable expense of storage batteries. It can also "bank" excess electricity for those times when the

system does not generate enough power, such as on cloudy or windless days. This is when a utility agrees to "buy back" net excess generation – electricity generated on site that is more than the facility needs. The amount is determined by net metering, which may involve a single meter that can run backward, creating a credit. Or, a utility may require a separate meter to measure onsite generation.

Solar is the heat and the light from the sun that technology harnesses. Facility managers should consider a variety of factors when deciding to use solar power in the facility:

- Amount of sun. As systems become more efficient, requirements for certain hours of sunlight are being lowered.
- In photovoltaic systems, the cost of electricity produced from other sources.
- In thermal systems, how the facility uses heated water. The most economic uses are in facilities that have a continuous need for heated water.
- Government or utility rebates.
- Potential to sell generated power back to the grid.

Biomass is organic material that comes from plants and animals. It is a renewable source of energy. When a facility has ample access to sources of biomass that do not require significant transportation, onsite generation of electricity and heat from biomass is practical. Burning the fuel produces heat directly. Fermenting it produces gas which becomes fuel. Excess heat can run turbines and generate electricity, which the facility may be able to sell back to the electrical grid.

Geothermal systems capitalize on the difference between air and subsurface temperatures. These systems are installed in both residential and commercial buildings. Underground horizontal or vertical pipes carry water (or in cold climates, an antifreeze/water mixture) into buildings. They may also use wells or surface water, such as ponds. The building uses heat transfer principles to both heat and cool interiors. Geothermal systems require a certain amount of space and the right type of soils.

Wind turbines produce few emissions, and in some locations, excess electricity may be sold back into the grid. High construction and battery storage costs, availability of transmission lines from installations and permitting processes may limit their large-scale use. For a facility with adequate and reliable wind speeds, small-scale wind generation may be a good option. For example, small wind turbines mounted atop parking lot lighting poles can supplement purchased electricity.

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Micro Hydro - Most people are familiar with large dams that generate enormous amounts of power. Some industrial plants have been able to capitalize on their locations to build small dams or "run of the river". In this type of hydro project, water from a river is diverted into a channel or pipe where it spins turbines to produce electricity. Like wind energy, hydro power releases few emissions, and excess electricity may be sold back into the grid. Unlike wind energy, it is predictable. Hydro's potential is highly dependent on location, and projects require significant capital investment as well as environmental review and permitting.

Lesson 2: Use Energy More Efficiently

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Understand energy pricing factors.
- Understand energy-efficient operational processes that can assist in managing energy use.

Understanding Electrical Energy Pricing Factors

To use energy sustainably, you must know its price, how the facility uses it, and how to generate income with energy surpluses and decrease the facility's carbon footprint.

When power is used and how much it is used in a timeframe affects electrical prices. High consumption and demand place a burden on transmission lines, which can carry only so much voltage. This can lead to disruptions in power supply, either a complete loss or a decrease in power.

Peak pricing reflects the realities of supply and demand. At those times when customers are more likely to use power, the kWh will cost more. Peak times typically occur during the workweek, during the workday, and during the cooling season.

Utilities may also add demand charges. A facility's maximum use during a period set by the electricity provider determines these charges. For example, the provider may set demand charges based on a facility's highest average kW as measured in 15-minute intervals throughout the day. This demand rate will apply and will stay at that level for a certain period, even if actual demand decreases.

A facility manager can lower the consumption and demand for electricity by improving the efficiency of core building systems and lowering the cooling load, or by changing operating procedures to avoid or lower peak demand.

Energy costs for the facility would decrease. This would also provide benefits beyond the organization:

- Environment
  - Lower use of fossil fuels
  - Fewer environmental effects from new power plants and transmission lines

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Monitoring and Managing Energy Use

To monitor and manage energy use you must:

- Know the pattern of electrical consumption in the facility.
- Be able to relate that pattern to pricing thresholds (e.g., peak and price step thresholds, peak times).
- Be able to manage energy consumption patterns.

A "smart" meter can track facility energy use, both in terms of how much energy is being used and when it is being used. The meter can also communicate with energy providers, letting the providers know when actual demand is exceeding or falling below anticipated demand.

By installing smart meters and submeters for each major area or process, the facility manager can map facility consumption and demand in small time intervals (e.g., 15 minutes). Software applications can then analyze this data and describe a load profile for the facility and for specific areas. The facility manager can study this data to identify opportunities for more sustainable energy management.

Submetering involves installing separate meters for different defined facility areas. These areas may be tenant spaces, equipment areas or areas with an energy demand that the facility manager wants to track separately.

One management tactic might be load shedding or load shifting. As seen in (Figure 2) **Load shedding** reduces peaks in consumption levels. This might be done by optimizing the HVAC system (raising cooling set points) or turning off certain banks of lights. **Load shifting** (Figure 3) involves rescheduling certain operations to lower peak demand. Operations that are not time-sensitive would move to periods when peak rates are lower. For example, a building may make ice at night, when the rates are low, and store it to use in cooling the building later in the day, when temperatures and electrical rates are highest.

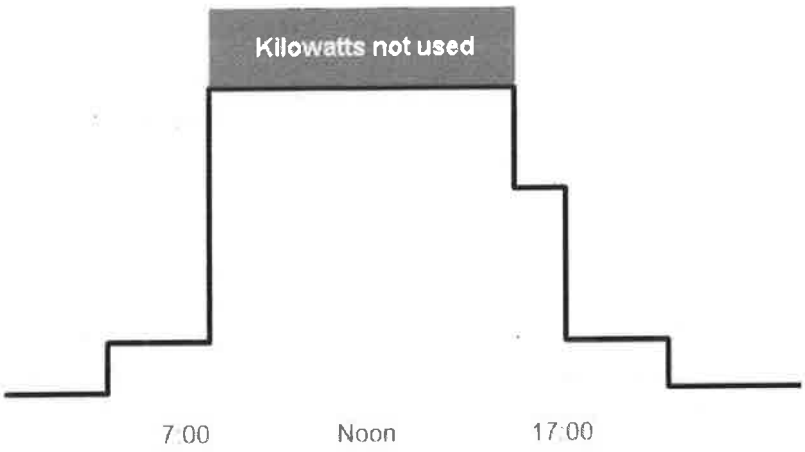

Figure 2 Load Shedding

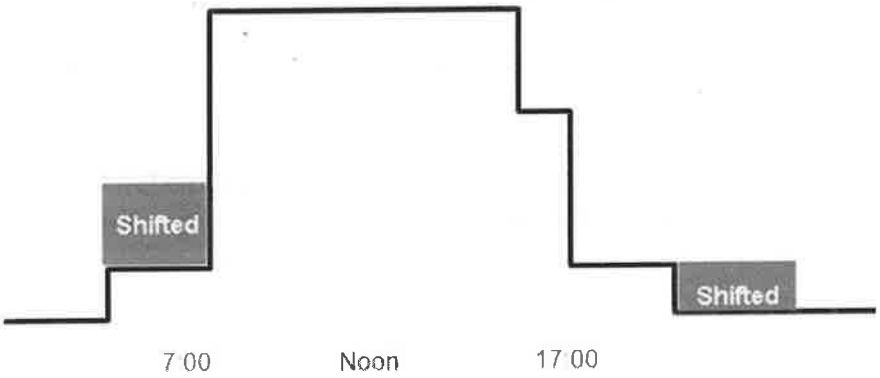

Figure 3 Load Shifting

Demand Response

Demand response is a contractual arrangement between facilities and power companies. Facilities agree to reduce or shift their consumption during peak demand periods in return for defined financial incentives. The demand-response contract specifies how much demand must be reduced and for how long. Demand-response arrangements reduce not only demand but also overall consumption – with reductions of four to eleven percent in overall electric consumption.

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Changing Occupant Behaviors

Technology may not be the solution in some situations. Facility managers may need to involve participants. Facility managers can:

- **Identify and remove obstacles to the desired occupant behavior.** Obstacles may be technological – e.g., occupants may not have access to necessary controls to turn off lights, or computers may need to be left on at night for IT reasons. Inconvenience and discomfort may be factors as well.
- **Educate occupants about the issue and their role.** Providing information on the facility's sustainability efforts can encourage occupant involvement. You can distribute the information through newsletters, e-mail or on a facility Web site. Some large facilities use "energy dashboards" that provide occupants with real-time access to the facility's energy performance.
- **Fit solutions to the environment and provide support solutions for occupants.** A solution may be technological, such as a hotel room card key that places a room in occupied energy mode when the key is placed in a receptacle by the room door. A solution may be more operational, such as an after-hours sweep by security guards who turn off lights in locked offices. Before choosing and implementing a solution, the facility manager should seek occupant feedback and buy-in. For any technological solutions, the facility manager should enlist IT support and set up a help line or desk.

Changing Occupant Behaviors Though Organizational Policy

Some ideas to influence occupant behaviors through organizational policy are:

- To support a higher (temperature) setpoint in buildings, implement a seasonal dress policy.
- Enlist a local champion to interact directly with occupants about tactics for lowering energy use.
- Implement a policy requiring all occupant equipment to be certified as energy efficient or it must be removed.

Changing Occupant Behavior through Feedback

Some ideas to influence occupant behaviors through feedback are:

- To show occupants the impact they are having on energy use, create an intranet "dashboard".

- Provide an incentive, such as a free group lunch, to reward lowered energy use or recognize compliance with policies.
- Use energy signage at the point of use. Change the message regularly so it doesn't become invisible.
- To provide tenants with floor-specific feedback on consumption, meter areas.
- Provide energy audit reports.

Implement a Carbon Trading Policy

Carbon trading is a market-based system that brings carbon-credit buyers and sellers together. Businesses that emit carbon dioxide can purchase carbon credits or "offsets" to make up for those emissions. A carbon offset is a measurable reduction of Greenhouse Gas[1] (GHG) emissions from an activity or project in one location that is used to compensate for emissions occurring elsewhere. You can buy them as metric tons of carbon dioxide equivalents or tCO_2e.

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You can produce offsets by:

- Reducing emissions through increased efficiency or destruction of GHG. Methane gas has 21 times the global warming potential of CO2, so removing methane from the atmosphere benefits the environment. You might do this by capturing and using or burning off methane released from landfills, manure and coal mines.
- Sequestration (isolation/chemical change) of carbon biologically (in plants) or geologically (storing of CO2 in rock formations).

Facility managers can support their organization's efforts to meet carbon caps, avoid carbon taxes and/or participate in carbon trading by:

- Ensuring that facility energy data is available, complete and accurate.

[1] Greenhouse gases are gases that absorb and emit radiant energy, impacting the earth's atmosphere by trapping heat in the atmosphere contributing to the greenhouse effect.

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- Focusing on facility projects that decrease carbon emissions. These are projects that decrease consumption of fossil fuels and increase the use of renewables.
- Documenting projects that will be used to support carbon offsets. Facility managers may also help validate carbon offsets the organization purchases.

Renewable Energy Credits (RECs)

RECs – or green tags or certificates, as they are known in Europe – have the same basic goal as carbon offsets but use a different approach. Carbon offsets represent removed or sequestered carbon. RECs represent electrical energy generated by renewable sources. They are a good way to capture reduction in Scope II emissions (indirect emissions, such as those from the generation of electricity). You can use them to meet voluntary renewable energy targets as well as compliance requirements.

Utilities, marketers, and third parties offer these certificates. Like shares in a company, you can buy and sell them. Although you have not actually produced anything, RECs entitle you to claim that you have produced the stated amount of renewable energy. Like carbon offsets, the REC system also allows producers to put into monetary terms the environmental value of energy.

Make sure you are purchasing RECs from reputable sources. In the U.S., the Center for Resource Solutions in San Francisco (Green-e) certifies sustainable energy products. The EU validates its own energy certificates through the Renewable Energy Guarantees of Origin (REGO) programs, which are operated within member states.

As a facility manager, you can have a significant impact on energy management without being an energy expert. The field of energy management provides many opportunities to show environmental leadership and a strong commitment to organizational financial and strategic goals.

Consider these low to no-cost opportunities for improving energy management:

- Train FM staff to observe, report, and correct minor facility flaws that can lead to energy waste:
  - Modify settings on occupancy sensors that are not working as expected.
  - Fix doors and windows that do not properly latch.
  - Repair openings or defects in the building envelope that allow air infiltration.
  - Check timer settings on exterior lighting to ensure that lights are only on whenever possible.
  - Use natural lights wherever possible.

- Teach occupants about the benefits of simple energy-efficient practices. Provide small incentives for them to follow these practices such as:
  - At the end of every day, turning off monitors.
  - Every time they exit the space, turning off office lights.
  - Throughout the day, adjusting blinds and window coverings to take advantage of or reduce solar gain.
  - When the space is not in use, closing blinds and tilting them down, particularly those below slot diffusers.
  - Eliminating the use of space heaters, which cause false space temperature readings and create hot and cold spots.
- Maintain and monitor equipment for optimum energy usage.
- When facilities are unoccupied, trace high energy users and look for ways to reduce that need. (Portable energy meters are widely available, often through the local energy supplier).
- To determine the best times to run the equipment, review the audit building automation system (BAS) settings for start-up and shutdown. Make sure that the system schedule accurately lists unoccupied times.
- As equipment is replaced, ensure that specifications require high-efficiency replacements. Make sure the installation is correct and that the new equipment works as intended.
- Use staggered occupancy and the occupancy level to rearrange seating.

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Lesson 3: Energy Management Evaluation

Lesson 3: Objectives

On completion of this lesson, you will be able to:

- Understand specific terminology related to energy management.

Introduction

The resources available for facility managers include a variety of standards. Industry groups or non-government organizations (NGOs) may provide voluntary assessment standards. Legal standards are those required by code, law, or regulation. Generally accepted voluntary standards raise and define an organization's practices.
Just a few examples include:

- The International Organization for Standardization (ISO) has developed ISO 50001 Energy management system – Requirements with guidance for use. It is a framework for organizations to establish, implement, and improve energy efficiency. ISO 50001 certification demonstrates an organization's commitment to energy efficiency and sustainability.
- BREEAM®, the Building Research Establishment Environmental Assessment Method, is a sustainability assessment method. It targets climate resilience in the built environment – mitigating our contribution to climate change and the impacts of that change on our facilities. (BREEAM, ND)
- Energy codes vary by jurisdiction. They are also found in building codes, which govern new construction. Canada's National Energy Code drives construction and operations in Canada. The International Energy Conservation Code (IECC) is recognized in most U.S. jurisdictions.
- ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) is a U.S.-based society that develops standards to help its members focus on energy efficiency. (ASHRAE, N.D.)

Terminology Specific to Energy Management

Instructions: Match the terms with the correct definition by drawing a line from the term to the definition.

Term	Definition

Carbon Footprint	The gases that absorb and emit radiant energy, impacting the earth's atmosphere by trapping heat in the atmosphere.
Carbon Intensity	The measure of annual building energy use divided by building area.
Energy Efficiency	Using less energy to produce the same product, output, or activity.
Energy Use Efficiency	The measure of the amount of greenhouse gases produced by human activities.
Greenhouse gases	The rate at which a specific activity or process emits greenhouse gases.

Facility Managers Need to Understand Terminology

Facility managers need to understand terminology specific to energy management, such as the following:

Carbon Footprint

Carbon footprint is the measure of the amount of greenhouse gases produced by human activities. Carbon footprint refers to the quantity or volume of greenhouse gases (carbon dioxide and other carbon compounds) that are produced and emitted to support an organization, an activity, or a product. Simply put, the energy used for workers to get to and from work, the energy used in operating a facility, and the energy that went into the gathering, manufacturing, transporting, installing and even that which will go into disposing of a product in or produced by a facility are all a part of carbon footprint.

Carbon Intensity

Carbon intensity is the rate at which a specific activity or process emits greenhouse gases and is the subject of the United Nationals Environmental Program - Sustainable Building and Climate Initiative (UNEP-SBCI). Carbon intensity is calculated as KgCO2e per square meter or occupant per year. In 2016, the U.S. and Canada were closely tied for the highest carbon emissions at over 14.9 metric tons while India emitted only 1.57 metric tons. Transportation as an industry has the highest carbon intensity rate. (Bewicke, Henry. 2019, January 2).

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Energy Efficiency

Energy efficiency means using less energy to produce the same product, output, or activity. Energy efficiency is tied directly to energy management and the reduction of operating costs. Energy efficiency also ties directly to sustainability goals related to reducing harmful emissions and reducing demand.

Energy Intensity

Energy intensity measures how much energy it takes to produce an output, activity, or product. Energy intensity is measured by energy use per monetary unit of gross domestic product and is calculated as kWh per square meter or occupant per year. This result is then multiplied by the official GHG emission coefficients published for each fuel type.

Energy Use Intensity

Energy use intensity, EUI, is a measurement for annual building energy use divided by building area. EUI can also be expressed per occupant or as a ratio of energy cost to organization revenue. It is used as a benchmark to compare against other organizations' energy use.

Greenhouse Gases

Greenhouse gases are gases that absorb and emit radiant energy, impacting the earth's atmosphere by trapping heat in the atmosphere contributing to the greenhouse effect. These include many chemical outputs, the most abundant of which are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).

Evaluating energy management processes and setting standards require careful analysis and balance. Particularly with equipment used to operate a facility, a decrease in one factor may lead to an increase in another.

Lesson 4: Energy Efficient devices

Lesson 4: Objectives

On completion of this lesson, you will be able to:

- Explain how devices and systems can be used to increase energy efficiency.

Energy Star

ENERGY STAR is implemented globally:

- Canada – Natural Resources Canada (NRCan)
- Japan – Ministry of Economy, Trade and Industry
- Switzerland – Swiss Federal Office of Energy (SFOE)
- Taiwan – Environmental Protection Administration of Taiwan, (ENERGY STAR, N.D.)
- Ministry of Power, Government of India.

Energy management has become a big selling point, and facility managers can choose from a wide range of products. This makes it easy to find devices to aid in energy management.

With so many choices, how do you choose the best products for your facility? A facility manager's trusted engineers, contractors, peer network and professional association are excellent resources to gather input about the performance of one product over another.

Let's look at some of the energy management devices available today.

Electric Submeters

You cannot improve what you do not measure. This is true in managing anything, including energy.

Electric submeters are devices that measure energy flow at a level beyond that of the power company's building meter. Submetering allows the FM team to see where energy is being used the most. It can measure the energy use from one tenant in a facility to another, between floors, or by building system (such as mechanical systems vs. plug load). (Washington State University Energy Program, 201t).

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Based on what the meter measures and its options, purchase and installation costs will vary.

You would plug in the simplest end-use energy meters between a device and the power source to measure the use of that one device. In some areas, such submeters are available through the energy company. They may also be available for loan through a local library or tool cooperative.

More complex systems can show power use by the type of system or the location of the equipment. You would install these submeters between the equipment and the primary power feed. At set intervals, you could review the data logs.

You can use the data to isolate equipment that is using more energy than expected, to fine-tune operations, and to measure improvements in energy management as adjustments are made.

To ensure the anticipated outcome, plan your submetering well. Consider the cost of the submeter as well as the complexity and cost of the installation. Communication from the device is important as are the computer hardware and software needed to evaluate the data. You will need to know what recording interval will produce the desired data. And make sure you have the resources required to calibrate and test the device, to maintain and analyze the data, and to act on the information you get.

Energy Management System

An energy management system (EMS) is a computer-aided tool that controls power grids or microgrids. A microgrid is a structure that allows some communities, large manufacturers, and industrial organizations to manage their own demand, storage, and generation from the main power grid. The term refers to the power grid between the energy provider and the consumer, where the management of that system is outside the organization's control.

By using an energy management system effectively, facility managers can monitor, analyze, and reset heating, ventilation, and air conditioning points like chilled water and hot water temperatures. The facility manager can then reprogram these values to the minimum levels required for occupant comfort. This will also help reduce stress on mechanical systems and prolong their life.

IoT Technology

The Internet of Things (IoT) has allowed rapid growth in the ability to monitor and improve energy operation. Most energy companies use IoT to reduce operating costs for energy production. IoT applications enable companies to monitor and diagnose equipment issues, and to monitor and log energy performance as well as emissions. Many Integrated Workplace Management Systems (IWMS) interface with EMS, allowing FM to implement a more intelligent energy management strategy. These systems are connected through IoT. (Particle, N.D.) IoT applications use conditions or parameters that you set to predict equipment failure and reduce downtime. This increases the reliability and energy efficiency of the equipment.

Plug Load Controllers

When plugged in, some devices continue to draw power even when not in use. Plug load controllers allow facility managers to monitor and control the energy that these devices use throughout the facility. These controllers can turn the power on and off to specific devices. They can also reduce the amount of power provided to a device or a customer. In some geographical areas, when extreme heat puts a heavy load on the air conditioner, power failures can occur. During peak demand periods, a plug load controller can reduce power to devices that use a lot of energy. The plug load controllers help prevent power failures.

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Lesson 5: Reducing Energy Use

Lesson 5: Objectives

On completion of this lesson, you will be able to:

- Describe options to help reduce energy use.

Reducing Energy Use

Controlling Devices

Smart thermostats allow users to adjust a thermostat remotely via wireless technology. You can program them to occupancy times. When working from home is an integral part of workplace management, you might also consider this as part of a smart-home system.

To maintain contents at an acceptable temperature, you can attach energy misers to vending equipment. When the space is not occupied or the equipment is not in use, the equipment remains in a lower power mode.

Charging stations that automatically turn off when a device is fully charged reduce the use of phantom power.

Use smart power strips to cut power to a group of devices when they are not in use. Reservation systems could be a component of an IWMS.

Computer Center

To manage energy use and find opportunities for savings, facility managers may want to coordinate with IT data center managers. Data centers are no longer massive rooms filled with racks of heat-generating equipment that require air conditioning. Many servers are now virtual, decreasing both energy draw and heat load, so you might negotiate an increase in the temperature of the data center. Work with your IT Division to find the specifications for the equipment and adjust accordingly. According to ENERGY STAR, every 1-degree Fahrenheit increase in temperature can save four to five percent in energy costs.

If the computer data center is still using room-cooling units, consider working with an engineer or energy partner to perform a total cost analysis on replacing that equipment with in-line rack cooling systems.

Lesson 6: Energy-efficient Systems

Lesson 6: Objectives

On completion of this lesson, you will be able to:

- Explain how devices and systems can be used to increase energy efficiency.

Energy-efficient equipment and energy-efficient systems have much in common. In this lesson, we have attempted to list devices in the equipment category and types of systems in the systems category. We will start with an introduction to a Building Automation System (BAS)

Building Automation Systems (BAS)

A Building Automation System (BAS) is an electrical system that uses both software and hardware to automate and manage heating, ventilation, and air conditioning (HVAC) systems; lighting; and even security over a single platform. With a BAS, the facility management team can check equipment settings, troubleshoot comfort issues, and modify settings as needed. For example, after installing furniture and carpeting, they may need to increase air exchange. A BAS also enables scheduling temperature setbacks for non-operating hours and holidays. Accessing the BAS remotely via a web platform allows you to respond more quickly to occupant needs.

A BAS gives you a high level of control over HVAC operations and logged metrics, which allows you to manage energy usage across the organization's platform.

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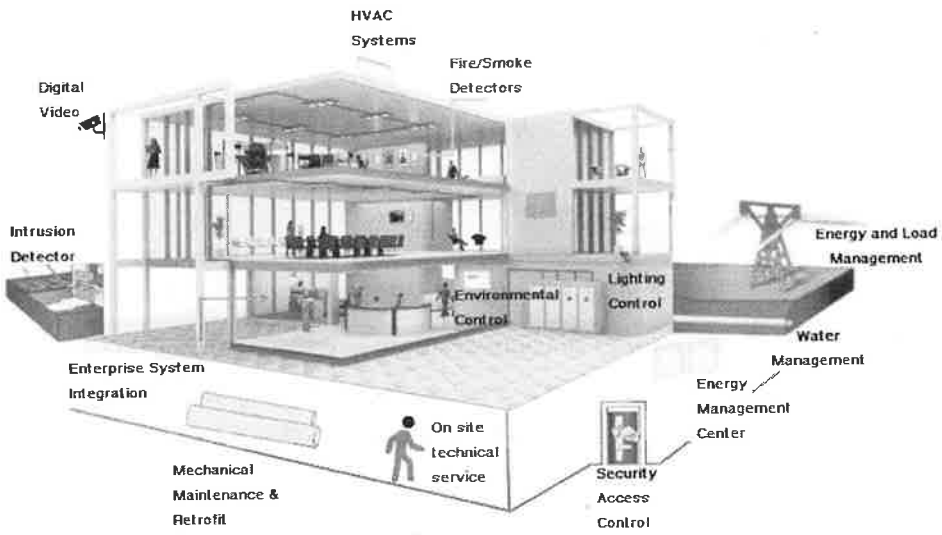

Figure 4 Building Energy Management System

For example: Consider the many elements of a HVAC system.

- A pre-set start-up time or space temperature sensors send signals to the space conditioning equipment. These signals tell the heating, cooling, or ventilation equipment to function in a certain way for a certain period.
- Chillers, boilers and similar systems respond by heating or cooling one or more zones in the facility. To do this, they use intermediate layers of the HVAC system, such as unit controls, rooftop units, and air handling units.
- The system controllers coordinate all this equipment to meet the condition called for A BAS system could automate this process.

Efficient HVAC Systems

HVAC systems are a significant investment for an organization. Their operation is a major cost, so you should choose equipment with great care.

For efficient HVAC systems, energy managers may consider any number of technologies. Among them:

- An efficient chiller on HVAC equipment.
- Because they respond independently to individual zone control needs, variable refrigerant flow (VRF) systems are very energy efficient.
- To meet both heating and cooling needs, waste heat recovery systems capture and convert heat from a process into energy. They are generally feasible only for large manufacturing processes.

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- To provide both heating and cooling, heat exchange systems transfer heat between two or more devices.
- To provide heating and cooling, a geothermal heat pump uses heat from the earth. It is one of the most energy-efficient HVAC systems.

When choosing HVAC systems, you should consider maintenance, estimated life and total cost of ownership, which includes energy efficiency. You should also consider the size, shape, and qualities of the facility, as well as operating conditions and needs.

Energy-efficient systems share some common features:

- **Variable frequency drives (VFDs)** vary the frequency and voltage supplied to a motor. Rather than running the motor at 100 percent full-time, they control the speed. At lower speeds, power consumption decreases, resulting in significant energy savings. The estimated payback of VFDs is just a bit over five years. (Boyajieff, 2017)
- **Economizers** measure outdoor air temperatures and humidity levels and use outside air to cool the building. This decreases utilization of the air conditioning unit, lowering energy use. In some cases, you can use economizers instead of refrigeration units. An academic study has suggested that the increased ventilation that economizers provide has the added benefit of reducing sick days from air pollutants. (Fisk, B, et. Al. 2004, June).
- **Demand Control Ventilation (DCV)** controls the supply of outside air based on occupancy, as compared to a fixed rate which controls the supply based on monitored CO2 levels. Implementing demand-controlled ventilation has one of the shortest paybacks of all energy control measures. You can recover your investment at just 2.24 years and get a high savings-to-investment ratio. (This is second only to controls system retro commissioning, discussed in the next section). (Boyajieff, 2017).

Renewable Power Sources

Renewable power sources are becoming more financially feasible. Including renewable sources into an organization's energy management strategy can help it meet multiple goals:

- You can include renewables, such as solar energy, into the design of parking structures. This can help meet local requirements for shade while powering the lighting for the structure.
- You can integrate wind turbines into the parking lot or roof design. This can help power not only the parking lot but some portion of the facility as well.

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- Bioenergy (energy produced or derived from organic sources) can power and heat manufacturing or farming operations. It may also be a viable option for powering vehicle fleets.
- Ocean or hydroelectric energy can provide power, heating, or cooling for those in extreme geographic regions.
- Demonstrating strong corporate citizenship, an organization that cannot generate its own solar or wind power can purchase power generated by these resources.

Computer Power Management

To maintain the integrity of an organization's data, IT divisions often perform security updates and software maintenance during non-operating hours. This can conflict with the desire to manage energy. Fortunately, most operating systems today have power management features that allow a systems operator or a software program to wake a computer, install an update, and then turn the computer off. Because of the many variables in equipment and PC power management solutions, estimating the savings would not be realistic. Given the volume of computers in larger organizations, it is easy to justify this solution for energy management.

Lesson 7: Energy-efficient Operational Processes

Lesson 7: Objectives

On completion of this lesson, you will be able to:

- Explain how devices and systems can be used to increase energy efficiency.

Commissioning (Cx) and Retro Commissioning (RCx)

Commissioning, or Cx, is the process of verifying and documenting that all new building systems perform together as designed and as required for the owner's operation. This is a planned step-by-step process. Retro commissioning, or RCx, is a planned evaluation of the system's operations to improve the efficiency of existing equipment and systems. RCx looks for processes and equipment that are not working as designed or at their peak. It identifies and fixes issues related to installation, retrofit, and replacement as well as maintenance. Seventy-two percent of fixes relate to how the systems are operated and controlled (Boyaiieff, 2017). These may include systems that are heating and cooling simultaneously, sensors that are out of calibration, and incorrect control sequences. Of all energy control measures, retro commissioning has the shortest payback at .38 years. It has the highest savings-to-investment rate at 23 financial units of savings per equivalent unit of investment (Boyajieff, 2017).

Measurement and Verification

Performance-based contracts commonly use detailed M&V to determine the energy and cost savings that efficiency measures bring.

Measurement and verification (M&V) are critical components of any type of resource management program. M&V is the process of quantifying the energy and cost savings that come from improvements to energy-consuming systems (M&V Guidelines V4, 2015). To ensure that planned savings were reached, this process follows implementation, often at several points. An initial verification ensures that the new equipment or modifications were implemented properly and are functioning as expected. However, more checks are

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required. Actual savings result from the absence of energy use. To determine savings, you must compare the energy and cost reductions post-installation to what those numbers were before the changes were made. You need a historical baseline with appropriate adjustments for changes in condition.

M&V has additional benefits:

- Allocates risks between the contractor and the customer.
- Accurately assesses energy savings for the life of a project.
- Monitors equipment performance.
- Identifies additional savings.
- Improves Operations & Maintenance (O&M).

Operational Practices

Because of improper and inefficient operations, 10 to 30 percent of the energy used in commercial buildings is wasted (Pacific Northwest Laboratory, 2020). To detect energy savings opportunities, the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) has developed a no- to low-cost Building Re-Tuning™ approach. This is a step-by-step process to identify and correct building operational problems that lead to energy waste.

Pilot programs and studies have found that many no- or low-cost operational changes can result in savings greater than 5 percent of the total consumption (Katipamula, 2009).

Organizations that performed Re-Tuning exercises identified some common issues:

- Systems running longer hours than needed.
- Improper economizer operations.
- HVAC systems running continuously, even when space was unoccupied.
- Dirty HVAC system filters and coils.
- Exhaust systems running all the time, even when space was not being used.
- Programmable thermostats were not programmed.
- Door seals were missing or worn.
- Operable windows were left open.
- Unsealed penetrations were found on the outside of buildings.

Good, scheduled O&M practices keep equipment and systems performing at their peak. This reduces energy consumption, extends equipment life and provides occupant comfort.

Energy Audit

An energy audit evaluates how a facility uses energy. A typical audit not only evaluates how and where energy is used but also the billing or rate structures that apply to that use. A commercial energy audit may identify low- to no-cost improvements that will save substantial amounts of energy. The American Society of Heating, Refrigerating, and Air Conditioning (ASHRAE) has identified three levels of energy.

The **three levels of energy audits** are:

- Level 1: Walk through analysis
- Level 2: Energy survey and analysis
- Level 3: Detailed analysis of capital-intensive modifications

Before performing any of these three levels, you must complete an energy-use analysis. You should:

- Assess the building and energy-consuming equipment in an onsite visit.
- Review the utility bills to determine whether changing the utility rate will save money.
- Summarize utility bill data.
- Calculate the energy use intensity (EUI).
- Benchmark the site's energy usage against similar sites in the same region.
- Estimate the cost savings if the building met an energy-use intensity target.

ASHRAE Levels for Audits

ASHRAE Level 1: Walk-through

The brief report focuses on low-cost and no-cost measures, although capital measures are identified when found. The report also includes:

- Summary of utility data.
- Estimate of savings associated with a rate change.
- Calculation of the energy-use index.
- Benchmarking.
- Targeting.

A small building will use less energy and have little potential for energy savings. For these small buildings, an ASHRAE Level 1 audit should meet your needs.

ASHRAE Level 2: Energy Survey and Analysis

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The ASHRE Level 2 audit is more detailed and requires skill and thought to create a quality audit report. The Level 2 audit includes a complete description of the facility, including:

- Equipment inventory.
- Energy balance.
- For each low-cost or no-cost measure, detailed energy savings and costs.
- For each recommended measure:
  - Financial analysis.
  - Recommended measurement and verification plan.
- For capital projects, identification and rough estimates of project costs and savings.

The Level 2 audit balances the need for engineering rigor with the need to keep the audit cost-effective. For larger buildings, the Level 2 audit is usually your best choice.

ASHRAE Level 3: Detailed analysis of capital-intensive modifications

For more expensive capital projects where risk is less tolerated, the ASHRAE Level 3 audit is more thorough and precise. In these audits, trend logs and data loggers show how the buildings react to changes in ambient conditions and occupancy. Hourly simulations calculate HVAC measures. You will review detailed costing estimates and life-cycle cost assessments. The contractors installing the measures must understand exactly what is to be installed, so this audit also requires a scope of work and schematics. The reports contain more detailed descriptions of the measures.

Level 3 audits are sometimes called Investment Grade Audits (or IGAs). These audits are typically part of a performance contract.

Energy Performance Contracting

Energy performance contracting gives facility operations an extraordinary opportunity. These instruments can help accelerate efforts to maximize the energy and water efficiency of facilities. Under a typical energy performance contract:

1) An **approved contractor** conducts a comprehensive building energy audit. The audit evaluates the operation, condition and efficiency of facility equipment.
2) The selected **energy service company (ESCO)** performs calculations to:
   - Weigh options.
   - Evaluate the value and cost of equipment replacement, operational improvements and building envelope measures.

3) The **organization** reviews the proposed packages. Each package includes that initiative's life-cycle cost information, guaranteed maximum cost, and payback. The organization selects a package from the options. The accepted project guarantees a specific payback within a defined period, with the ESCO responsible for meeting that payback.

   Audits are a part of the contract to ensure that guaranteed savings are achieved. In many situations, you can fund the cost of the improvements by the savings generated. Perhaps the best part is that the implementation is turn-key, meaning that the energy service company fully manages the project.

4) Once the organization selects the initiative, the ESCO:
   - Solicits competitive bids for the project.
   - Manages all contractors and subcontractors.
   - Maintains the budget, schedule, risk and communication plans.
   - Trains facility staff in the operation and maintenance of all equipment and operations included in the performance contract. Some performance contracting arrangements can even include ongoing commissioning services designed to ensure that system performance is maintained.

Performance Contracting Case Study Part 1

Case Study Background

XYZ County operated 14 facilities, many of which were more than 20 years old. The county's new facility manager was handling multiple roles, including FM and project management. The FM staff of 4 was managing over 400,000 sq. ft of facility across a 275-square-mile geographic area. The facility manager was implementing a mission-critical technology project in eight of the facilities. Each of those facilities would have to close temporarily while physical modifications were being made. The phased temporary closures meant that significant collaboration between divisions was critical. HVAC equipment had outlived its useful life, and the facility manager knew that she had to replace it. But capital funds for needed upgrades had been budgeted to begin several years in the future, and she did not have the workload capacity to add another project.

The facility manager learned about energy performance contracting. After due diligence and research, she prepared and presented a business case to the Board of Trustees. She requested authorization to engage in the first phase of an Energy Performance Contract, the technical energy audit, with the following conditions:

- The Energy Service Company (ESCO) would be selected from a group of thirteen firms. She had selected these firms based on responses to a bid form provided by

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the State's energy office. The State energy office had also reviewed contract forms and audit procedures for the process, which would lighten the administrative load.

- For a fixed fee, the selected ESCO would perform the technical energy audit on all the county's owned facilities. If the county chose to enter an energy performance contract, the fixed fee for the audit would be rolled into the project.
- The county would have multiple options for funding any improvements selected for development. The ESCO would provide resources for funding. The ESCO would also help with the application for and benefit-sharing of any rebates or incentives available to the project.
- If approved, the project implementation would be turn-key, preserving the functional capacity of the facility manager.

After weighing the proposed options, the Administrative Services Director and the FM requested and got approval for a guaranteed maximum project investment of US$3.4 million, funded through Certificates of Participation at an exceptionally competitive rate. The guaranteed annual savings of US$221,500 combined with operational improvements (made possible by the upgrades) would provide much of the payment on the certificates. The necessary equipment upgrades were escalated by years, preventing the near-certain failure of some equipment components.

One year after implementing the project, the county met with ESCO representatives to review the savings. That year, and in the years that followed, the county's savings exceeded the US$221,500 guarantee by at least US$75,000 – a 33 percent surplus savings. One-year energy savings attributed to the project was 1,851,069 kWh, 26,959 therms 438kgal.

Note: A therm is a unit for natural gas used over time.

Performance Contracting Case Study Part 2

Assume the business case was approved, and the audit was performed. The ESCO proposed improvements to all facility systems and demonstrated payback for each. The recommendations focused on upgrading the aging equipment and providing controls systems. The ESCO proposed options that ranged from geothermal, ground source, solar and wind power, to chilled beam and more traditional HVAC systems. Each option was presented with a total cost of ownership (TCO) analysis and expert guidance from the ESCO HVAC team.

The approved project included lighting improvements, vending misers, water conservation projects and PC power management. It also included a resource conservation management program that would commit a commissioning agent for 20 hours per month to ensure the continued efficiency of the equipment. The eight facilities would be fitted with new HVAC

systems and building controls. The FM staff would be trained to troubleshoot the equipment and to manage the building automation system (BAS). If they met the established criteria for payback period, additional scope items were included. For example, in one facility, aging cardboard ductwork was providing more conditioned air to the plenum space than to the user space. In that facility, all ductwork was replaced. To ensure that its new assets were properly maintained, the contract also stated that the ESCO would help the county procure a new HVAC service company.

Reducing Power Usage

Many of the equipment options that help reduce energy use are widely available and relatively simple to implement and manage. In fact, in some product categories, you may have trouble finding a device that is *not* designed to reduce energy use.

Lighting

LED technology has been in use for decades and has become the standard for lighting. LED lighting offers tremendous efficiencies that help with energy management and make them attractive to facility managers:

- LED lighting is 80 percent more efficient than incandescent light. A 10-watt LED bulb provides the same lighting as a 60-watt incandescent bulb (Hoyt, Bobby. 2019, February 1).
- LED lamps produce little heat, saving cooling energy.
- On average, LED lamps last tens of thousands of hours, saving maintenance labor-hours.
- LED technology is dimmable and available in a range of light temperatures and colors. You can tune some LED technology to different light temperatures and colors to fit your needs.

LED lighting is not as costly as it once was. In many cases, a facility manager will find that the cost of purchasing and installing new LED fixtures may be the same or less than repairing an existing fluorescent or incandescent fixture.

In Germany, laws regulate the purchase of energy efficient lighting. In most cases, this means LED lights.

Light Sensors

As the name suggests, occupancy and vacancy sensors detect when a space is occupied or vacant. These sensors control lighting and other space equipment as appropriate.

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According to the *Energy Management Handbook*, savings can range from 25 to 50 percent for a private office, from 45 to 65 percent for conference rooms, and from 50 to 75 percent for warehouses. (Doty, 2009). The savings realized from using sensors will vary with the type of lighting.

When sensors fail to operate as expected, you may need to educate the occupant and the FM staff. For example, vacancy sensors require the occupant to turn on the lights. When the space is vacant, the sensors turn off the lights. Users may not be aware of this type of device in their space and may feel frustrated that the lights do not automatically turn on. These devices also have sensitivity settings that you can fine-tune. This allows you to ensure a coverage area and avoid having the device turn on or off at the wrong time.

Based on the need and usage, you might choose different sensors for different applications. An enclosed office with a single occupant needs a different type of sensor than a conference room. The sensors require different installations, such as wall switch, ceiling, corner, etc. To provide appropriate coverage of a room or space, the sensors use some combination of passive infrared and ultrasonic technologies and are tuned for varying ranges.

Beyond lighting, workstation sensors installed at workstations can cut power to a room or space when not in use. This would reduce costs associated with phantom plug loads. In more sophisticated setups, so that vacant spaces are not using energy, you can tie the sensors to the heating and cooling of a space. You might even control them by a reservation system or calendar.

As with any other building infrastructure, energy monitoring, reduction and controls require regular maintenance.

Chapter 2: Progress Check

1. What is the primary benefit of electric submetering in a sustainable facility practice?
   a. Electric submeters allow the facility manager to chargeback costs to different business users or occupants.
   b. Submeters provide information about energy use by type of use or even by device to aid energy consumption management.
   c. Electric submeters provide a double-check on the utility metering to ensure correct charging.
   d. Submeters shut power off to groups of devices to prevent phantom power use.

2. The support of renewable power sources requires the installation of equipment on-site. Which statement is correct?
   a. Organizations can rent renewable power equipment on site.
   b. Organizations that cannot generate renewable power on-site have opportunities to purchase power generated by others.
   c. Renewable equipment is shared with the next building on the block.
   d. The grid's infrastructure has increased stability when equipment is on-site.

3. What energy control measure provides the shortest payback period?
   a. Demand Control Ventilation (DCV)
   b. Economizers
   c. Controls System RCx
   d. Installation of VFDs

4. What are measures presented as options in an energy performance contract based on?
   a. Life-cycle cost, guaranteed maximum cost, and payback
   b. Organizational desire for a specific technology, regardless of payback
   c. Speed of payback
   d. Availability of funding

5. What is the purpose of retro-commissioning?
   a. To return HVAC and control settings to the original setpoints.
   b. To ensure that equipment and systems are operating as designed.
   c. To find equipment that is failing or in need of repair.
   d. To go back to the old equipment for upgrades.

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6. Heating and cooling are two of the core building systems. What is the third?

   a. Landscaping
   b. Lighting
   c. Insulation
   d. Security

7. What does the term "load shedding" mean?

   a. Reducing peak in consumption levels, for example, turning off a specific bank of lights.
   b. Rescheduling of operations to lower peak demand, such as making ice at night.
   c. Installing submeters in a significant process area to reduce electrical load.
   d. Applications that allow FM to map facility consumption and demand in short time intervals.

Chapter 3: Water Management

Lessons

- Objectives
- Lesson 1: Introduction to Water Management
- Lesson 2: Minimizing Utilization of Potable Water
- Lesson 3: Methods to Reduce Water Waste

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Objectives

Chapter 3: Objectives

On completion of this chapter, you will be able to:

- Summarize the importance and benefits of water management.
- Understand the importance of reducing water loss.
- Identify methods to reduce water waste.

According to the U.S. Geographic Service (USGS), about 71 percent of the surface of the earth is covered by water, and about 96.5 percent of all the earth's water is in the oceans. Water should be plentiful! Yet few places in the world can rely on abundant sources of freshwater to meet facility and occupant needs. Just over three percent of the earth's water is fresh.

The World Health Organization (WHO) estimates that 785 million people worldwide lack basic drinking water service, and at least two billion people use a drinking water source that is contaminated. By 2025, WHO believes that half of the world's population will be living in water-stressed areas. (WHO, 2019). At any given time, significant populations are suffering severe drought conditions. These statistics provide a strong argument for water management.

As economies around the world develop, we must find ways to address what the UN World Water Development Report 3 (UNWWDR3) called a "water box". This is a cycle of effects that put increasing pressure on water resources.

Water is not an infinite resource. Each gallon of drinkable water requires treatment and distribution systems. These systems all require energy to operate. Like energy, water management gives organizations opportunities to demonstrate responsibility and to reap the rewards of more efficient operations and lower costs.

Lesson 1: Introduction to Water Management

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Summarize the importance and benefits of water management.

Water Flow

Facility managers should understand how water enters the facility, how it is used throughout the facility, and how it leaves the facility. In addition, they should be familiar with the general issues surrounding water use in the facility's community as well as the regulations and guidelines with which facilities must comply. Figure 5: Water Flow illustrates how water flows into and out of the facility as well as external factors that influence water use.

A facility manager should know where and how much water is used within the facility as well as seasonal patterns of use. Users may include:

- Occupants – Drinking water and sanitation.
- Facility processes – Manufacturing, food service, laundry, recreation.
- Core building systems – Boilers and chillers.
- Site maintenance – Landscaping and exterior maintenance, including testing sprinkler systems.
- Product purchasing – Indirect use of water through product life cycle.

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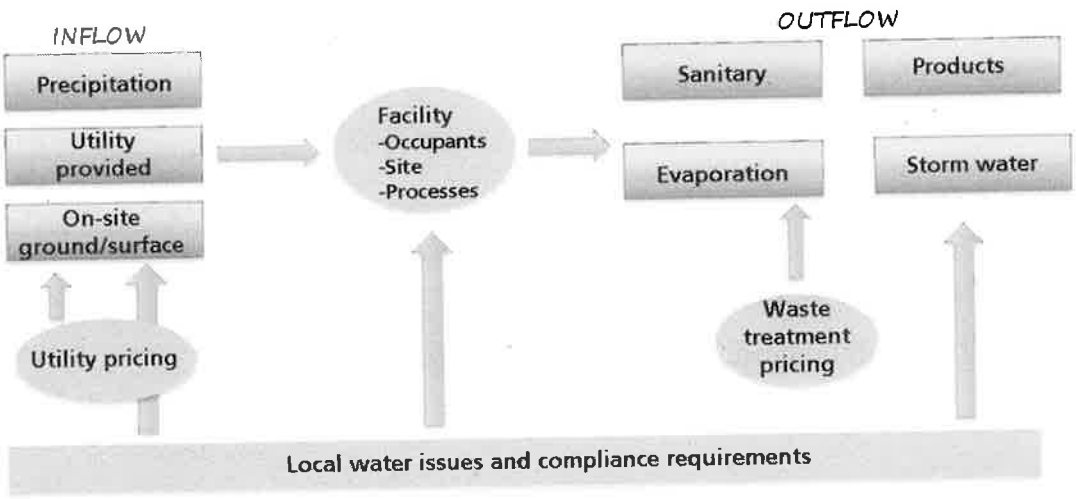

Figure 5 Water Flow

Four Principles of Water Management

Water management is founded on four basic principles:

- Reducing water waste and controlling the usage.
- Increasing the efficiency of fixtures, systems, and processes.
- Educating users about the need and means to reduce unnecessary water use.
- Reusing water supplies that may otherwise be discharged. (EPA, 2016).

Implementing these principles requires planning and commitment. If planned into new construction, some methods of reusing water are relatively inexpensive. Implementing those same measures for an existing facility may be impractical. Large water conservation projects tend to have a longer payback period than energy projects in regions where water is plentiful, but they are still important. For industrial operations that count on quality water for critical processes, this is particularly true.

In a relatively short timeframe, you can implement many low-to-no cost water-saving measures. You can budget many of them within a standard operating and maintenance budget. Facility staff and occupants can activate them as appropriate.

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Opportunities may exist to speed up the implementation of the program. You may come across some unexpected alternatives. Opportunities will vary by organization and may include:

- Grants for innovation and conservation.
- Rebate programs and other utility incentives.
- Participation in an energy performance contract (EPC), which is likely to include water management measures.
- Implementation of measures as a part of capital project plan.

Guidance for Implementing a Water Management Program

Establish a Baseline

Planning and implementing a water management program begins with understanding the organization's water usage. This helps focus improvement measures and establishes a baseline for measuring progress.

Submeters throughout a facility can establish baselines of water use. You can also establish baselines by simply observing and measuring over time. The data you collect will help you plan and evaluate water conservation measures. You can also use it to identify potential leaks – for example, through a spike in water consumption in a particular area.

Developing the baseline uses information available to the facility manager:

- **Water and sewer use data** are typically available on the utility bills. In many areas, the bill will provide separate categories, such as irrigation water versus indoor water use. If those charges are not from separate meters, you can still figure out the irrigation charges by comparing water use in the irrigating and non-irrigating seasons. To establish a baseline, you can also compare monthly water use over multiple years. This analysis may help FM catch issues such as leaks. It should also reflect known changes in water use.
- The FM team will want an inventory of **water-using fixtures, equipment, systems and processes**. This information should include the expected performance of that equipment, such as gallons or liters per flush (g/lpf) for toilets, or gallons or liters per minute (g/lpm) for faucets. The FM team can take advantage of these in-person visits to note or repair any equipment that is leaking or not working properly.

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- The facility manager should also identify the **sources of water on the site**. These may include:
  - Potable water, which is water that is approved for human consumption.
  - Non-potable water that is from natural freshwater sources but is not treated for human consumption.
  - Onsite alternative water, such as rainwater, gray water, air-conditioning condensate or other reused water.
  - Purchased reclaimed water that has been diverted and used for beneficial purposes, such as irrigation. (WaterSense, 2012).

With this information, the facility manager can conduct a process called a water audit or water assessment. A water audit looks at four different types of water uses:

- Leaks
- Domestic indoor water uses
- Non-domestic indoor uses
- Outdoor water use.

Water audits, like energy audits, can have different levels of detail. A basic water audit requires little to no advanced knowledge of analysis techniques and may lead to many efficiency gains. Advanced audits may require more numerical analysis and specialized equipment, such as sub-meters. An excellent resource to guide a facility manager through a water audit is the *Water Efficiency and Self-Conducted Water Audits at Commercial and Institutional Facilities – A Guide for Facility Managers* published by the South Florida Water Management District (Wanvestraut, 2013).

Evaluate Opportunities

Work with key organizational stakeholders to evaluate improvement opportunities. Start with easy wins, such as educating occupants, looking for malfunctioning equipment, implementing aerators in faucets and reprogramming irrigation systems. Consider relatively low-cost means of catching water waste early, such as flow meters on irrigation lines. Brainstorm to identify more sophisticated water management techniques. The goal of this process is to get a sense of the level of improvement that you can reasonably attain with the resources available.

Goals and Commitment

The next step is to set goals and get a commitment from the demand organization's leadership. To show alignment, link the goals to the organizational sustainability strategy and objectives. If timed properly, you may formalize the details of the program in a budget

request or a business case. For certain recommendations, you may need approval from the organization's leadership for any deviation from a standard.

Case Study

An organization has multiple facilities in a semi-arid geographic zone. After multiple years of severe drought, the area was under watering restrictions and struggling to maintain its bluegrass turf. The organization's standard was to have large areas of beautiful green turf, but neither the organization nor visitors ever used those areas. Neighbors and customers of the facilities commented on the dry condition of the lawns. Trying to maintain the vast areas of turf with limited irrigation was frustrating the landscape maintenance staff. No capital budget was available to implement a major landscape modification project.

1. As the facility manager of this organization, what would you do first?

The team developed a plan and presented it to the governing board. The team presented the challenge, the options they'd identified, and their recommendations. They pointed out the financial savings, which included reduced water usage as well as reduced landscape maintenance costs. Under the new plan, native grass would gradually take over the outer portions of the landscape. Irrigation would be phased out by zone until it was finally eliminated. As the bluegrass species was dying out, native seed was sewn, and invasive species were carefully controlled. The irrigation that had been saved now watered the remaining turf areas. Irrigation levels now fell within the acceptable levels, and the organization met its goals for the appearance of the site. With a clear understanding of the problem, the process that had been followed to identify the solution, the stakeholder input, and the cost/benefit of the proposed change, the board approved the plan.

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2. What do you think happened after the plan was implemented? Do you think it was successful? Why or why not?

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Lesson 2: Minimizing Utilization of Potable Water

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Understand the importance of reducing water loss.

Reduce Water Loss and Educate Users

According to WaterSense (2017), a leaky faucet that drips at a rate of one drip per second can waste more than 3,000 gallons (11,356 liters) of water per year. For an organization that uses millions of gallons/liters of water per year, the financial and local resource impact can be significant.

In many parts of the world, potable water usage is the basis for wastewater treatment costs. In other words, the more water your facility uses, the more you are likely to pay for sanitary sewer or other wastewater treatment processes. This provides added incentive to decrease water use.

The simplest way to detect leaky faucets (or toilets that fail to shut off properly after refilling) is to ask the maintenance staff and occupants to report the drips. Many occupants of a facility want to be a part of conservation efforts and look for opportunities to contribute.

Other suggestions include:

- Report landscape sprinkler heads that do not operate at the right time, or that hit hard surface instead of landscape.
- Ask occupants to shut off the water while scrubbing hands.
- Train facilities and custodial staff to look for, listen for, and report water leaks. Janitorial closets that are only visited once or twice per day can hide substantial water flows.
- Monitor HVAC equipment locations for unexpected water flows.

Other high impact but relatively low-cost measures include:

- Install flow meters on irrigation lines to detect and report leaks before thousands of gallons are lost.
- Check water meters or utility invoices for unusual usage.

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- When facilities are not occupied, use the water meter to determine if water is flowing that should not be. Use phones or radios between a person at the water meter and a person at a toilet or faucet to check that the equipment is not using more water than it should. For instance, if a toilet designed for 1.6 gallons per flush registers 3 gallons, you need to resolve an equipment issue. Use that data to track down unexpected water flows.

Monitoring and Measuring

Monitoring and measuring water use will help an organization reduce water waste. To do this, you must first identify the sources and quantities of that waste and check for anything out of the ordinary. The ENERGY STAR Portfolio Manager, also discussed in the Energy chapter, is a resource to help track and monitor water (and energy) use.

Water-efficient Equipment

Water-efficient equipment has become the norm rather than the exception. You should look for this type of equipment and ensure that it is installed and working properly. If existing equipment is not already water-efficient, you can calculate the payback period for replacing that equipment. For most "user" equipment (bathroom fixtures, kitchen fixtures, etc.) the payback will be quite short. Also, your local utility may offer free or low-cost surveys and provide incentives to make improvements.

Consider these pieces of water-efficient equipment:

- **Water-efficient equipment for restrooms** includes:
  - **Aerators for sink faucets** can reduce water flow by thirty percent or more without impacting performance.
  - **Low-flow or dual-flush toilets** can reduce a flush from 7 gallons to either .8 or 1.6 gallons per flush. The early low-flow toilets were not always effective at flushing waste away. Today's models are quite efficient at removing waste. In many cases, they are superior to standard flush.
  - **Waterless urinals**. The public did not respond well to early models. When cartridges are installed properly, models available now are widely used and well accepted.

- **Break rooms and kitchen facilities** can benefit from the following:
  - Instead of hand-washing dishes, using a **dishwasher** cuts potable water use from 27 gallons (102 liters) per load to 3 gallons (11 liters) per load. (Bradford, 2017).
  - **Faucet aerators** are easy to install and generate significant savings.
- **Irrigation efficiency:**
  - Irrigation efficiency starts with the **controller**. The payback period to replace an older model standard irrigation controller with a smart controller is short. You can program smart controllers for the specific irrigation needs of the vegetation, the slope and the type of soil. Based on levels of humidity and precipitation, you can measure and modify irrigation cycles.
  - Smart controllers can water in **soak-cycles**. Rather than watering in a single spot for a long period, soak-cycles rotate through each zone in short cycles. This gives the water time to penetrate the ground to the roots before the next short cycle starts. Roots grow deeper, so plants need less water and are better able to tolerate droughts.
  - Evaluate and adjust the type of **irrigation heads** and the **zoning** of the equipment. Where you need targeted watering, drip irrigation or bubblers may be more efficient. High-efficiency nozzles or heads in other zones can apply water evenly.
  - **Irrigation leaks** can be particularly difficult to detect. Landscape management teams should regularly test the irrigation operation in each zone and watch for a change in the water pressure to the system. Another way to detect leaks is to watch the meter when the facility is unoccupied, and no mechanical systems are operating.
  - Install **Flow meters** between irrigation mains and zones. Program them to electronically notify of unexpected water flow. These devices can catch irrigation breaks before they cause costly damage.
  - Use **landscaping plants** that require little water. For example, California changed from grass to natural
- **HVAC Equipment Efficiency**
  - Depending on the equipment, significant amounts of water can be used in heating and cooling. This water is sometimes called process water. Dempster estimates that HVAC operations account for 48 percent of a building's water consumption. Most water loss from cooling towers is due to evaporation (the drift of water droplets with exhaust air) or blowdown (intentional draining of water from the system to maintain the appropriate chemical balance). Optimizing your HVAC system will save both water and energy. (Dempster, 2019).

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Lesson 3: Methods to Reduce Water Waste

Lesson 3: Objectives

On completion of this lesson, you will be able to:

- Identify methods to reduce water waste.

Rainwater Harvesting

For facilities with a large roof area and a significant demand for non-potable water, rainwater harvesting can be useful. This is particularly true in regions where rainwater is plentiful. You must account for the storage space. Building officials must approve the means of reintegrating the water. By recycling this water, a facility manager can save significant amounts of water.

For locations **that allow** for rain water harvesting:

- You can use a Reverse Osmosis Deionized (RODI) unit to access blowdown water from a recycling cooling tower. Blowdown water ejects heavy mineral-concentrated cooling water directly into the sewer.
- Rain water shed from the exterior of the facility (generally from the roof) is stored and reused for non-potable purposes, such as irrigation, laundry, toilets, etc.
- You must account for the storage space. Building officials must approve the means of reintegrating the water. By recycling this water, a facility manager can save significant amounts of water.

For locations that **do not allow** for rain water harvesting:

- In some areas, water appropriation laws do not allow rainwater harvesting. In Colorado (U.S.), the water appropriation rights referred to as "first in time, first in right" prevented any rainwater harvesting. Facility Managers should check the laws where their facility is located.
- In 2016, a new law was passed that allows residential homeowners to collect a total of 110 gallons from rooftops. (NCSL, 2018).
- No commercial rainwater harvesting is permitted. As with any method that reduces water waste, the diversion of the water from the sewer system benefits that municipality.

Greywater

Greywater harvesting is a water reclamation method that reuses water that was used in washing machines, tubs, showers, and bathroom sinks. Rather than allowing this water to go into the sanitary sewer system, it can be used for non-potable purposes. Greywater is diverted from the waste cycle and processed through a combination of filters, solids, aeration, and biological treatment. The treated greywater is stored on-site and recycled for applications such as toilet flushing, condenser water, and site irrigation. Initial investments for greywater systems are significant. If designed into new construction, the systems are much more reasonable. In some particularly drought-stricken areas, this type of system may be the only way a facility can operate. Carefully analyze the costs and anticipated benefits before implementing a greywater system. (Spigarelli, 2012).

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Chapter 3: Progress Check

1. What are the four basic principles in water management?
   a. Reduce waste, increase efficiency, educate users, and reuse discharged water
   b. Control usage, increase efficiency, educate users, and reuse discharged water
   c. Reduce waste & control usage, educate users, increase efficiency, reuse any discharged water
   d. Recycle, collect rainwater, educate users, and increase efficiency

2. How much annually is wasted from a water faucet leaking at a rate of one drip per second?
   a. 10,000 gallons (37,854 liters)
   b. 5,000 gallons (18,927 liters)
   c. 3,000 gallons (11,356 liters)
   d. 2,000 gallons (7,571 liters)

3. What is process water?
   a. Water used in supplying heating and cooling
   b. Water used for organizational chemical processes
   c. Water that is a combination of wastewater from kitchen sources
   d. Water that is a combination of wastewater from bathroom sources

4. What is the purpose of a flow meter on an irrigation line?
   a. To detect leaks early
   b. To report the water pressure in the line
   c. To control the distribution of water for the irrigation system
   d. To terminate the water connection after the watering cycle is complete

5. What is rainwater harvesting?
   a. Rainwater is stored and reused for watering the exterior grounds of the organization
   b. Rainwater is of reused for non-potable purposes such as irrigation, laundry, toilets, etc.
   c. Rainwater is the collection of water in a big container and sterilized for drinking.
   d. Rainwater is stored and reused to flush toilets.

6. What are acceptable uses of greywater?

   a. Showers, and bathroom sinks
   b. Toilets and lawn irrigation systems
   c. HVAC equipment and chillers
   d. Saunas and hot tubs

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Chapter 4: Materials and Consumable Management

Lessons

- Objectives
- Lesson 1: Introduction to Materials and Consumables Management
- Lesson 2: Renewable Resources
- Lesson 3: Minimizing the Use of Substances that Harm Health and the Environment
- Lesson 4: Purchasing Materials & Resources that Promote Ethical Behavior & Corporate Social Responsibility

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Objectives

Chapter 4: Objectives

On completion of this chapter, you will be able to:

- Understand the product life-cycle.
- Understand the benefits of sustainable procurement.
- Define the concept of renewable resources.
- Identify how biodegradable and natural materials can be utilized as an alternative to those that are hazardous to health and the environment.
- Define social responsibility and ethical behavior as it relates to procurement.

Materials and Consumable Management

The best way to accomplish these goals is to develop a sustainable procurement policy and ensure it is followed.

Purchasing is buying or placing orders under the umbrella of a procured goods or service contract. Procurement is an organization's formal agreement for the purchase of goods and services. Purchasing is simply the act of acquiring something. Procurement includes the components of the supply chain (logistics, transportation, packaging, etc.).

In our earlier discussions, purchasing meant buying things at the lowest possible price. The bottom line was the most important thing for any organization: staying within the budget or getting an item as cheaply as possible, maximizing profit. Sustainable procurement expands the definition of "price" to include costs associated with the entire product or service life cycle as well as the impact on the environment and people.

Facility managers may share the purchasing responsibility with other departments, such as purchasing/procurement and finance. If an organization has committed to sustainable procurement, facility managers must consider sustainability in their purchasing practices and be able to justify their choices. They may need to seek out new providers and bring sustainable options to the organization.

When considering a potential provider or supply chain partner, you will have to look at factors such as:

- Ability to meet the organization's requirements for product performance,
- Level of quality control.
- Stability of pricing.

- Timeliness of delivery.
- Miscellaneous added-value items, such as the ability to warehouse and manage inventory for the facility.

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Lesson 1: Introduction to Materials and Consumables Management

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Understand the product life-cycle.
- Understand the benefits of sustainable procurement.

Materials and Consumable Management is Extensive

As they begin to work in the profession, few facility managers learn about materials and consumables management. They probably simply understand it in terms of the acquisition and proper storage of materials when needed to do work.

Materials and consumables management is far more extensive. It includes:

- Using and reusing materials more efficiently throughout their life cycle.
- Ensuring that the products purchased are not harmful to the facilities and stakeholders.
- Confirming the production and later disposal of the products are not harmful to the environment.

Product Life Cycle

The life cycle of a product can be viewed as a process that starts with the extraction of the raw materials needed to make the product along with manufacturing, distribution, usage and, finally, end-of-life management (through reuse, recycling, energy recovery or placement in a landfill). (EPA)

- **At the extraction level**, the principles of sustainable management suggest that the materials should be limited to those that are sustainable or renewable. They should be harvested or extracted using only methods that do not adversely impact habitat, species or environment.
- **At the production level**, sustainable materials manufacturers design the products using fewer resources and only materials that contain no harmful chemicals or

toxins. They also consider the use of recycled or biodegradable material in packaging, the means of transportation, and impacts of the ultimate disposal of the product.

- **Distribution and delivery of materials** are examined for efficiency and impact. Again, manufacturers evaluate the packaging to ensure that the product is packaged to minimize waste while promoting efficient transport and sufficiently protecting the product during distribution. They ensure that all parties in the supply chain engage in ethical and responsible practices.
- Naturally, **usage** is the most important factor for most consumers. Consumers decide whether the product serves the intended purpose and is as durable as is needed.
- Sustainable materials management also asks questions if the use and later **disposal** of the product adversely impacts other resources, increases pollution or is harmful. Products that are easily broken down into separate elements for proper disposal are more environmentally friendly than those that offer no choice but disposal in a landfill.

Sustainability and Costs

Some organizations will base their mission, vision and brand on their CSR goals. Procurement of any sustainability initiative or project should consider the following financial factors:

- Acquisition costs:
  - The total cost of the purchase, including solicitation, planning, purchase, transport, installation, finance and taxes.
- Ownership costs:
  - Operation and maintenance costs, warranty costs, costs associated with training, risk/insurance/liability, opportunity costs, downtime costs, utility cost, and upgrading cost.
  - End-of-Life costs.
  - Replacement costs.
  - Disposal costs.
  - Environmental costs.

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Labeling Standards and Certifications

Two labeling standards provide comprehensive environmental data regarding products:

- **Environmental Product Declaration (EPD) and Product Environmental Profile (PEP).** These are environmental declarations that conform to the ISO standard, ISO 14025 Environmental labels and declarations – Type III environmental declarations – Principals and procedures. They provide specific and verifiable information about a product through its life cycle. The declaration lists what resources in what quantities were used in the extraction and production of the resource, how the item is transported, use recommendations, and end-of-use recommendations. It gives information on the use of recycled content and recyclability. The PEP profile provides information needed to meet nearly any global sustainability certification evaluation profile. Companies that participate in the very exhaustive process required to achieve EPD or PEP labels have made a significant commitment to sustainable manufacturing.
- **Health Product Declaration (HPD) Open Standard** contributes to consistent, standardized reporting of product contents and associated health information for products. The program is compatible with numerous rating and certification standards, including International Living Future Institute, Cradle-to-Cradle Products Innovation Institute, Clean Production Action, Business and Institutional Furniture Manufacturer's Association (BIFMA), LEED, WELL, and others. HPDs can be searched at https://www.hpd-collaborative.org. (HPD. N.D.)

Facility Manager's Point of View

From a sustainable point of view, facility managers should be able to:

- **Determine a product's total cost of ownership and its life-cycle costs.** Total cost of ownership (TCO) is a financial management strategy that accounts for the complete life-cycle costs of a product (both direct and indirect) from acquisition to disposal. From a facility manager's perspective, TCO is useful because it provides a more complete cost comparison. It reflects not only the cost of acquisition but also the cost of operation and ancillary costs. When costs are viewed over time, changes in cash flow may support sustainable purchasing options.
- **Ensure the validity of sustainability claims.** The facility manager must determine the validity of sustainability claims and not be swayed by the green-washing (false claims of sustainable activities and impacts). The most common method of validating a product's sustainability claim is a third-party certification. Acceptable certifications are conducted by an independent, neutral party with no interest in the manufacturer being certified.

  Increasing demand for sustainability has driven manufacturers to automatically provide life-cycle performance information as well as information on sustainability

features. This information is generally available through the manufacturer's website, on material cut sheets or by request to the manufacturer.

Benefits of Sustainable Procurement

Adopting a sustainable procurement policy benefits an organization:

- By adopting a wider approach to whole-life costing, controls costs.
- Through performance assessments, improves internal and external standards.
- Complies with environmental and social legislation.
- Manages the organization's risk and reputation.
- Builds a sustainable supply chain for the future.
- Involves the local business community.

Barriers to Sustainable Procurement

Within an organization, little or no knowledge of sustainability, poor training and lack of accountability are significant barriers to building supplier capacity with sustainable suppliers. Other common barriers and some ideas on how to address or overcome them are listed below:

- **Lowest price.** Greater consideration must be given to more areas than just price. For organizations where the lowest bidder always wins, this is a major shift. Just because an item is sustainable doesn't always mean it is more expensive.
- **Leadership.** The organization must have a consistent message and a champion at the top to emphasize the importance and value of sustainability initiatives.
- **Setting priorities.** In any request for proposal or invitation to tender, organizations should clearly state their intentions regarding sustainability. They must require that appropriate solutions be addressed in any responses.
- **Improving the supply chain.** In the past, a limited number of vendors offered sustainable products and processes. That is no longer the case. Reliance on only one supplier is not a good business practice, no matter the initiative.
- **Verifying product claims/certifications.** Use reliable third parties, such as the Global Ecolabelling Network, to help verify a vendor's sustainability claims about their product.

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Building a Sustainable Supply Chain

According to **"Supply Chain Sustainability: A Practical Guide for Continuous Improvement"**, supply chain sustainability is the management of triple bottom line impacts throughout the life cycles of goods and services. It also encourages responsible governance practices. The purpose or objective of supply chain sustainability is to protect and grow environmental, social and economic value when bringing products and services to market. Through supply chain sustainability, organizations protect the long-term viability of their business. Emphasis on sustainability has made supply chain management even more complex. Still, sustainable supply chain management is seen as one of the cornerstones of corporate social responsibility.

Why is a Sustainable Supply Chain Important?

Laws and regulations regarding the manufacture, import and export of goods and services may influence an organization to implement a sustainable supply chain. Internal and external stakeholders also influence organizations to become more responsible for the social, environmental and economic impacts of the organization. By meeting the legal requirements and seeking to improve the environment through the management of their supply chain, organizations meet their own needs and those of society at large.

Steps to Build a Sustainable Supply Chain

Building a sustainable supply chain is about finding a process that can guide decisions regarding organizations within the supply chain. The process will include the following steps:

- **Ensure organizational commitment to a sustainable supply chain.** This may involve selling the benefits of sustainable supply chains to management. These benefits include:
  - Reduced risk from supplier misbehavior and non-compliance.
  - Reduced carbon footprint.
  - Helping to grow a competitive market of sustainable products.
  - Providing a competitive edge or improving the organization's branding.
  - Meeting stakeholders' concerns
- **Establish a good working relationship with selected suppliers.** Facility managers should ensure that suppliers understand the demand organization's sustainability goals and policies and plan for continuous communication and alignment.

- **Measure the impact on the organization's goals.** Facility managers should identify upfront the data that is meaningful in measuring progress toward individual goals. The facility manager must then collect and analyze this data.
- **Monitor the relationship.** It is important to verify compliance. This can be done through either a formal or informal auditing process. Many organizations use a three-step process for vendors that are not in compliance:
  - Step 1: The vendor is given a warning.
  - Step 2: The vendor is put on formal probation.
  - Step 3: The vendor is removed from the program and all contracts are terminated.

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Lesson 2: Renewable Resources

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Define the concept of renewable resources.

Renewable Resources

A **renewable** material is one that can be manufactured or generated quickly enough to keep pace with use. (Garvin, 2018). A **rapidly renewable** material can regenerate itself in ten years or less. Both renewable and rapidly renewable materials can be appropriate choices when harvested responsibly.

Rapidly renewable materials include:

- **Feedstocks, such as linseed, cotton, or sunflower.** These are converted into flooring products, cabinetry, fabrics, insulation, and other building fixtures.
- **Natural rubber, bamboo, hemp, cork, and straw**. Construction and tenant finish products increasingly specify building products made from these materials.
- **Biopolymers such as cellulose, starch, collagen, soy protein, and casein.** They are produced by living organizations and make things like cardboard, corn plastic, and recycled cut glass.

Although recycled materials technically cannot be considered renewable resources, they do meet the intent of the rapidly renewable concept: They are in abundant supply and avoid the use of natural resources.

When purchasing products using wood, look for the Forest Stewardship Council (FSC) seal, which certifies that sustainable growing and harvesting processes were used throughout the production of the product.

Environmentally, renewable resources are considered far superior to products made from virgin, non-renewable, or slow-growth resources, but they do have some drawbacks. The transformation of any resource into a new product carries life-cycle concerns to evaluate, including:

- The resources used to produce the material.
- The use of any chemicals or toxins in the production of the materials and the impact of those on the environment.

- The resources needed to transform the materials into a product.

Protecting Endangered Species

According to the Center for Biological Diversity, plant and animal species are going extinct at up to 1,000 times the natural rate. Habitat loss is the greatest threat to species diversity as human populations clear land for agriculture, housing, roads, logging, pipelines and other development. (WWF,N.D.)

The use of responsibly generated renewable resources protects the habitat of endangered species. The less extraction from the earth, the more protection for land and habitats. By reusing and repurposing existing resources, we reduce our reliance on raw materials and our contamination of lands.

Beyond the use of renewable resources, we can help protect endangered species by:

- Controlling the use of harmful chemicals in outdoor environments.
- Ensuring that the development of new land does not threaten species by dividing habitat, forcing wildlife to cross developed roads or limiting the availability of the housing, food, and water required for support of life.
- Buying recycled products which reduce the need to extract raw materials.
- Researching the origin of the products that you purchase and refusing to purchase those that are either made from species nearing extinction or those that are produced in a way which threatens those species.

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Lesson 3: Minimizing the Use of Substances that Harm Health and the Environment

Lesson 3: Objectives

On completion of this lesson, you will be able to:

- Identify how biodegradable and natural materials can be utilized as an alternative to those that are hazardous to health and the environment.

Common and Abundant Hazards

Renewable energy resources reduce our reliance on fossil fuels, and that benefits wildlife. Unfortunately, wind, solar and hydro energy can destroy habitats and kill wildlife, including some on the endangered species list. (Robbins, 2014) If we do not use renewable resources, we will continue to degrade the habitat, and our climate will further deteriorate, creating an even greater threat to wildlife. To address this dilemma, as renewable energy resources are expanded, new attention is being paid to siting. For example, you can place wind power cooperatives in areas designed to minimize the impact on known migration paths of birds. Solar resources can take advantage of existing structures or already-developed sites rather than stretches of native land.

Substances that are harmful to health and the environment are surprisingly common and abundant. Here are just a few examples:

- Chemicals used to package, flavor, color or preserve foods may contain substances that are harmful to humans.
- Chemicals that are used to protect and encourage the growth of fruits, vegetables and animal stock may be harmful to the health of those consuming the products.
- Products that are not recycled at end of life end up in landfills. Either during transport to the landfill or at the landfill, many of these leach chemicals which are harmful to the environment.
- Cleaning chemicals commonly used in facility custodial services can contain hazardous chemicals that leave residue on surfaces.

Minimizing the use of products and substances that can harm health and the environment does not require you to use only natural products. But to minimize the potentially negative

impacts of their choices, consumers need to think before purchasing materials. For instance

- Rechargeable batteries are not appropriate for all uses. Where appropriate, they reduce the number of batteries that need to be recycled and properly disposed of.
- "Green" cleaning chemicals may not meet the need for all applications. Products with fewer toxins known to be harmful to humans and the environment can be used.
- Many packaging alternatives to Styrofoam exist.

Use of Biodegradable Materials

Packaging

Many products that once were packaged in Styrofoam are now available in recycled paper cartons or upcycled corrugated cardboard. These include food products as well as electronics, various consumer products, and many supplies. Work with suppliers to request natural packaging wherever possible.

Mycelium is a relatively new product on the market, but it is already in wide use for packaging in place of Styrofoam. Mycelium is a multicellular yeast that can be rapidly grown into predictable forms and is being used to help replace plastics. (Bayer, 2019).

Architectural Materials

Many architectural materials are gaining popularity, or regaining attention as biodegradable resources, including the following:

- **Cork**. The harvesting of cork causes no harm to the tree, and the resource removed regrows within ten years. Cork is fire-retardant, has acoustic qualities and is waterproof. (Thorns, Ella. 2018).
- **Finite**. Finite is a relatively new material that you can use to build temporary structures, then leave to naturally decompose. It is made from desert sand, which is abundant, and the material is non-toxic. When the structure is no longer needed, you can remold the material for use in another project. (Construction Climate Challenge. 2019, February 15).
- **Linoleum** is made from natural materials like linseed oil, flax, pine rosin, powdered cork, limestone and natural resin. Linoleum is long-lasting, does not emit VOCs, and is biodegradable. (Riha, N.D.)

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In North America, look for the BPI (Biodegradable Products Institute) logo. Products that have earned this logo have been independently tested and verified as biodegradable. For more information about the requirements for earning the logo, go to https://bpiworld.org/

Use of Natural Alternatives

Packaging and Food Service

Styrofoam has become one of the most popular, affordable, and convenient materials for transporting meals, serving food, and storing leftovers. Many consumers do not know that Styrofoam can release toxic chemicals into food, particularly when heated. When exposed to sunlight, Styrofoam creates harmful air pollutants. Styrofoam is not biodegradable. In fact, it may take as long as 500 years to biodegrade. Approximately one-third of the waste in our landfills is packaging. Recycling of Styrofoam is extremely limited (Collier County, ND).

Packaging and food service alternatives to Styrofoam include:

- Bamboo or corn-based serving dishes.
- Cornstarch, mushroom and seaweed packaging are organic and cost-effective.
- Organic fabrics can replace plastic bags in packaging. At end-of-life, they biodegrade in 100 days. (Johnson, Amanda. 2019, July 8)
- Corn and sugarcane can be converted to 100 percent vegetable packaging, such as bottles and bags. (Shippr, 2019)

Lesson 4: Purchasing Materials & Resources that Promote Ethical Behavior & Corporate Social Responsibility

Lesson 4: Objectives

On completion of this lesson, you will be able to:

- Define social responsibility and ethical behavior as it relates to procurement.

Definition Social Responsibility and Ethical Behavior

What is seen as socially responsible and ethical in one culture may be perceived differently in another.

Making ethical and socially responsible decisions starts with understanding the demand organization's values. For example, many organizations have purchasing policies that give preference to a specific business sector, such as minority, women or veteran owned.

You will need to know the values that your organization supports. These are driven by culture, tradition and many other factors. Is the focus on:

- Environmentally responsible practices for acquiring resources and manufacturing?
- Socially driven factors, such as fair pricing for raw material producers or fair and equitable labor practices?
- Political values?

Many manufacturers and suppliers provide corporate social responsibility (CSR) statements on their web sites. This makes it much easier to understand their practices. For example:

- FedEx explicitly states a commitment to combating slavery and human trafficking, to data security and privacy, to public policy engagement, and to environmental policy.
- Mitsubishi Electric Group publishes an annual CSR report highlighting the global organization's values and actions in support of those values.
- Kirin Brewery Company publishes an annual report that addresses its social initiatives as well as its initiatives for environmental management, packaging, resource recovery, and other factors.

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- Tata Group CSR statement states, "We believe Corporate Social Responsibility is a critical mission that is at the heart of everything we do, how we think and who we are. Tata group is committed to integrating environmental, social and ethical principles into the core business, thereby enhancing long-term stakeholder value and touching the lives of over a quarter of the world's population.

  In addition to CSR statements, much information about the ethics and social responsibility practices of a publicly held manufacturer or supplier can be found in the stock reports for that organization.

Socially responsible purchasing is a complex process that requires definition and research. Finding the right trade-off between being socially responsible and being financially responsible can be a balancing act. Let the organizational policies around the purchase of materials and resources guide you.

Fortunately, many resources are readily available to assist you. To achieve this balance, you need to understand the demand organization's values and existing policies, research the practices of suppliers, and validate any claims regarding the characteristics.

ISO 26000 Guidance on social responsibility offers guidance to organizations who are developing social responsibility programs. It is also a way to assess an organization's overall commitment to sustainability.

Chapter 4: Progress Check

1. What is the first phase of a product life cycle?

   a. Extraction of raw materials
   b. Design products to use less resources
   c. Distribute and deliver product
   d. Stop using the product

2. The environmental product declaration conforms to what standard?

   a. ISO 41001 FM Management System
   b. ISO 14005 Environmental Management System
   c. ISO 14025 Environmental labels and Declarations
   d. ISO 26000 Guidance on Social Responsibility

3. What is one criterion for defining a rapidly renewable material?

   a. The material can regenerate itself in 20 years or less
   b. The material can regenerate itself in ten years or less
   c. The material can regenerate itself in five years or less
   d. The material can regenerate itself within one year

4. Name the best alternative to replace the use of Styrofoam for food serving dishes.

   a. Bamboo leaves
   b. Corn-based materials
   c. Paper bags
   d. Plastic bags

5. What does CSR mean?

   a. Customer service representative
   b. Customer service referral
   c. Corporate social responsibility
   d. Corporate social risk

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Chapter 5: Waste Management

Lessons

- Objectives
- Lesson 1: Introduction to Waste Management
- Lesson 2: Procurement Activities that Promote Consumption of Materials to Appropriate Levels
- Lesson 3: Recycling and Waste Diversion
- Lesson 4: Waste Disposal Techniques that do not Harm the Natural Environment

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Objectives

Chapter 5: Objectives

On completion of this chapter, you will be able to:

- Explain the importance of managing waste effectively in all operations.
- Identify procurement activities that effectively manage waste.
- Understand the principles and practices involved in recycling waste.
- Utilize waste management techniques in a way that is environmentally responsible.

When the term waste management is discussed, thoughts automatically turn to trash and recycling. Waste is any output material that is being disposed of from a product system, usually no longer wanted or needed. Waste management is the practice of collecting and disposing of the waste. The source of waste is post-consumer or post-industrial.

- **Post-consumer** waste is the output material that has been "used" and disposed of. It has served its intended use and has been diverted and recovered for recycling. These items are part of a broader category of recovered materials.
- **Post-industrial** waste is generated by industrial or manufacturing processes. Not often considered recycling in the traditional sense, it reintroduces the waste back into the industrial process.

The World Bank provides the following statistics:

- The world generates 2.1 billion tons of municipal solid waste annually. At least one-third of that is not managed in an environmentally safe manner.
- Global waste is expected to grow to 3.40 billion tons by 2050. The growth in solid waste is predicted to be more than double the population growth over the same period.
- High-income countries, which account for only sixteen percent of the world population, generate more than one-third of that waste.

In many European countries, waste management is regulated by law and directives, which include comprehensive reporting duties for FM.

Much of our waste worldwide ends up in locations that harm health or the environment. The photos reproduced above show feature sculptures that are a part of a traveling exhibit titled "Washed Ashore". The sculptures are created entirely of plastic and Styrofoam pollution fished from the Pacific Ocean.

Waste management provides opportunities for much more than just managing trash and recycling. Facility managers are in a unique position to impact waste management in their organizations and to raise awareness of waste practices well beyond the work. Opportunities include purchasing and custodial practices, facility maintenance operations, and construction, as well as day-to-day waste disposal.

Sustainable waste management is described using a hierarchy, listed here from the highest environmental impact to lowest, which includes:

- Disposal
- Energy Recovery
- Recycling
- Reuse
- Minimization
- Prevention

The more that we can successfully divert from landfills, the more that we can keep from contaminating the environment.

Together, these can help create waste management goals based on:

- Creating the least possible waste.
- Making the best use of the resources that we have.
- Properly disposing of those resources when they can no longer be used.

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Lesson 1: Introduction to Waste Management

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Explain the importance of managing waste effectively in all operations.

Facility Managers Take the Lead

Whether an organization is engaged in sustainable practices or not, facility managers take the lead in setting waste management practices. Consider that:

- Waste management is involved in more than just contracting for removal of trash and recyclables from facilities. Facility managers are responsible for educating occupants about acceptable waste practices and providing options for the proper disposal of hazardous items.
- Even though modern landfills are designed to minimize chemicals leaching into water supplies, this type of contamination can occur, polluting water sources. Since solid and hazardous waste may leak during transport, even transporting waste to the landfill can be a source of contamination. (King, 2017). Facility managers are responsible for ensuring that waste transported from their sites does not contain hazardous materials that can worsen that problem.
- Facility managers are familiar with the billing practices of waste management companies. That helps them educate the organization on the benefits of minimizing waste through smart purchasing practices, such as purchasing in appropriate quantities, and purchasing only what is needed.
- Without proper management, organizations may improperly dispose of hazardous materials and chemicals, and not realize it. This could expose them to penalties, fines, and perhaps most devastating, public exposure of unsafe practices that could lead to harm for persons or the environment.
- Facility managers need to understand the process for managing waste that is generated at the site or facility. Their involvement with the waste management process can lead to improved compliance with local and legal rules and regulations.

Waste Collection

Collection Methods

Collection methods vary widely between different countries and even within a country. In urban areas, management of nonhazardous waste is usually the responsibility of local government authorities while management of hazardous waste is usually the responsibility of the generator of that waste.

The two main collection methods are pick up and drop off. In pick up, the waste is taken to a central point where the collection agency picks it up. In a facility, these might be containers in a less visible area. In the drop-off method, the generator of the waste is responsible for collecting, transporting, and dropping off the waste at the collection agency.

Waste Disposal Methods

Disposal methods also vary widely around the world. For example, Australia is a large country with a low-density population. There, the most common method to dispose of solid waste is to send it to a landfill. Japan is a much smaller country, and the land is scarce. There, waste is often incinerated.

Waste Disposal Methods

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- **Landfills**. Disposing of waste in a landfill is the most traditional method of waste disposal, and it remains a common practice in most countries. A well-run landfill can be a clean and relatively inexpensive method of disposing of waste materials. Older or poorly managed landfills can create several adverse environmental impacts, including wind-blown litter, attracting vermin, and the leaching of soluble contaminants into the groundwater. Many countries tax the waste that is sent to landfills usually based on the tonnage that is delivered.
- **Incineration.** Incineration is the process of destroying waste material by burning it. Incineration is still a waste management tool in many countries, especially developing countries. But in these same developing countries, it is becoming a highly controversial practice. The gases and the ash residue produced are uncontrolled and could be toxic. In most developed countries, to reduce the toxic products released into the environment, incinerators use elaborate pollution control

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measures for exhaust gases. Even after taking these extra measures, many environmental organizations are questioning the toxicity of the pollutants released during incineration.

- **Resource recovery.** A recent shift in thinking has caused waste material to be considered a resource as opposed to a burden, a potential source of income rather than a liability. There are many ways to recover the latent value in waste, some more costly than others. New technologies for waste recovery are emerging, but many are quite costly. Three of the more common resource recovery methods that facilities throughout the world use are:
  - **Recycling** – The process of reusing a material (beyond its intended use) or producing a new product from recycled materials. An example of recycling is the widespread collection and reprocessing of single-use beverage containers (plastic, glass or cans).
  - **Composting** – A process that decomposes the organic matter and kills any pathogens. The output is then recycled as mulch or compost for agricultural or landscaping purposes.
  - **Thermal treatment, including pyrolysis and gasification** – A process in which materials are incinerated at extremely high temperatures with limited oxygen. Converting material to energy this way is more efficient than direct incineration, with the ability to recover and use more energy. Gasification is used in biomass power stations to produce renewable energy and heat.

Lesson 2: Procurement Activities that Promote Consumption of Materials to Appropriate Levels

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Identify procurement activities that effectively manage waste.

Construction & Renovation Projects: Large Waste Streams

Construction and renovation activities can create large waste streams. Many practices during construction and renovation can make the process more efficient, save money, and meet waste management goals. Among these:

- Most raw materials for construction come in standard sizes or quantities. Designers and contractors can make smart decisions about materials that will not only save money but will save waste.
- For proper disposal, all waste generated in a demolition or deconstruction project can be separated by type. A general contractor should know and have resources for this.
  - Even if the contracting organization has no interest in recycling, the contractor will benefit from recycling metals. Steel, copper and other metals will bring enough at a recycler to pay for the effort of segregating and transporting the waste.
  - Reuse some materials in the project, either in their present state or in some modified state.

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- Some elements may be repurposed or donated. Depending on disposal regulations for the organization, individuals or charitable organizations may be willing to recycle furniture, doors, hardware and even electrical components that are in good condition. If the demand organization is not able to repurpose, they can salvage the items to the general contractor or to an organization that specializes in salvage. The salvage operator may elect to take materials to a not-for-profit home builder warehouse or other location.
- Any materials with hazardous content, such as lead-based paint, lamps with mercury or other toxic elements, and electronic waste should be properly dismantled, segregated, and disposed of.

Lesson 3: Recycling and Waste Diversion

Lesson 3: Objectives

On completion of this lesson, you will be able to:

- Understand the principles and practices involved in recycling waste.

Recycling

Recycling has been a key focus of sustainability efforts for many years. Recycling is gaining more prominence and is globally accepted. Worldwide, the packaging is labeled with information about whether and how the product can be recycled.

In response to the declining markets for recycling and recycled goods, recycling guidelines are now changing. This is causing a necessary shift in focus and a need to be aware of recycling guidelines and waste management practices.

Currently, less than ten percent of the more than 300 million tons of new plastic produced annually are recycled. The markets for recycled goods have shifted: What was once the profitable activity of collecting and recycling plastics to create new products has become a depressed market. It is more cost-effective to produce virgin plastic than to recycle materials. The fact that plastics degrade each time they are processed has further decreased their value. Until 2018, America's primary export to China was plastic for recycling. China is no longer accepting these imports, so recyclers worldwide have been looking for new solutions.

Considering the amount of waste generated throughout the world, every bit of waste diverted from landfills is a measure of success.

Characteristics of a Recycling Program

A successful recycling program should meet the following criteria:

- **The program must be viable.** It should not involve a significant impact on existing work processes.
- **The program should be desirable.** People must want to participate.
- **The program should be adaptable.** It needs to be a phased solution that can expand and decrease with the changes in demand from the organization.

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- **The program should be feasible.** There should be local organizations that also accept recyclable materials.

Recycling Guidelines

Many models for developing a successful recycling program are available. One model is outlined below:

Gain Management Support

Management's role in a successful program is to:

- Implement a company-wide recycling policy.
- Allocate resources (personnel and money).
- Lead by example – reduce waste, recycle, and buy recycled.
- Stay committed and involved.
- Offer incentives to reward staff participation.

Report and provide feedback to both management and occupants, reflecting their interests in the program. Depending on local requirements, facility managers may also be expected to submit a report to the local authorities.

Conduct a waste assessment

To conduct a waste assessment, a facility manager first determines what kind of waste the organization is currently generating, and where in the facility it is being generated. The highest volume of materials are called targeted materials. Build a recycling program around these materials and target areas with high waste volume.

Design the program

A good recycling program includes five aspects:

- **Removal.** Either by a recycling service provider or by self-hauling. The facility manager must select a service provider who can meet the facility's needs in terms of volume, types of materials collected, frequency of pick up and compliance.
- **Collection.** Single stream recycling is easier for occupants than dual stream recycling, which requires recycled materials to be separated by type. A successful facility recycling program makes the process as easy as possible – ensuring that there are ample recycling bins in the most appropriate places and providing explanatory signage. Facility managers must also plan for temporary storage of recyclables between scheduled pickups.
- **Education.** Before the program is implemented, facility managers should consider who they need to communicate with, what information needs to be communicated,

and how best to communicate that information. Communication programs are discussed in more detail under implementation of the recycling program.

- **Policy**. The organization should have policies and procedures that communicate the company's commitment to both waste reduction and recycling. Having this clear vision will help with goal setting and ensure management support. The policy should be communicated companywide.
- **Purchasing**. Sustainable purchasing decisions can greatly support recycling programs. One way of showing support is to make it a company practice to purchase products with recycled content whenever possible.

Implement

Items that must be completed prior to the kickoff of the program are:

- Approve the company policy.
- Contract with the service provider.
- Put out the collection bin.
- Communicate the program to occupants.

Regardless of business size, how to effectively implement recycling programs is essentially the same. At its most basic, implementing a successful recycling program has three components.

- Make it easy.
- Promote the program and motivate participants.
- Educate staff, occupants and visitors about what's involved.

Monitor & Track

When evaluating the success of a program, specific measurements of the amount of materials being generated are useful. It is important to track revenues both from recycling and from savings, such as lower waste removal bills.

In addition to financial numbers, gather anecdotal feedback from employees, their opinions about what is and is not working.

Reporting recycling program metrics is important and often overlooked. Reporting on the recycling program benefits the organization's efforts to be sustainable by:

- Increasing occupant and organization awareness (line of sight) of the actual amount of tonnage being recycled by the organization.
- Providing data to support requests for additional funding and/or sustainability certification.
- Giving positive feedback to the organization and occupants, celebrating the success of the program.

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- Motivating other occupants to participate.

Continual Improvement & Communication

Like any initiative, once the excitement of the kickoff has passed, you will need to keep all parties informed. Issue recycling program updates on a regular basis. The key is to show people that their participation matters and produces results.

Waste Diversion

To prevent the rapid growth of landfills, waste diversion uses a combination of recycling and source reduction. You can divert waste from landfills in many ways:

- Generate less waste. Some consumers use reusable containers for food storage and for carrying groceries. Using refillable water bottles would save tons of waste. Just consider the impact of one person using one water bottle per day times millions of people.
- While single-serving packaging is convenient for consumers, it generates tremendous waste.
- Rather than going to the landfill, some materials might be useful to others. Consider whether nearby organizations can take advantage of what your organization no longer needs.
- So that materials can be properly recycled, many manufacturers will assist with the return of their used and obsolete products. Examples include:
  - Car battery recycling
  - Propane tank returns
  - Beer keg deposits
  - Many carpet manufacturers will now arrange for proper recycling and disposal of older carpet when new product is installed.
- Consider alternative waste disposal methods, such as composting.
- In some cases, you can convert waste to energy for heating or electricity.
- Consider a pre-demolition walkthrough with a salvage company. Prior to having a general contractor proceed with demolition of building features, materials and equipment, walk through the project with a salvage/recycling company to identify salvageable materials and equipment.

  New requirements designed to prevent the spread of easily transmittable viruses/bacteria are presenting a challenge to waste reduction and diversion activities. This makes it even more important for each of us to help in any way possible, and for facility managers to act as leaders in setting goals for waste diversion.

Protecting the Natural Environment

Given the massive quantities of waste that the world generates every day, every step that we take to reduce waste protects the environment.

Consider the following suggestions for implementation in facilities:

- Sponsor a competition among occupants to generate ideas for reducing waste. Among these may be:
  - Ask occupants to use plastic, glass or stainless straws and take them home for thorough cleaning.
  - Rather than plastic bags and disposable dishes, pack meals in reusable containers.
  - Rather than using disposable water bottles, provide filtered water and washable containers for drinking beverages.
  - Rather than plastic ware, which cannot be recycled in most areas, provide washable dishes and cutlery.
  - Rather than plastic bags, bring food to and from work in recyclable bags.
- To encourage the recycling of batteries so that they do not end up in landfills where they will leach toxic chemicals, create a battery collection point.
- To ensure that electronic waste is properly broken down, the recyclable materials are properly recovered, and any toxic elements properly disposed of, look for and support electronic waste recycling efforts.
- If composting (discussed below) is feasible, provide clear guidelines for what can be composted and what is trash, and ensure that composting containers are checked and properly maintained.

While developing a new waste disposal program (and periodically thereafter), consider performing a waste audit. In short, separately weigh a day's waste and recycled materials. Evaluate each for contents that do not belong, record that information and share it with occupants. Encourage occupants to work toward continually improved scores. This can become a positive information competition between locations. It can also help occupants focus on and accept the organization's sustainability goals.

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Lesson 4: Waste Disposal Techniques that do not Harm the Natural Environment

Lesson 4: Objectives

On completion of this lesson, you will be able to:

- Utilize waste management techniques in a way that is environmentally responsible.

Disposal of Organic Waste

Not all waste harms the environment. Among the techniques for waste disposal that are beneficial to the environment are the proper disposal or recycling of organic waste and composting.

Organic waste includes food waste, paper waste, animal processing waste, landscape (green) waste and some biodegradable plastics.

Organic waste disposal refers to the disposal of quantities of food waste, such as expired foods from grocery stores and waste from restaurants. While disposing of organic food waste into the landfill sounds like it would be a good thing, it can seriously harm the landfill. As it decomposes, it generates methane, which is released into the atmosphere as a greenhouse gas.

Organic waste producers have multiple options to properly dispose of organic waste:

- **Biogas** is generated through a process that uses organic kitchen waste to produce fertilizer and energy. In a single year in Italy, 100,000 tons of organic waste was transformed into 20,000,000 kWh of electricity and 35 tons of compost. (GBE Factory. 2014)
- Composting controls the process of decomposition to turn the organic waste into nutrient-rich soil. The product of composting is high-quality material for improving soil. Commercial composting services may be available in your area, or you may be able to connect with a farming operation that would welcome the organic waste as fertilizer. In a commercial or industrial composting environment, the types of composting are separated into three separate processes:
  - **Windrow composting** is typically used for landscape and garden waste. It is an open-air process where the "windrows" are turned to allow all materials to rotate into the warm, moist center of the pile for decomposition.

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- **In-vessel composting** takes place in an enclosed space and can accommodate food scraps and meat. The mix is rotated to ensure aeration and to encourage the growth of the bacteria needed for decomposition.
- **Aerated static pile composting** piles waste in layers with bulking agents (shredded newspaper, green waste, wood chips) to allow air to pass through. (UrthPact, 2017)

In this chapter, we discussed waste management and the role FM plays in it. We reviewed principles and activities that a facility manager could use to manage risk and discussed the different types of waste and the disposal of organic waste. In Chapter Six, we will look at the workplace and site as it relates to sustainability.

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Chapter 5: Progress Check

1. Which statement is true about waste management?

   a. Waste management is only about contracting for removal of trash and recycling
   b. Waste management includes all the activities from start through final disposal of materials
   c. Waste management is primarily the responsibility of all the building occupants
   d. Waste management is only about the recycling of waste material

2. Given that construction and renovation create large waste streams, which statement accurately reflects waste reduction.

   a. Buy materials in standard sizes and quantities so to minimize the waste
   b. Put waste generated in a demolition project into the same bin
   c. Give all waste generated back to the general contractor for recycling
   d. Donate the waste generated in a demolition project to the schools for use

3. What is the definition of windrow composting?

   a. Is a technique of composting material for landscaping and gardens
   b. Compost piles with large bulking agents such as newspapers
   c. Composts in an enclosed space that can accommodate food scraps
   d. Compost material from coffee scraps

4. Which is the correct order of the phases for sustainable waste management?

   a. Disposal, Recycle, Re-use, Energy recovery, Minimization, Prevention
   b. Disposal, Energy Recovery, Re-Use, Recycle, Minimization, Prevention
   c. Disposal, Energy recovery, Recycling, Re-Use, Minimize, Prevention
   d. Disposal, recycle, reuse, minimize, prevention

Chapter 6: Workplace and Site Management

Lessons

- Objectives
- Lesson 1: Indoor Environmental Quality (IEQ)
- Lesson 2: Standards and Guidelines

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Objectives

Chapter 6: Objectives

On completion of this chapter, you will be able to:

- Identify the elements that impact indoor environmental quality.
- Understand the factors that contribute to thermal comfort for occupants.
- Recall the standards and guidelines that govern a sustainable workplace.

Sustainable workplace management requires using available facility space in the most efficient way possible. Efficient use of the workplace meets basic triple bottom line criteria. In many cases, because it contains all capital costs, this is even more cost-effective than energy management. Many resources are available to assist facility managers just starting on the path toward sustainable FM.

Workplace and site management refers to those aspects of sustainable FM that relate less to saving money or resources and more to providing a productive, safe environment for occupants. That environment is likely to extend beyond the walls of the demand organization's primary facility. In most countries, regardless of where they are working, an organization has a duty of care for its employees while they are working. That extends the definition of workplace and site beyond traditional boundaries.

In addition to available resources, other challenges exist, including:

- In response to global health challenges, evolving guidelines and standards for occupant safety.
- The development of new technologies and procedures for maintaining quality indoor environments.
- In response to organizational need and the preferences and work styles of new generations, rapidly emerging workplace options.

Lesson 1: Indoor Environmental Quality (IEQ)

Lesson 1: Objectives

On completion of this lesson, you will be able to:

- Identify the elements that impact indoor environmental quality.
- Understand the factors that contribute to thermal comfort for occupants.

Indoor Environmental Quality

Indoor environmental quality (IEQ) refers to the conditions inside a facility and their effects on occupant well-being and comfort. Facility managers are responsible for managing IEQ factors, such as:

- Air quality
- Thermal comfort
- Lighting
- Sound and acoustics
- Views and access to daylight

One common element among most of the IEQ factors is that if you provide occupant controls, satisfaction levels will increase. This is a challenge for FM, to balance occupant desire for control over the environment with responsible management of the organization's resources.

Here are some of the ways that facility managers can improve IEQ to maximize occupant safety, satisfaction and productivity.

Indoor environmental quality (IEQ) refers to the conditions inside a facility and their effects on occupant well-being and comfort. Facility managers are responsible for managing IEQ factors, such as:

Heating and cooling

- Facility managers operate the heating and cooling equipment to provide thermal comfort. In providing those resources, they must pay attention to the ventilation and the air exchange rate supplied by the system. The ventilation rate must overcome emissions from air quality contaminants inside of the facility and carry

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those pollutants out of the space. Bringing too little fresh air into space can lead to unsafe levels of carbon monoxide (CO) and trap indoor pollutants in the occupant space. This can bring about health problems and comfort complaints.

- In terms of heating and air conditioning, filters are a complicating factor for IAQ. To meet IAQ requirements, green building standards require a specific MERV rating (Minimum Efficiency Reporting Value) for HVAC filters. Not all HVAC systems are made to accommodate this MERV rating.
- A high MERV rating on an air filter also means that the filter is usually thicker, and the HVAC system will have to work harder to circulate air throughout the facility. When the equipment works harder, the efficiency is reduced. To find the appropriate balance, facility managers need to work with their HVAC technicians and equipment manufacturers.

Mold or mildew

- Mold or mildew can grow in any place where there is moisture, organic matter and limited airflow. While some molds may not cause immediate harm, others can be highly toxic, and some occupants are sensitive to molds. To maintain a productive environment and to protect the demand organization from costly litigation, facility managers must take steps to detect and control the growth of molds in facilities.

Humidity

- Even without the growth of mold or mildew, humidity levels inside a facility can cause problems for occupants and affect their productivity. Humidity levels affect how people perceive air temperature and air quality. When air is highly conditioned and humidity levels are too low (less than 30 percent), occupants may become uncomfortable and experience physical discomfort associated with dry air, such as respiratory difficulty or symptoms of allergies. If humidity levels are too high (over 70 percent), occupants perceive the temperatures as warmer, and productivity, particularly in activities that require substantial physical exertion, may be reduced.

Volatile organic compounds (VOCs)

- Building Materials and furnishings emit **odors and volatile organic compounds (VOCs)** which can cause short- or long-term health issues and odor complaints. VOCs come from glues, paints, cleaning chemicals, pest control techniques, furnishings and even office equipment. Steps that facility managers could take to manage and reduced VOCs in facilities include:
    - **Carefully select products for the facility**. In common facility products in some countries, strict governmental requirements for reduction of VOCs have led to the availability of a wider variety of low- to no-VOC products. You should research and understand the VOC content of any products that you introduce into your facilities.
    - **Increase ventilation**. Allowing more fresh air into the facility removes VOCs and reduces contaminants. Wherever possible when introducing new furniture

or furnishings into a space, temporarily increase ventilation to the space to flush excess VOCs.

- Store paints, glues and materials known to produce high levels of VOCs in well-ventilated spaces. If possible, store these items in a separate storage facility or area.

Cleaning processes

- Cleaning is a common source of indoor air quality complaints. Some occupants are sensitive to odors. When exposed to cleaning residue, they may experience headaches, sinus discomfort or even more serious health issues. Air fresheners used to mask facility odors may be more objectionable than the facility odors themselves. Some laundry soaps used for uniforms or hotel sheets, or spray-on odor eliminators for furniture products, can cause such serious reactions that occupants may not be able to remain in the space. And while some occupants are sensitive to the odors of cleaning products, others believe that if they can't smell the cleaning products, the space has not been cleaned. Steps that facility managers can take to reduce the IAQ impacts of cleaning processes include:
  - Look for cleaning products that are certified under one of the green certification systems, such as EU Ecolabel, Ecomark, Green Label, Green Seal, Ecologo, Safer Choice, etc.
  - Where those products can meet the disinfectant and sanitation needs of the facility, use natural products and processes. Consider processes such as electrostatic fogging or O3 cleaning.
  - Remember that cleaning and disinfecting are different processes. Cleaning visible dirt, dust, tissue and bodily waste from a surface is necessary before a surface can be disinfected.
  - Clean up after cleaning up. The use of disinfectants is a growing environmental hazard. Many disinfectants are meant to be followed by removal of the disinfectant residue by wiping with water. The introduction of disinfectants into a space may also require an increase in ventilation to clear the air.
  - Educate staff and occupants about the cleaning processes used and remind them that clean does not have a smell.

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Occupant Sources

- Facility occupants themselves contribute to indoor air quality challenges. Cosmetics, perfumes and colognes, laundry products on clothing that they wear, residue from smoking, at-work meal preparation, personal hygiene and even normal bodily functions can cause IAQ concerns. Ventilation can ease the impacts of some of these, such as ensuring that exhaust fans are operational in bathroom, breakroom and kitchen facilities. You may have to collaborate with demand organizational leadership on some sensitive discussions.
    - In some organizations, staff are advised (or requested) not to wear perfumes or colognes in the workplace.
    - In others, staff are asked not to prepare high-odor meals in the workplace, such as cooking or re-heating fish.

Outdoor air

- **Outdoor air.** Through infiltration into the facility, either through gaps, cracks, or unplanned openings, or through planned ventilation sources such as operable windows and planned fresh air HVAC exchanges, outdoor air quality impacts IAQ. In areas with high levels of outdoor air pollution, facility managers may need to install supplemental air cleaning systems to provide the fresh air exchange needed. When conducting maintenance activities outdoors that generate odors or use chemicals that can potentially affect users, either reschedule those activities to non-operational hours or temporarily turn off outdoor ventilation to avoid harming occupants. This is particularly important for activities such as asphalt repair, roof maintenance involving glues or tars, and some pest control and chemical landscape applications.

Thermal Comfort

Many organizations have established standards or policies for the temperature range that will be maintained within the facility during operating hours. In fact, facility managers who have not already done so will find great benefit from the practice. Hot and cold complaints are among the most frequent facility issues reported, and they can be a source of much occupant dissatisfaction. Working with organizational leadership to set policy gives the FM team a way to respond and reduces complaints. In fact, where occupants can see a thermometer showing the space temperature and know the accepted temperature policy, they are generally more willing to accept the standard and plan their wardrobe accordingly.

Beyond the minimum and maximum temperature setpoints, facility managers can implement several measures to help with thermal comfort:

- Air velocity is a great factor in thermal comfort. When air is too still, temperatures are perceived to be hotter. When air movement is noticeable, temperatures may be perceived to be cooler. Most systems have a recommendation for air flow, but where adjustments are needed, facility teams can work with HVAC maintenance.
- As discussed in the section on IAQ, humidity affects the perception of thermal comfort and will affect occupant productivity as well as the quality of the indoor air. Humidity levels in the 40-60 percent range are generally considered optimal for commercial facilities. Some industries may set a different standard based on the specific type of business.
- In cold climates, facility managers may be familiar with space heaters and personal fans, which seem to appear out of nowhere. Because individuals perceive temperatures differently, what may be quite comfortable for many occupants may feel very cold to others. Of course, the same is true for those who always feel too warm. These reactions are real and cause significant loss of productivity as well as dissatisfaction with the work environment. Allowing the use of space heaters only makes the problem worse. The space heater heats a single individual's space but may cause the temperature reading for nearby spaces to read warm, which prevents the HVAC from maintaining an accurate setpoint.

Facility managers can remind occupants of all the methods that are in their control:

- Educate occupants about the temperature setpoints that the organization has set and the reasons for them. Remind them that everyone experiences temperatures in different ways and that the systems cannot meet individual preferences. Suggest that they dress in layers so they are prepared for feeling warmer or cooler in their space.
- Demonstrate the effectiveness of using window shades to decrease or increase solar gain. Just as standing in the shade on a hot day outside provides a level of relief, tilting the blinds to reflect the sun back out the window during hot temperatures and to allow the sun in during cold temperatures can have a significant impact.
- Tell staff about the impact that their use of a personal fan or space heater has on those around them, as well as the energy usage and safety concerns with those devices. If your organization does allow the use of personal space heaters, consider researching and selecting one or two models that address both safety and energy concerns. Place them to minimize the impact on nearby spaces.
- Help occupants understand the impact of their choice of food and drink on their perception of temperature. Those who drink iced beverages all day long are likely to feel cooler than those drinking warm beverages, and vice versa.

Lighting

Workplace lighting can impact worker productivity, concentration, energy, mood, alertness and comfort. Lighting can also help people find their way in a space by suggesting areas of more, or less, activity.

Sixty-eight percent of employees complain about lighting in their offices (Luenendonk, 2019). A second study showed that "good" office lighting can result in a 16 percent increase in productivity, a 24 percent increase in job satisfaction and a reduction in days taken off, a 52 percent decrease in office accidents, a 15 percent increase in employee comfort, and a 22 percent reduction in energy costs (Luenendonk, 2019).

Lighting levels will vary by space, but some common guidelines apply:

- **Color temperature.** Lighting in lower color temperatures, below approximately 3,000 Kelvin (K) is perceived as warmer and tends to reduce productivity. Color temperatures closer to 7,000 K are considered colder and can have adverse effects on occupant comfort. Color temperatures in the range of 3,100 to 4,500 K are considered by some to be best for office.
- **Lighting levels.** The International Energy Conservation Code (IECC), used in many local building codes, gives requirements for lighting levels in many spaces. For example, the standard in an open office is 30-50 foot-candles (FC) measured at work surface height (approximately 31" above finished floor), 300-500 lux, .98 watts per square foot. The IECC references standards by the Illuminating Engineering Society of North America (IESNA), which collaborates with the International Commission on Illumination to promote uniform standards globally.
- Occasionally conduct **light level testing.** Over time, fluorescent bulbs lose their lumens capability and may provide less light than a new bulb. To save on labor and maintain consistent color, when one bulb goes out in a ceiling fixture, consider replacing all the bulbs.
- **Color selection finishes** have a significant impact on light levels as well. Facility managers should consider lighting level requirements when choosing finishes in design and/or renovation projects.

New Construction

When you have an opportunity to participate in new construction planning, pay attention to the location and direction of the lighting. Check how the furnishings affect the lighting. For example, in libraries or manufacturing spaces with large equipment, the furnishings can cast shadows or otherwise prevent intended light from reaching the occupant space at the level desired. In those situations, indirect lighting may provide the most even coverage. It

also allows flexibility for the future when those furnishings and equipment may move. For this type of lighting design, you may want to invest in a qualified designer.

Beyond meeting strict requirements through new construction, facility managers can provide some occupant control of lighting that will enhance comfort and productivity. Among those are:

- **Task lighting.** Task lighting allows an occupant to choose whether, and when, to supplement the provided lighting. Many task lighting options allow the user to select color temperature within a specific range.
- **Dimming.** Most lighting used in commercial applications is now available as dimmable. This is particularly useful for private offices, where the occupant may not always want full lighting.
- **Switching.** Isolate lighting to multiple switches rather than having large areas all on one circuit. This enables the use of smaller areas of lighting and provides a level of occupant control. And when one worker may be in a large open office environment outside normal operating hours, being able to switch on only the lights for the space being used will result in some energy savings for the organization as well.

Views and Access to Daylight

Most office workers spend a large part of their day with their eyes focused on a computer screen. The quality of lighting provided in workspaces has a notable effect on productivity and occupant satisfaction. Providing a productive and comfortable workplace requires attention to other visual aspects of the space. One research poll of 1,614 North American employees concluded that access to natural light and outdoor views ranked at the top of workplace benefits (Meister, 2018).

Because of the importance of views and access to daylight for facility occupants, most building standards now formally recognize, and in some cases require, these factors for sustainability certification. The WELL Standard requires that 75 percent of all regularly occupied space be within at least 7.5 meters of view windows. Recognition of the importance of views and natural light have shifted the standard. Offices used to be located around the perimeter of the facility, closing off natural light and views from those in the core of the facility. In the current model, offices are at the core of the facility, each facing a window, with low open workspaces between the offices and the windows so that the views and daylighting are shared by all.

Such an arrangement is not possible or in fact appropriate in all facilities. In those cases, you may need to consider other designs. Here are a few options:

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- **Dimmable solar lighting.** Use solar tubes, light tubes or sun tunnels to channel natural light into a building's interior. In many cases, solar tubes provide so much natural light that occupants tend to turn on facility lights only on dark or very overcast days. If needed, these systems can channel light at an angle and can be fitted with light dampers so that the solar tube can act as a dimmable light fixture.
- **Skylights** provide views and natural light, but do not provide the same concentration of natural light as solar tubes. Installation of skylights is more costly than solar tubes, but skylights tend to be larger, allowing more view of the outside sky.
- **Light shelves** are shelf-like surfaces placed near a window to reflect daylight to the ceiling and then well into a facility.
- Many lighting options are available in **color temperatures** that approximate natural light. While artificial lighting cannot fully take the place of natural light, providing lighting that approximates natural light can make occupants more comfortable.
- **Paint and wall covering materials** can also reflect light. Low sheen and dark finishes can dampen the brightness of the light's rays.

Sound and Acoustics

In a new or remodeled facility, sound, noise, and acoustics have been among the most overlooked aspects of design (Nagada, 1989). Changes in the way that a business plans its spaces have brought some new acoustic challenges:

- Architectural design concepts that use exposed ductwork and open ceilings require special acoustic design to dampen sound.
- To prevent a productivity clash between users who require more quiet space to work and those who need to collaborate, the move to more open office environments and collaborative spaces must be carefully planned.
- As populations expand in metropolitan areas, many types of businesses are increasing their facility size and raising the height of roof lines to create architectural balance. The result is particularly clear in larger restaurants where noise levels can be so high that diners must speak loudly to have a conversation.

Even the traditional office has its acoustical challenges. Sound transfer from one office to another, distracting mechanical vibrations and spaces, and noises from outside the facility disrupt the comfort and productivity of occupants.

Facility managers will find a wide variety of acoustic products to help with these challenges:

- For traditional offices, in addition to adding sound batting in walls, you may consider flexible acoustic sound boots, duct silencers, ceiling tile barriers and light hoods designed to block the travel of sound.

- To dampen sound transmission in large open spaces, consider using acoustic clouds or sound baffles designed to match the décor of the space.
- Many building finishes that can be incorporated into design have acoustic properties.

In the U.S., the National Institute for Occupational Safety and Health (NIOSH) and OSHA define the acceptable decibel level in a working area per given hours of time. shows the acceptable noise dose for both OSHA and NIOSH.

Time to reach 100% noise	Exposure lever per NIOSH REL (dBA)	Exposure level per OSHA PEL (dBA)
8 hours	85	90
4 hours	88	95
2 hours	91	100
1 hour	94	105
30 minutes	97	110
15 minutes	100	115

Table 6 Acceptable Noise Dose Levels

For larger spaces or more persistent challenges, facility managers will want to enlist the services of an acoustic designer.

Sound Masking

Sound masking is readily accessible to most facility managers and may be an economical solution to sound issues related to speech privacy. A sound masking system adds background noise at a specific wavelength. It distorts the sound waves enough to provide a level of speech privacy and reduce some distractions. The sound is very much like the constant HVAC sound that most occupants are accustomed to, but the wavelengths are specifically intended to mask speech. Different colors are associated with the power spectrum of a noise signal. White noise machines are the most referenced of these, but many users find that pink noise is more pleasant and more effective way to mask speech (N.A. 2012).

When considering a sound masking system, remember that it is not the space where the sound originates that needs to be masked. Sound masking treats noises from other spaces. For an executive office with a sound privacy concern, the sound masking would be applied outside the executive office rather than in the office itself.

Occupants may not be aware of sound masking but would certainly miss it if it were provided and then later removed.

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Lesson 2: Standards and Guidelines

Lesson 2: Objectives

On completion of this lesson, you will be able to:

- Recall the standards and guidelines that govern a sustainable workplace.

Standards and Guidelines

Many standards and guidelines govern or provide valid recommendations for sustainable workplace and site management. Here are just a few:

- **ASHRAE** is "a global society advancing human well-being through sustainable technology for the built environment". (ASHRAE). ASHRAE has published over 4,000 standards for the design, testing, and maintenance of indoor environments, many of which are cited in sustainability practice and certification systems worldwide.
- **APPA** is a professional association for higher educational facilities professionals. APPA is known for its standard of care in facilities, which identifies cleaning standards based on specific identifiable characteristics around cleanliness. One of the current focus areas for APPA is monitoring and providing input into standards which may impact higher educational facilities through other associations, including ASHRAE, the International Code Council (ICC), National Fire Protection Association (NFPA), OSHA, ISO and more.
- **ISSA** is a worldwide association that provides standards for business practices in the cleaning industry. Their educational programs provide expertise for managing green cleaning, sustainability, and the protection of human health. (ISSA).
- **Green Seal** is a global non-profit organization that provides third-party certification. It assures that products carrying its label have met rigorous standards related to sustainability, performance, and health.
- **Global Reporting International (GRI)** standards provide a structure and global best practice for sustainability reporting. Sustainability reporting helps organizations understand and share their true impact on sustainability issues, including climate change, human rights, governance, and social well-being.

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Certifications

In addition to (or often accompanying) standards and guidelines are sustainability certifications. Many of the certification systems reference the standards and guidelines above. Most prominent among the certification systems are the following:

- **ISO 14001 Environmental management systems – Requirements with guidance for use** specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance.
- **LEED – Leadership in Energy and Environmental Design** is a globally recognized green building rating system developed by a U.S.-based entity - the U.S. Green Building Council (USGBC). The rating system evaluates buildings on six key areas: Impact on-site and location, energy efficiency, water efficiency, use of materials, IEQ and innovation. Multiple project types can be certified under LEED, including new buildings, new interiors, existing buildings and spaces, neighborhood development, cities and communities, residential, recertification and retail. (USGBC).
- **BREEAM (the Building Research Establishment Environmental Assessment Methodology)** predates the LEED certification system and is used more frequently in the U.K. One of the principal differences between BREEAM and LEED is in the certification process itself: In LEED, the design team collects and submits the sustainability calculations and information. In BREEAM, licensed assessors evaluate the sustainability calculations and issue a certificate when those criteria are met. (Dolan-Del Vecchio, 2016).
- **Green Globes Certification by the Green Building Initiative (GBI)** is a direct competitor to LEED and BREEAM and is said to be much less costly for an organization seeking certification. The focus of Green Globes is on improved operations (and reduced operating costs), occupant comfort, and climate. (Green Building Initiative).
- **WELL (by the International WELL Building Institute)** is a rapidly emerging sustainability certification program that is focused on designing for health in the workplace. The system establishes measures to help relieve workplace stress and give the organization an advantage in efforts to keep and retain talent. WELL standards categories include nourishment, light, movement, thermal comfort, sound, materials, the mind, community and innovation. (WELL).
- **OSHA** Europe Workplaces, equipment, signs, personal protective equipment (PPE).

Whether or not an organization elects to adopt a standard or pursue a certification, the guidelines provided in those documents and programs provide useful guidance toward the sustainable operation of a facility and care for the health, safety and comfort of occupants.

The skills, knowledge and expertise required to lead sustainability initiatives will be of increasing importance for all organizations. For those individuals looking for professional

development opportunities, IFMA offers the Sustainability Facility Professional® (SFP®) – an assessment-based certificate program demonstrating a proven comprehension of environmental stewardship and sustainability in FM. This program will equip the SFP credential holder with knowledge and skills to integrate sustainability efforts with the organization's values and strategies, present a business case for a sustainability initiative, evaluate initiatives from a financial point of view, and track and report accomplishments.

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Chapter 6: Progress Check

1. What is NOT considered part of indoor environmental quality?

   a. Air quality and temperature
   b. Ergonomics
   c. Daylight
   d. Sound and acoustics

2. What is the sustainability rating system designed for health in the workplace?

   a. LEED
   b. BREEAM
   c. Green Globes
   d. WELL

3. What is the acceptable OSHA noise limit in a working area for 2 hours?

   a. 100 dBA
   b. 97 dBA
   c. 91 dBA
   d. 85 dBA

4. Which organization has published over 4,000 standards for design, testing, and maintenance of indoor environments?

   a. ISO
   b. APPA
   c. ASHRE
   d. ISSA

Progress Check Question Answer Key

Chapter 1: Introduction to FM Sustainability

Objectives

1. b
2. a
3. d

Chapter 2: Energy Management

Objectives

1. b
2. b
3. c
4. a
5. b
6. b
7. a

Chapter 3: Water Management

Objectives

1. c
2. c
3. a
4. a
5. b
6. b

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Chapter 4: Materials and Consumable Management

Objectives

1. a
2. c
3. b
4. b
5. c

Chapter 5: Waste Management

Objectives

1. b
2. a
3. a
4. c

Chapter 6: Workplace and Site Management

Objectives

1. b
2. d
3. a
4. c

Appendix

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