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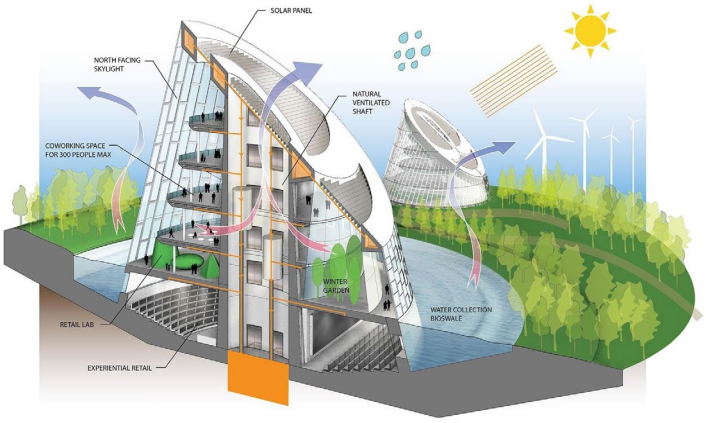

SUSTAINABILITY GUIDELINES

For Construction

ABSTRACT

The CMAA Sustainability Guidelines Course Materials is a supplement to the CMAA Construction Management Standards of Practice's sustainability chapter. It gives construction managers (CMs) realistic advice on how to handle their responsibilities from project conception to post-occupancy activities in a sustainable manner

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TABLE OF CONTENTS

Preface

This CMAA Sustainability Guidelines paper is a supplement to the CMAA Construction Management Standards of Practice's sustainability chapter. It gives construction managers (CMs) realistic advice on how to handle their responsibilities from project conception to post-occupancy activities in a sustainable manner.

Updated information on energy, climate adaption, and resiliency planning is included in these guidelines. CMs must stay up with the evolution of sustainability and how it may affect their clients, projects, and programs when new projects and programs are developed.

World events continue to have an impact on the industry, and CMs must be ready to react by embracing technological improvements like improved virtual communication, which allows projects to stay on schedule with minimal disruption. While managing all areas of a project, a CM's direction is also critical for supporting and championing emerging safety procedures.

The following are the programs, systems, and products mentioned in this document:

The US Green Building Council® owns the trademark LEED®, which stands for Leadership in Energy and Environmental DesignTM.

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The Abu Dhabi Urban Planning Council developed the Pearl Rating System as part of its Estidama sustainable development strategy.

Introduction

The CMAA Sustainability Guidelines offer CMs advice on how to implement a project that is sustainable, green, resilient, and/or high performing. The goal of these guidelines is to give context, information, and tools to help the CM finish a sustainable project or one with sustainability aims or characteristics. These principles do not offer a prescriptive strategy to creating a long-term project. For both buildings and infrastructure, the CM has access to a variety of sustainability certification systems, products, and techniques.

The Brundtland Commission (http://www.un-documents.net/our-common-future.pdf), whose 1987 commission report helped raise global awareness of sustainable development, defines the term "sustainable development" as "development that meets our current needs without obstructing future generations' ability to meet theirs."

Efficiency in utility usage, resource and waste management, sustainable site development, stormwater management, high-performance building design and construction, maintenance and operation to sustainable standards, and indoor air quality for healthy buildings and infrastructure are the most common core concepts of sustainability in construction.

To aid in design decisions, lifecycle assessments (LCA) should have been undertaken as part of the planning process. During the construction process, it may be important to evaluate LCAs to identify any changes that have occurred, such as technological developments that were not previously available.

The Stockholm Resilience Center defines resilience as "the ability of a system, be it an individual, a forest, a city, or an economy, to deal with change and continue to develop." This concept has become an increasingly important part of sustainable development, addressing the capacity to anticipate unexpected social/ecological changes in order to ensure consistent sustainability.

Sustainability has progressed from sustainable building certifications to infrastructure certifications for transportation, water utilities, and remediation projects, and has gone from a

mainly voluntary adoption practice to a core value. Many owners now require proof of sustainability qualifications and reporting as part of their procurement process, essentially making it a primary filter in the selection process for most large private and public sector owners who want to incorporate the economic, social, and environmental aspects of their project to improve the "triple bottom line."

The adoption of sustainability as a design guiding principle by the owner is a key first step in constructing a sustainable project. After that, a long-term project is built by employing consistent project and construction management procedures, rigorous documentation, common sense, and thoughtful architectural and engineering design.

The CM is in charge of keeping a grasp of the changing regulatory environment, new best practices, and quickly increasing technical breakthroughs in energy and ecological high-performance monitoring, measurement, and control capabilities in a sustainability program. The CM should also foster a culture of learning and experimentation when it comes to using CM best practices to achieve sustainability on each project. to be more specific

» The owner and the project team must be educated on the benefits, features, constraints, and implementation methods of a project's sustainability features by an agency CM (working as the owner's agent).

« A CM at-Risk (CMAR) is in charge of organizing a team of subcontractors and consultants that are aware of and committed to constructing a long-term project that meets the owner's expectations.

MODULE 1

SUSTAINABILITY CONSIDERATIONS

Avoiding resource depletion of energy, water, and raw materials is one of the most important factors in sustainable design. Another goal is to avoid environmental deterioration during project development and operation by creating designs and built environments that improve human health, such as high-quality indoor air, natural lighting, high-efficiency HVAC, and resilient design.

Using a process to produce a sustainable design and using construction and assembly procedures to produce a facility with sustainability characteristics is what it takes to achieve the goals of a sustainable project.

Common features of a sustainable project include:

- Water management and conservation systems.
- Energy-saving features or measures that employ both passive and active tactics.
- Applications and systems for renewable energy
- Materials that are derived in a sustainable manner.
- Waste minimization strategies
- Systems that minimize contaminants throughout construction and operations to maintain healthy indoor environments.
- Health-and-Safety-Supporting Strategies (ex. COVID-19 pandemic).
- Wellness strategies and a better user experience in the building (acoustics, daylight, views).
- Resilience to climate-related consequences is taken into account.

Among the strategies for achieving sustainability goals are:

- Maximizing the possibilities of the site and existing structures.
- Energy usage optimization.

- Water, wastewater, and stormwater as resources must be protected and conserved.
- Environmentally friendly products are used.
- Indoor air quality protection and improvement.
- Procedures for operational and maintenance optimization

MANAGEMENT OF PROJECTS

Sustainability is a crucial component of project and construction management, just as cost, schedule, quality, and safety. A successful CM's major responsibilities in terms of sustainability should include the following:

1. Recognize the needs of the property owner. A project with sustainability criteria may involve high risk due to the adoption of new technology or processes. To practice a "no surprises" policy, the CM must have a clear understanding of the owner's expectations, boundaries, and goals.
2. Assist in the hiring of qualified designers and contractors. Some designers, contractors, and consultants may encounter requirements that are novel or specific to projects incorporating sustainability characteristics. The CM is responsible for ensuring that project requirements are properly defined so that the chosen team can address or reduce any risks.
3. Be aware of the project's objectives. It's critical for CMs to grasp the project's objectives and their role in achieving them.
4. Oversee a multidisciplinary project team. CMs should be aware that the addition of team members, new features and technologies, and unfamiliar installation, testing, or verification processes can all increase complexity to a project.
5. Organize the actions of the many stakeholders. Complexity is introduced by sustainability standards, which emphasizes the significance of clear and consistent communication.

The project or construction management plan, as well as its component or subordinate aspects, should clearly describe the CM's major instruments for meeting scope, schedule, budget, and quality control objectives.

To incorporate sustainability standards, the following strategies might be used:

Commissioning Plan — This is based on the owner's project needs, with the owner's input. Training, sustainability certifications and requirements, installation and functional testing requirements, and operating needs that may affect the owner after turnover are all outlined in a commissioning plan.

Construction Procurement Plan - This should spell out the contractual obligations and responsibilities of consultants and contractors tasked with delivering a project that meets sustainability standards. (The CM could be referred to as a consultant.)

Contract Administration Procedures – While sustainable design and construction requirements may be included in design/contract documents for reference, CMs should integrate sustainability requirements as much as possible in contract documents and project/program management procedures to help minimize coordination risks on the project's cost, schedule, scope, and quality parameters. CMs should evaluate and alter standard papers as required by legal counsel and insurance providers for project-specific use before including or using them on a project.

Management Information Systems (MIS) — An MIS is a project's data repository and computer-based "toolset," and systems like energy modeling and Building Information Modeling can be considered part of a project's sustainability aspects (BIM). High-performance modeling, the incorporation of sustainability features in the design process, sustainability credit

tracking, and post-construction maintenance plans that maximize energy efficiency maintenance practices and capital replacement decisions can all be made easier with BIM. The related requirements should be addressed clearly in project management procedures. Appropriate technical help and supervision should be provided.

Quality Management Plan (QMP) – During construction, the QMP should include sustainability metrics that are deeply embedded by integrating performance, testing, and inspection requirements for sustainability aspects or features, and separately identified as requisite elements of the project's sustainability program.

Project Management Plan - This plan should include processes for guiding the performance of tasks in design and construction to guarantee that the project's sustainability elements are developed and included.

Project Safety Plan - Because certain team members may be unfamiliar with sustainability features or regulations, additional attention must be given in any safety plans to explicitly explain construction sequencing, testing, and inspection methods.

Project-specific sustainability goals/objectives/requirements, roles and duties, and important methods for coordinating activities and tracking progress on deliverables and milestones should all be clearly identified in this plan. A Sustainability Plan serves as both a guide and the basis for a reporting system. It must be as brief as feasible.

Taken together, these guidelines and tools can help a trained and conscientious CM and team manage a project to a successful implementation of sustainability criteria. (See also the Construction Management Association of America's Construction Management Standards of Practice paper.)

MANAGEMENT OF COSTS

Cost management and control is one of a CM's primary responsibilities, which can be accomplished by developing a realistic, all-inclusive budget that meets the owner's goals,

restrictions, and limitations, as well as managing project risks in a way that yields the best value within the project budget.

When an owner places a high value on sustainable design results and the stakeholder team is open to working more closely together rather than in "silos," CMs should consider including the integrated design process into the project management plan.

Integrated design can help save money by:

- Reducing capital expenditures.
- Reducing design changes in order to improve project delivery.
- Early in the project, improve architect/engineer workflow.
- Using occupant-focused designs to save operations and maintenance costs.

Sustainability expectations must be identified early in the project's lifecycle and clearly documented to establish accurate budget estimates and develop the work scope, and the CM works with the owner to establish sustainability goals and objectives, which will drive the design and engineering team's design development and preparation of contract documents. Sustainability expectations must be identified early in the project's lifecycle and clearly documented to establish accurate budget estimates and develop the work scope.

If a project is to be LEED certified, for example, the risk of not achieving the required level of certification can be mitigated by hiring an experienced design team to develop the engineering process, a commissioning consultant to manage commissioning and quality processes, and a LEED consultant to handle LEED paperwork and submissions. Early in the process, it's critical to estimate the costs of specialized equipment and installation, as well as identify and monitor market dynamics that may have an impact on the project, in order to learn about alternative ways to accomplish sustainability goals while staying within the project budget. Design features must also be documented for use in the LEED process and later commissioning activities to ensure that systems are installed and running as planned.

Early estimation and post-construction verification of project lifecycle costs, as well as the use of lifecycle assessment (LCA) and alternatives analysis techniques, may be required for sustainable projects. Specialty consultants may be hired by the project or design team to undertake these studies. The CM should be familiar with the principles and procedures involved in these analyses.

Because of the rapid development and evolution of developing sustainability technologies, certain purchases of highly technical components may need to be postponed in order to include the most up-to-date technology into the project. To account for anticipated cost increases for such products, adequate contingency for the owner, designer, and contractors must be set.

Standard cost management systems and fundamental project management best practices, combined with increased awareness of cost risks associated with new technologies and processes, will enable a project team to meet sustainability goals and objectives while staying under budget constraints. (See the Construction Management Association of America's Construction Management Standards of Practice and Cost Management Guidelines.)

MANAGEMENT OF TIME

Throughout the life of a project, it is critical to maintain a focus on time management. Sustainable project features' time implications must be quantified or properly approximated. The requirements and implications of a project's sustainability elements should be anticipated and monitored using normal scheduling methods, just like any other aspect of construction, so they are not willfully sacrificed by mistakes in planning and management.

Sustainable goals and objectives must be included into the project's program rather than being considered as an afterthought. This necessitates defining and include tasks related to sustainable objectives in the master plan, as well as ensuring that additional tools, such as milestone calendars, reflect activities necessary to achieve sustainability goals.

Scheduling strategies span from simple bar charts to complicated software programs and critical path method (CPM) research. Contract milestones for sustainable design and construction should be taken into account and incorporated into project documents.

Time contingencies for sustainable project elements must be integrated into master and milestone schedules in construction, and the CM must actively monitor the performance of subcontractors, designers, and suppliers who are accountable for these features. Inspection and verification procedures that are part of the commissioning and quality management processes will aid in determining the need for intervention and mitigation.

The CM should understand the technologies and applications, performance and installation requirements, staging, phasing concerns, and quality processes for a project with sustainability aspects that rely on novel or unusual technologies, practices, or means and methods.

Understanding wait times for emerging or "hot" technology or a certain sort of equipment that will be supplied from another nation is one example that CMs may face. What are the logistics and potential consequences? Have you found qualified local practitioners/skilled trades for installation and service?

Another example is coordinating the drilling of ground source heat exchange wells or facilitating renewable energy hookup with permit and electric utility requirements utilizing gradual or phased communication that grows in detail and/or frequency as the event approaches.

In conclusion, nothing can substitute a diligent CM who is acutely aware of how a project's execution fulfils the promise of its design principles, particularly sustainability. (For more information, see the CMAA Time Management Guidelines.)

MANAGEMENT OF QUALITY

The extent to which the project and its components fulfil the owner's expectations, objectives, standards, and intended purpose is referred to as quality. The compliance of the project to the plans, specifications, and applicable standards is used to determine its quality.

When a project owner decides to include sustainability principles and/or particular goals in the project's expectations and objectives, this decision must be supported by design solutions and requirements embedded in project implementation plans and success indicators.

Planning, organizing, executing, monitoring, and documenting a system of rules and procedures that assign, coordinate, and direct relevant project resources and activities in a manner that achieves project objectives and performance standards is known as quality management.

Throughout the facility lifecycle—pre-design, planning, procurement, construction, post-construction, operation, and maintenance—a project with sustainability features applies its quality management system systematically to yield healthy, durable, and environmentally or ecologically sound performance.

Using quality management and control approaches, embed sustainability into the quality management system/plan by converting sustainability goals and requirements into essential project metrics and milestones.

The goals, plans, performance indicators, and verification processes required to verify the attainment of sustainability objectives should be clearly articulated in the QMP and related procedures and documentation.

The following should be included in the QMP:

- Include reviews of long-term sustainability.
- Examine typical reviews for features that are special to sustainability.
- Determine metrics that capture intermediate and final performance metrics.

- Include sustainability-specific hold points, milestones, and performance objectives in checklists, recordkeeping, and document control systems, which are frequently used as part of the commissioning plan and processes.
- Take advantage of commissioning.
- Define testing and verification procedures to assure compliance and allow for ongoing improvement.

If a project must meet a specified level of a sustainability rating system such as LEED, Green Globes, Envision, or ENERGY STAR, procedures must be modified or created to assign and monitor the responsibilities and obligations of each project participant involved in the process. This includes submitting and processing applicable certification papers, obtaining the information needed to get an acceptable written certification, and keeping track of the certifications earned. A Green Building Facilitator (GBF) should also be hired to oversee the project's green building objectives.

The commissioning agent (CxA) and the sustainability consultant (i.e., GBF) should both be members of the quality management organization, and their opinion should be sought and included into quality and project management protocols and processes. The green building aims of a project are coordinated or implemented by a GBF.

The CM should be familiar with the performance standards, any applicable green building rating system, as well as the means, techniques, and constraints of sustainability measures.

The following tasks may be performed by the CM:

- Assist in the establishment of long-term objectives.
- Provide budgetary advice on sustainability strategies.
- Provide guidance on the timing implications of sustainability actions.
- Provide guidance on issues of public acceptance.
- Assist with the selection of a design consultant, a sustainability consultant/GBF, and a contractor.

- Assist in the evaluation of options for achieving sustainability objectives.
- Assist in the verification of progress and the attainment of sustainability goals.
- Assist in sustainability impact analysis, value engineering, and other studies to ensure or verify sustainability goals are met.

(See also the Construction Management Association of America's Construction Management Standards of Practice and the Construction Management Association of America's Quality Management Guidelines.)

ADMINISTRATION OF CONTRACTS

Contract administration is the process of putting a contract's terms and conditions into action using pre-determined processes, policies, and procedures. The project or construction management plan (PMP/CMP), the Sustainability Plan, and the Project Procedures Manual are the most important contract administration tools. The project scope, milestone schedule, budget, team organization, contracting and procurement strategy, and basic systems to be used are all outlined in the CMP. The Project Procedures Manual lays out the particular steps that will lead to the achievement of key performance goals such as cost, time, scope, and quality.

Contract administration activities must include the methods to ensure compliance with sustainability objectives and control the outcome to produce a project that conforms with contract documents when a project contains sustainability goals or characteristics. To provide for recording and controlling the flow of submittals needed by the GBF, the CM should define (or force the development of) submittal procedures early in the project—preferably in the pre-design phase.

ENVIRONMENT OF REGULATION

While the ideas of sustainable, green, and high-performance design and construction are widely accepted, the regulatory environment governing sustainable projects differs significantly between municipal and state governments, public and private sector decision-makers, and financing sources. Furthermore, depending on the project type, performance requirements,

and regulatory jurisdiction, the sustainability language can differ. For guidance, CMs should look into applicable local and state codes and standards.

Advances in climate and biodiversity science, the availability of new products, and the consensus that responsible development requires the construction industry to embrace practices that are sensitive to ecological and environmental factors are all driving the real and perceived importance of sustainable development, design, and construction practices to grow.

The following government agencies have a strong interest in and influence on sustainability issues:

- Environmental Protection Agency of the United States (EPA)
- Department of Energy of the United States (DOE)
- Defense Department of the United States of America (DOD)
- Interior Department of the United States of America (DOI)

The following federal codes and standards apply:

- *ASTM E2432 is a standard that specifies how to make a product.*
- Standard Guide for the General Principles of Building Sustainability
- The Energy Independence and Security Act (EISA) is a federal law that promotes energy (EISA 2007)
- Act to Buy American
- The Energy Policy Act of 2005 is a piece of legislation that was passed in 2005. (and subsequent iterations)
- Efficient Federal Operations Executive Order 13834 (2018)

The governing building code usually refers to national standards and consensus standards developed by non-governmental organizations (NGOs) such as professional societies, government-sponsored research and development organizations, universities, and private sector companies to address the material performance and energy efficiency of systems, equipment, and building components and assemblies. Most professional societies provide

knowledge and training in sustainable, green, or high-performance methods for certain disciplines and sectors**. These include, in addition to CMAA:**

- ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers
- ASTM is the acronym for the American Society of Testing and Measurement.
- Engineer in Refrigeration and Air Conditioning
- IEEE is an acronym for the Institute of Electrical and Electronics Engineers.
- The American Society of Mechanical Engineers (ASME) is a professional society of mechanical engineers based in the United States.
- ISI (Institute for Sustainable Infrastructure) is a non-profit organization dedicated to the development of sustainable infrastructure (Envision)
- American Society of Civil Engineers (ASCE)
- UL stands for Underwriters Laboratories.
- American National Standards Institute (ANSI)

A CM's understanding of the sustainability area is critical. Professionals should take use of professional development opportunities offered by professional organizations, regulatory agencies, and certifying bodies that are most closely connected with their professional training and work responsibilities.

Finally, groups dedicated to bringing the ideas and goals of sustainability to market have created consensus criteria for the construction industry. **These are some of them:**

- The LEED grading system and the LEED Accredited Professional certificate were designed and maintained by the US Green Building Council (USGBC).
- The Collaborative for High Performance Schools (CHPS), which creates and updates state and regional school criteria, as well as rating systems and an Operations Report Card.
- The Green Building Institute (GBI) is the organization that created and manages the Green Globes advice and assessment program, as well as the Green Globes Professional Certification.

MANAGEMENT OF SAFETY

Preparing for and implementing processes to protect the health and safety of all individuals on a project site, including workers, visitors, and the general public, is part of safety management. Safety management is a loss control risk management method that is aimed to protect against the costs of life and property damage, injury, treatment, and cleanup. As a result, in a construction project, standard safety precautions include safety education, training, and insurance.

Safety also pertains to the features that contribute to sustainability in many projects with sustainability features.

After the construction is finished, there will be a healthy working atmosphere. This can include correctly operating air handling systems, protected, and cleaned ducting, low VOC-emitting and/or no red list (toxic) components, and low greenhouse gas (GHG) emissions.

The experience modification rate (EMR) is a multiplier used by the insurance business to assess the cost of workers' compensation insurance during construction. It is a multiplier used by the insurance industry to gauge past costs of injuries and the risk of future injuries. An EMR of 1.0 is regarded ordinary, while an EMR of less than 1.0 is considered low.

An EMR of less than 1.0 is good; an EMR of more than 1.0 is poor, which will be reflected in a higher relative construction bid because an insurer's workers compensation rates will be higher. The Occupational Safety and Health Administration (OSHA) incident rate for "recordable injuries" and "lost time injuries," which OSHA publishes annually for various types and markets of construction, is another indicator of safety performance.

Due to a lack of data, EMRs and incident rates for projects with sustainability characteristics that involve new or developing technology and contractors with minimal expertise may be relatively high. All work aspects and areas involving new or developing technologies or processes should be treated with caution, with special attention paid to the formulation and

implementation of safe work plans that detail the work sequence, hold points, inspections, risks, means, and techniques.

The CM's role as "communicator-in-chief" is to ensure that project participants understand the importance of safety and the measures in place to protect life and property. A well-trained workforce is a safe and long-lasting one.

RISK ADMINISTRATION

The systematic application of management methods to mitigate the negative impact of uncertainties on a project's cost, schedule, and quality expectations is known as risk management. Financial losses, damages, and other unfavorable events, such as the loss of chances, are all possible outcomes of risk. Risk is inherent in significant capital building projects, but risk may be amplified on a project with sustainability goals due to a variety of unknowns, such as:

- Contractor performance on a project with specific sustainability standards that hasn't been verified.
- The performance of new or upcoming technologies has yet to be demonstrated.
- New or emerging technology performance by an unproven consultant, contractor, subcontractor, or supplier.
- Uncertain impact of commodity pricing on project sustainability elements, such as solar equipment components and unpredictable commodity (energy) pricing.
- Scarcity of skilled technical and specialized subcontractors.
- Delay in finalizing specific issues related to developing technologies and equipment in order to ensure that the "latest" technology is used in the project, potentially affecting final pricing and schedule.
- Owner expectations that are unrealistic.

Issues that may arise when contract compliance is overseen by a third party. Certification to a LEED standard, for example, may be a contract obligation, and the scoring required to attain a specific LEED level is decided by a third party. Owner-driven modifications or delays in a manufacturer's capacity to provide proper documentation of assertions can muddle the results.

Inadequate budgeting for sustainability-related materials and systems or increasing costs.

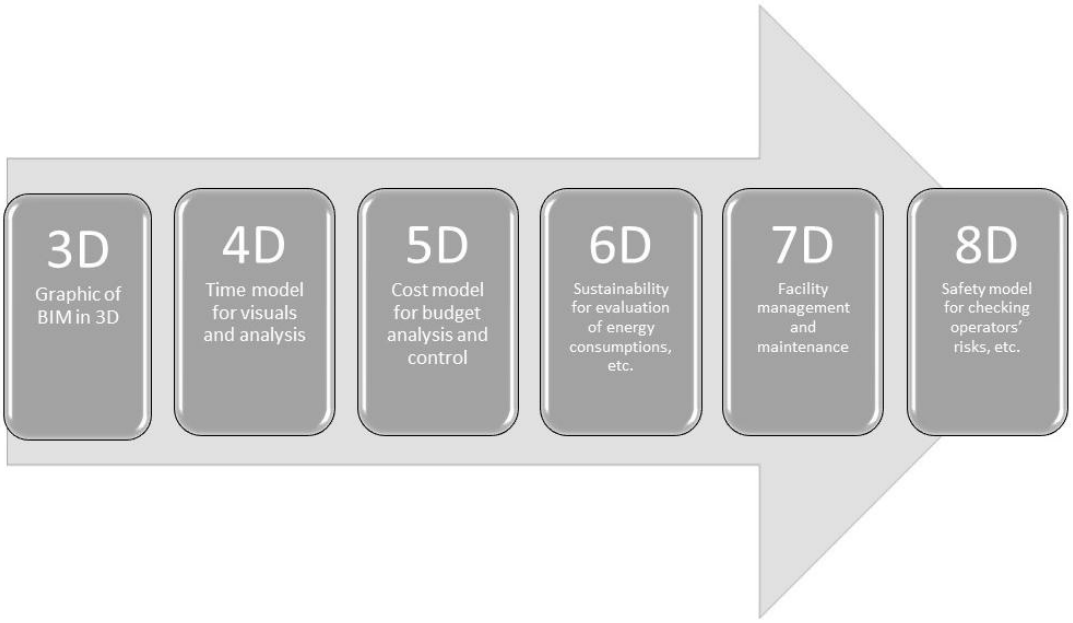
Identifying, understanding, and eliminating uncertainties are the most effective ways to manage risk. Uncertainties that cannot be eradicated must be controlled by establishing boundary expectations utilizing contingencies. Risk can be decreased by inquiry, design, and engineering that lowers uncertainty, or by transferring risk to a third party, such as through the use of insurance products.

Efforts to manage risk should be examined during meetings during each project phase. Sustainability-specific status and challenges should be discussed as a separate agenda item to ensure adequate vigilance to sustainability objectives.

MODELING OF THE CONSTRUCTION PROCESS

Designers pioneered modeling, which was later adopted by contractors for coordination and fabrication. Contractors and construction organizations are increasingly using the technology as routine procedure. Architects, engineers, and construction professionals can use a 3-D model-based method to plan, design, construct, and manage buildings and infrastructure more efficiently.

BIM is a method of capturing, analyzing, documenting, and assessing virtual representations of a facility's physical and functional attributes, and then revising them iteratively throughout the



design and construction process. 3D parametric modeling, engineering analysis, collision detection, 4D scheduling, quantity take-off, and information assignment are all possible with BIM (including specification and product data linkage).

By making design and technical information consistently available as a basic component of the design process, BIM has the potential to reduce the cost of sustainable design.

This collaboration and project delivery platform can fulfil the needs of project participants at all stages of the project lifecycle, including those tasked with determining whether the project will meet the standards of credit-driven sustainability programs such as LEED. BIM may improve coordination and eliminate potential errors involved with assessing sustainability performance since it can incorporate correct modeling information early in the design phase. As-built conditions can be added into a project's BIM to help identify if it is being constructed within defined design tolerances and will meet stated credit requirements.

Long before a project is built, BIM may be used to model facility orientation, window location, and lighting, making it ideal for assessing daylight modeling and solar access, both of which can affect a building's sustainability credit profile. Furthermore, BIM may play a significant role on a project with sustainability aims by putting design decisions in the hands of designers by generating calculations for lighting, airflow analysis, site analysis, energy consumption, and water use in support of trade-off considerations and design decisions.

The technology can be used to assess and convey the building process in a virtual environment throughout the construction process, including order of work, means and methods, logistics, and documentation of as-built conditions.

BIM can provide ongoing analysis to the project team, such as:

- How much recycled content is used in individual components and throughout the facility?
- The amount of construction material sourced within a specified radius.

The model is used to make decisions throughout the lifecycle of a facility, from conception to design through building, occupancy, and operation.

On a project with sustainability features, the CM must carefully choose a BIM system that represents the facility as an integrated database of coordinated information, meets the team's expectations for modeling and management of the design and construction process, and includes functions that will aid the sustainability program.

Management of Resources

For government and private/commercial initiatives, the concept of sustainability and resource management has evolved over time. What began as a recognition of the necessity of energy saving has evolved into a proactive practice of incorporating sustainable construction practices into all projects.

The following points are highlighted in this section:

- Energy conservation, efficiency, and renewable energy
- Stormwater, wastewater, and water
- Materials
- Budgetary considerations

ENERGY

The US Energy Information Administration's (EIA) mission is to improve "the nation's energy system's rapid, material, and efficient transformation and secure US leadership in energy technologies." According to EIA studies, the residential and commercial sectors accounted for over 40% of total energy use in the United States in 2018. Previously, the emphasis on sustainable energy was on efficiency and conservation.

"Using less energy to give the same service" is how energy efficiency is defined. Improving efficiency is one of the most constructive and cost-effective strategies to address high energy prices, energy security and independence, and air pollution.

To save energy, conservation is monitoring utilization, lowering usage, or eliminating a service. vii That strategy has evolved into a proactive and flexible one.

Working toward a zero-emissions, efficient, and resilient facility is a best practice in the building business.

There are three main approaches to increasing energy efficiency:

1. Cutting-edge design and building methods.

2. Buildings that have been upgraded.

3. Materials and equipment that save energy.

EFFICIENCY OF ENERGY

CMs should ensure that energy efficiency and renewable energy measures, finance, incentives, and related regulatory concerns are evaluated with owners, and that all energy-related measures are implemented as approved by owners as the most important component of sustainability.

The majority of energy efficiency and renewable energy decisions are determined in the pre-design phase and refined during the design phase. Sustainability elements are monitored during procurement and construction to ensure that the appropriate equipment is procured and installed correctly. The commissioning process should demonstrate that the systems are meeting their objectives. During the building operations phase, this activity continues.

An energy efficiency study is advised prior to the start of any major renovation or addition for a project to fulfil numerous critical tasks, including but not limited to the following:

- Establish a baseline or benchmark for energy performance at the current location so that when adjustments are made, the incremental changes in energy use can be properly documented.
- Conduct an inventory of HVAC equipment, lighting, insulation, and heat mapping to an appropriate level of detail, or update a current inventory.
- Create a clear plan of action for improving energy efficiency in those parts of the project that may be left in place.
- Assist in estimating the possibilities for on-site renewable energy to offset current and projected energy demand.
- Look for sub-metering opportunities to track the energy consumption of loads that account for a large portion of the site's total consumption and demand.

1. BENCHMARKING

Benchmarking is the process of comparing a project's energy performance to a "something similar" baseline. The baseline could be internal, such as performance at the same time last

year in a modernization project, or external, such as performance compared to equivalent facilities elsewhere in a new construction project. The owner may have predefined benchmarks that fall into these generic categories in some cases; nevertheless, they may require assistance from the CM in defining appropriate benchmarks for their individual needs.

A rising number of towns are introducing benchmarking regulations to encourage existing buildings to improve their energy efficiency. At the very least, such rules assist to enhance building owners' awareness of their facilities' energy efficiency in contrast to other similar structures.

2. SUB-METERING

While wireless submetering is not a new technology, it has enabled building owners to meter large individual pieces of equipment or categories of loads such as lighting, chillers, fans, and pumps, providing valuable information in the management of those loads as well as data for capital investment validation. The sub-metered data can be examined and analyzed in real time when connected to a building automation system/building management system/energy management software (BAS/BMS/EMS) and a dashboard.

Sub-metering any load or category of loads that consumes more than a certain percentage of the total site's electricity consumption and/or demand can earn you extra credits in some sustainability certification schemes, such as LEED v4.

Sub-metering should be considered by CMs as a way to provide the building owner with the necessary data to justify gradually higher initial expenses for more energy-efficient lighting and HVAC systems.

3. KEY INDICATORS OF PERFORMANCE

In the context of energy efficiency, key performance indicators (KPIs) are parameters that are crucial to the site's continuous energy efficiency and conservation. The Energy Use Intensity (EUI) per square foot per open hour of operation is an example of an energy KPI for some firms. It might be the EUI per employee or client served for others. It's critical for the CM to

understand the owner's key performance indicators (KPIs) and tailor energy efficiency equipment and systems to match those goals while also effectively communicating operational efficiency to the owner.

ENERGY USE

One of the most important indicators in the area of energy efficiency is the EUI. Essentially, the EUI measures how much energy a structure uses as a function of its size or other features.

EUI criteria for buildings and infrastructure are required by many pieces of law at the federal, state, and local levels. The following are some instances of federal energy efficiency legislation:

The Energy Policy Act of 1992 mandated that certain federal, state, and alternative fuel supplier fleets develop an inventory of alternative fuel vehicles (AFVs). The Energy Conservation and Reauthorization Act of 1998 and the Energy Policy Act of 2005vi, which stressed alternative fuel use and infrastructure development, were both revised multiple times.

The American Recovery and Reinvestment Act (ARRA) of 2009 vii set aside nearly $800 billion for job creation, economic growth, tax relief, educational and healthcare improvements, infrastructure modernization, and investments in energy independence and renewable energy technologies, as well as fuel tax credits. The ARRA law required state energy codes to be adopted, beginning with ASHRAE 90.1 in 2009, with mandatory "upgrades" every three years. By 2020, ASHRAE wants to see net zero or energy neutral construction.

Executive Order 13693, published in 2015, set new targets for federal agencies in terms of energy efficiency and sustainability, including specific goals for energy use reduction and renewable energy adoption. Efficient Federal Operations, Executive Order 13834, was issued in 2018.

California has its own energy efficiency standards, which are modified on a regular basis to meet more stringent energy criteria. www.energy.ca.gov/title24/ x Copies of the most recent version of Title 24:

Under the jurisdiction of Section 103 of the Clean Air Act, the Federal Environmental Protection Agency and the Department of Energy established the ENERGY STAR program in 1992. (g). The administrator must "conduct a fundamental engineering research and technology program to develop, evaluate, and demonstrate non–regulatory solutions and technologies for decreasing air pollution," according to Section 103(g) of the Clean Air Act. The Energy Policy Act was passed by Congress in 2005. Section 131 of the Act amends Section 324 (42 USC 6294) of the Energy Policy and Conservation Act, stating that the Department of Energy and the Environmental Protection Agency "established a voluntary program to identify and promote energy-efficient products and buildings in order to reduce energy consumption, improve energy security, and reduce pollution through voluntary labelling of or other forms of communication about products and buildings that meet the highest energy efficient

The ENERGY STAR program offers direct assistance in the selection of energy-efficient building materials as well as energy-saving construction tools:

For Products: Products must be third-party certified based on testing in EPA-recognized laboratories to achieve the ENERGY STAR label. A percentage of all ENERGY STAR products are subjected to "off–the–shelf" verification testing each year, in addition to up–front testing. The purpose of this testing is to guarantee that changes or deviations in the production process do not jeopardize a product's compliance with regulatory requirements.

Requirements for the ENERGY STAR Program

New Homes: Earning the ENERGY STAR label requires verification of a home's energy efficiency by a third-party organization. There are two ways to get an ENERGY STAR for your home.

The prescriptive path is built around a set of improvements, whereas the performance path is built around a customized set of upgrades. The core energy efficiency specifications for both the prescriptive and performance paths are defined by the National Program Requirements. (See the National Geographic.)

Requirements for the program.

The inspection checklist document has four inspection checklists that must be completed for both the performance and prescriptive paths:

Rater for Thermal Enclosure Systems

HVAC System Installation Quality Rater

Contractor for HVAC System Installation of High Quality

Builder of Water Management Systems

Building science techniques that promote enhanced comfort, indoor air quality, and durability in certified homes are included on these checklists. The inspection checklist document includes the four checklists that must be completed by any home certified under version 3.

For Commercial Buildings: To be eligible for the ENERGY STAR, buildings with a Portfolio Manager score of 75 or higher must be confirmed by a licensed expert (Professional Engineer or Registered Architect). The licensed professional must verify that all energy use is accurately accounted for, that building characteristics (including square footage) have been properly reported, that the building is fully functional in accordance with industry standards, and that all indoor environmental criteria have been met.

A Professional Engineer must attest that the information used to compute the plant's energy performance score of 75 or higher is correct for industrial plants. Furthermore, the plant must pass an EPA environmental compliance screening.

MODELING OF ENERGY

Energy modeling is used to generate simulation models of heating, cooling, lighting, ventilation, and other energy flows as well as water in buildings, as required by codes or voluntary sustainability certification systems. Modifications to the model can be made to accomplish specific energy efficiency goals.

Energy models typically provide an estimate of the project's total energy usage, which allows the design team and the client to not only understand the approximate costs of operating the building's energy requirements, but also to estimate the energy that could be offset by on-site renewable energy systems.

The assigned mechanical engineer reporting to the A/E team normally does energy modeling and simulation, although it can also be done by a third party such as the commissioning authority. Energy modeling is an iterative process that should start in the pre-design phase to enable the design team to make important decisions about orientation, location, and façade construction. As the design process advances, a complete energy model should necessitate the construction of numerous models and should be undertaken by the A/E team on a regular basis to validate the design solution.

ENERGY THAT REGENERATES

It is critical to design for energy efficiency first in new construction and modernization projects, lowering the need to incorporate renewable energy capacity to offset energy demand. Utility power, power from third-party off-site energy suppliers, renewable energy credit (REC), on-site solar and wind, and biogas from on-site digester systems that can be used to power turbines on-site are all options for delivering electricity. Natural gas, propane, gasoline, fuel oil, and diesel may be utilized to power a project, but because they are produced from fossil fuels, they are not considered sustainable.

Some certification systems may ask the owner to identify the source energy for the project's energy requirements, especially if the owner wishes to pursue REC from off-site sources or is pursuing a net zero designation.

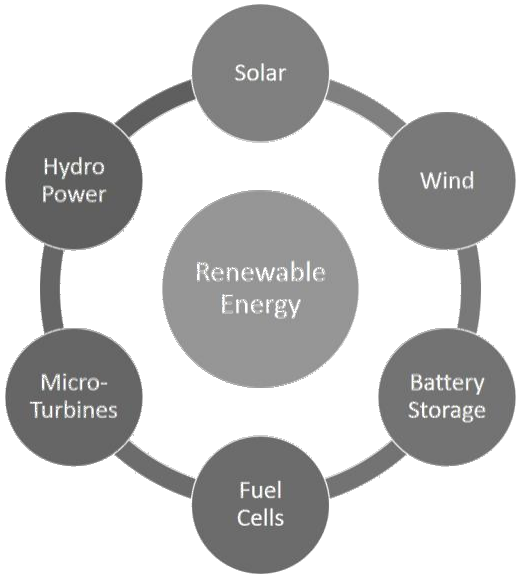
Working with the energy provider, which could be a local utility company or an independent power producer, to identify their energy production systems, confirm the fuel and renewable energy sources produced, and calculate the percentage of renewable energy in the provider's total energy production is all part of this process.

SOLAR

Solar collectors are divided into three categories:

1. Photovoltaic (PV) solar panels are the most common type of solar panel utilized in commercial and residential applications.

Since 2008, panel prices have dropped drastically, and installation costs have dropped dramatically as mounting hardware and installation processes have improved. Inverters that convert the electricity generated by the panels from direct current (DC) to alternating current (AC) have been improved.



Improved cost efficiency in both installation and operations have resulted from (AC). Solar panels can be installed on roofs, carports, and even the ground. They can be installed on a fixed tilt system that does not react to the sun's motions, or on single or dual axis trackers that adjust to the sun's movements during the day.

2. Concentrated Solar Power (CSP): CSP collectors come in a variety of shapes and sizes, but the majority employ highly reflecting surfaces to collect heat that is then transferred to a fluid that drives a turbine. These systems are very specialized and are typically found in utility-scale

power plants that generate enormous amounts of megawatts. Because of their size and heat output, most of these systems are not suitable for installation on buildings or carports.

3. Thermal Solar Collectors: Thermal solar collectors utilize the sun's heat to generate energy, which is then used to heat water or other fluids.

Solar PV systems generate electricity rather than heat, whereas solar thermal systems generate heat. Thermal solar collectors are frequently used to provide warmer water for hot water heaters and swimming pools.

Higher water temperatures are possible with concentrated thermal solar collectors, which might be used to support absorption chillers and hot water requirements for food and healthcare.

WIND

Wind turbines employ available wind to power a generator by turning propellers or other devices with either a horizontal or vertical axis.

Due to code restrictions and community opposition, few projects in urban areas include small wind turbines near to buildings or on rooftops. Large-scale wind turbines are being constructed in rural areas with abundant wind. Although it still accounts for a small fraction of global energy consumption, this approach is gaining worldwide acceptance as a large-scale energy source.

STORAGE OF BATTERIES

The use of batteries to store extra power generated by solar or wind systems gives these systems a lot of flexibility. These power sources can be scaled to meet a wide range of demand levels because they fluctuate with weather or daylight conditions. The addition of battery systems to store excess power when it is available increases and expands the capacity of these systems significantly.

The cost of lithium Ion and other battery storage technologies has decreased, increasing the availability and efficiency of renewable energy sources. The battery systems can store power for subsequent use during peak output hours. These systems are utilized to supplement hydrocarbon-based energy generation systems in countries such as the United States, Australia, and Europe.

FUEL CELLS

A fuel cell produces electricity using the chemical energy of hydrogen, natural gas, biogas, or other fuels in a clean and efficient manner. If hydrogen is used as a fuel, the only products are electricity, water, and heat. Fuel cells are environmentally good because they can run on a range of fuels, however they are only renewable when using hydrogen or biogas.

Transportation, material handling, permanent, portable, and emergency backup power are just a few of the applications for fuel cells. Fuel cells provide a number of advantages over traditional combustion-based technologies, which are being used in a number of power plants and passenger vehicles. According to the DOE, a traditional combustion-based power plant normally creates energy at a rate of 33 percent to 50 percent efficiency, but fuel cell systems can generate electricity at a rate of 60 percent or greater efficiency. Fuel cells emit fewer pollutants and are quieter than combustion engines because they have fewer moving parts. Fuel cells are similar to batteries in that they do not run out of power or require recharging. They generate electricity and heat while supplying fuel.

MICRO-TURBINES

Micro-turbines are a type of distributed generating technology that is used for stationary energy generation. They are a form of small-scale combustion turbine that generates both heat and electricity. These units can typically run-on biogas or natural gas, making them an additional green energy source for projects.

Micro-turbines have a variety of advantages over other small-scale power generation technologies, including a small number of moving parts, compact size, lightweight, higher efficiency, lower pollutants, cheaper electricity costs, and the ability to use waste fuels. These systems can reach greater than 80% efficiency by utilizing waste heat recovery.

The majority of micro-turbines are small and have cheap capital, operating, and maintenance costs, as well as automatic electronic controls. Micro-turbines provide a cost-effective and environmentally friendly option for direct mechanical drive industries including compression and air conditioning.

HYDRO ENERGY

Hydropower is created by extracting energy from moving water using electricity generators. Although there are benefits and drawbacks for local ecosystems, rivers, streams, and waves from bigger bodies of water are now directed through hydro turbines to produce energy.

While it is rare that hydro power will be delivered directly to a project, the owner may choose to acquire hydro power from its servicing utility to meet the renewable energy requirements of certification systems or to meet their own sustainability goals.

STRENGTHENING ENERGY MANAGEMENT

Passive and active strategies can be used to manage the energy consumption of a building. Improved building envelope construction, passive design for energy-independent buildings, updated lighting technologies, and improved HVAC/ventilation technology, including building controls systems, are all examples of energy management best practices.

1. EMS/BMS/BAS - The terms building energy management system (EMS), building management system (BMS), and building automation system (BAS) are frequently used interchangeably to refer to any electrical control system that controls a building's indoor and outdoor lighting, heating, ventilation, and air conditioning (HVAC) system. EMS/BMS/BAS can also monitor security, fire alarms, water flow alarms, and almost any other electrical loads in a building during new construction, depending on the desired level of control and monitoring required by the owner, as well as the costs of implementation.

ISO 50001 outlines the requirements for developing, implementing, maintaining, and enhancing an EMS and provides guidelines on how to do so. The goal is for an organization to be able to take a systematic approach to improving energy performance, including energy efficiency, energy use, and consumption. Certification to ISO 50001, like other ISO management system standards, is achievable but not necessary. Some businesses choose to apply the standard only for the advantages it offers. Others choose to seek certification in order to demonstrate to outside parties that they have implemented an EMS. Certifications are not carried out by ISO; instead, they are carried out by accredited companies to assure independent validation.

Building operators can create and regulate a sequence of actions for all controlled electrical loads using an EMS/BMS/BAS to increase efficiency, control operations, and provide monitored consumption statistics. The importance of planning, system design, hardware installation, and software integration in delivering the projected benefits of these systems cannot be overstated. This includes ensuring that the team has the appropriate skills to complete installation and integration to the required standards.

Automated demand reduction (ADR) systems have been implemented by several utility companies in the United States, as well as some international organizations. These programs are designed to alert building owners of an emergency and encourage them to reduce electricity loads in any way possible to avoid power demands surpassing power supply, such as during high heat waves. The EMS/BMS/BAS are critical in receiving the utility's signal and then

shedding loads in pre-programmed methods as agreed between the owner and the utility, all while minimizing the impact on the building's operation.

2. Building Envelope - The building envelope is the physical barrier that separates a building's conditioned and unconditioned areas. This has always been a crucial factor in a building's energy efficiency. Despite the fact that most energy efficiency attention has been focused on lighting, HVAC, and fuels, sustainability certification systems are now awarding credits for energy-efficient designs and commissioning for the building envelope, which includes insulation, wall materials, roofing, windows, and doors. Advances in technology in each of those areas, such as triple-pane glass, highly reflective cool roofs, and spray-on air barriers and insulation materials, have resulted in a significant increase in energy efficiency by improving temperatures inside conditioned space and thus reducing the need for cooling and heating.

3. Energy Independent Buildings - Grid-neutral, off-the-grid, and zero-energy buildings are among the next generation of energy independent buildings (ZEB). More buildings are being built with the goal of being as energy self-sufficient as feasible, such as:

» Grid-Neutral - A grid-neutral building produces as much renewable energy on-site as it consumes over the course of a year. The building is "grid-neutral" if it uses 500,000 kilowatt hours (kWh) per year and generates 500,000 kWh or more from an on-site solar photovoltaic or other renewable energy system.

« Off-the-Grid - The terms "off-the-grid" and "grid-neutral" are not interchangeable. Off-the-grid structures typically generate all of their own energy, though not always from sustainable sources. They do not draw energy from the grid, except for backup power in the event of a power outage on-site. Off-the-grid systems have a narrow range of applications, primarily in remote places where utility power is scarce. Most utility standby prices are fairly high, making these types of systems less financially appealing.

« Zero Energy - ZEBs, also known as net zero buildings, are buildings with net zero source or site energy consumption and/or zero carbon emissions from building operation on a yearly basis.

The embodied energy of the building and the emissions created during construction are not included in this definition.

its constituents Not just electricity, but all fuels required on-site to power the building, a ZEB creates the same total amount of all energy as it consumes. ZEB can refer to the energy utilized at the site, as well as the energy and any transmission losses for energy from natural gas and propane sources, as well as the energy used to convey the energy to the building. Even if the energy is generated off-site, a ZEB must obtain 100 percent of its energy from renewable sources.

4. Lighting - Studies suggest that lighting accounts for roughly 40% of overall site energy use. Based on the development and application of new lighting solutions, this estimate is improving. For example, the development and widespread acceptance of Light Emitting Diode (LED) lighting has resulted in a significant reduction in lighting's energy effect as a percentage of total project energy use. LED lighting adoption rates for new construction and modernizations should become more prevalent as costs for LED lighting prove to be a good value and energy prices continue to rise.

The management of lighting utilization is a top responsibility for a BAS. Some automation uses analysis and prediction to optimize use or even alter occupant behavior patterns to reduce energy waste from unnecessary lights.

Environmental concerns over fluorescent bulb materials, as well as the gradual phase-out of incandescent lamps through law, have made lighting decisions difficult; yet,

Lighting consultants and electrical engineers should be able to assist CMs in determining the best lighting solution to fulfil the owner's needs while maintaining a high level of energy efficiency.

Heating, ventilation, and air conditioning (HVAC) - Significant advancements in chiller technology have made it possible to regulate chiller operation to be more responsive to temperature changes inside the conditioned space while still retaining great energy efficiency

over the last few years. New chillers with water-cooled systems are more energy efficient than air-cooled chillers or package units with direct expansion (DX) refrigeration systems, with a few exceptions.

The compressors in many DX systems now work more efficiently in partial load performance modes, allowing for the use of variable speed drives and greater efficiency motors for the supply and return fan motors, enhancing the whole DX system's energy efficiency. Although DX systems are not as efficient as most chilled water systems, some clients prefer several package units over a single centralized chiller system for better redundancy and zone management.

Most HVAC systems now use variable speed drives (VSDs) or variable frequency drives (VFDs) to operate fans, pumps, and compressors. If properly configured through an automation system, each type of drive modulates the action of the motor it serves, making it more efficient.

« Air-Side Economizer or Free Cooling

An air-side economizer system, which brings outside air into and distributes it throughout a structure, is used in almost all new construction. The exhaust air from the servers is simply routed outside, rather than being recirculated and cooled. If the outside air is extremely cold, the economizer may combine it with the exhaust air to keep the temperature and humidity within the building's ideal range.

The air-side economizer is part of a central air handling system with intake and exhaust ducting; its filters minimize the quantity of particulate matter (or pollutants) carried into the building. Using free cooling to delay or eliminate the requirement for mechanical cooling from compressors or chillers is a key aspect of the operation sequence.

Due to the age, location, or type of the building, existing buildings may not have air-side economizers and so may not be able to utilize outside air as an effective cooling method.

Evaporative Cooling is a type of cooling that works by evaporating water

Evaporating water into the air is a natural and energy-efficient way to cool in low-humidity environments. Evaporative coolers, often known as swamp coolers, use this technique to chill outside air by passing it over water-soaked pads and allowing the water to evaporate into it. The cooler air is then blown into the structure. Evaporative coolers are half the price of central air conditioners to install and utilize a fifth of the energy. They do, however, require more frequent maintenance than refrigerated air conditioners and are only ideal for low-humidity environments.

« Ground-Source Heat Pumps or Geothermal Heat Pumps

A geothermal heat pump (GHP) heats and cools buildings by utilizing the constant temperature of soil or water below ground. Since the late 1940s, geothermal heat pumps, also known as GeoExchange, earth-coupled, ground-source, or water-source heat pumps, have been in use. Instead of using the outside air temperature as the exchange medium, they employ the earth's constant temperature.

Although many sections of the country suffer seasonal temperature extremes, ranging from blistering heat in the summer to sub-zero freezing in the winter, the ground temperature remains generally consistent a few feet beneath the earth's surface. This ground temperature, like that of a cave, is warmer in the winter than the air above it and cooler in the summer. GHPs take advantage of this by using a ground heat exchanger to exchange heat with the earth.

Even though a geothermal system's installation costs can be several times that of an air-source system with the same heating and cooling capacity, the increased expenses should be offset by energy savings.

Due to environmental conditions such as significant seismic activity or insufficient temperature transfer due to limited changes between above-ground and below-ground temperatures, some areas are not conducive to the functioning of geothermal heat pumps.

WATER

"Water efficiency" is defined by the EPA as "the intelligent use of our water resources through water-saving devices and easy activities that we can all take around the house." The Energy Policy Act of 2005 compels the federal government to boost building energy efficiency and gives tax credits for certain energy-efficient purchases or upgrades, which will assist assure reliable water supplies today and for future generations."

Sustainable water management in the construction sector aims to preserve water, minimize pollution, and reuse or recycle water whenever possible. Efficiency in fixtures, rainwater collection and management, and greywater reuse are all examples of conservation.

The National Institute of Building Sciences' Whole Building Design Guide (WBDG) offers practical advice on how to protect and conserve water in buildings.

EFFICIENCY IN THE USE OF WATER

- Include water conservation and efficiency in construction criteria.
- In buildings, use high efficiency plumbing fixtures.
- Create water-saving landscaping.
- Keep track of how much water you use.
- Measuring cooling tower make-up water supply separately, installing water-conserving cooling towers, and considering hybrid cooling towers are all options.
- Controlled irrigation can help to reduce evaporation.
- Inspect hoses and pipes for leaks on an annual basis.
- As part of the project quality assurance process, commission water and sewer systems.
- Use efficient landscape irrigation equipment as much as possible; specify Water Sense labelled items for high-quality, water-saving products; and implement the Water Sense irrigation program.
- Implement water- and energy-saving best practices in institutional foodservice operations.

QUALITY OF WATER

- Install and maintain stormwater runoff filtration systems such as water quality ponds or oil/grease/grit separators.
- Get rid of any lead-based materials.
- Make use of non-toxic cleaning supplies.
- To avoid contamination of natural water sources through runoff, limit the use of pesticides, fertilizers, and other chemical treatments in groundskeeping. This can be done by choosing landscaping that requires little to no irrigation or fertilizing.

GREYWATER AND NON-SEWAGE WATER

« Irrigate non-sewage wastewater and use it for other purposes allowed by code or local ordinance.

» For on-site operations like flushing toilets, use rainfall, groundwater, and water from sump pumps.

Condensate from HVAC systems can be captured and used.

« Recognize that the production and distribution of greywater is increasing as the demand for this water source grows.

> Install a separate greywater pipe system.

» Read the Council on Environmental Quality's "Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes."

> Work with officials from the local water authority to secure approval for greywater initiatives.

PROGRAMS FOR TREATMENT AND RECYCLING

> Treat garbage on-site with biological waste treatment systems.

> For on-site operations, use greywater, roof water, and groundwater.

MATERIALS

The materials used in a structure have a significant impact on its environmental impact over its lifetime. Recycling and reusing construction and demolition (C&D) materials has numerous advantages when done in an environmentally responsible manner, including the conservation of raw materials, offsetting the impacts of using virgin material in the construction and renovation of buildings and infrastructure, reducing landfilling impacts, and conserving landfill space.

CMs should consider optimizing building space and materials, eliminating waste, using recycled items, conserving energy, and water, and avoiding negative effects on indoor air quality and lifetime costs when establishing specifications. Any project's overarching purpose should be to incorporate the best practices listed below.

PRODUCTS, FACILITIES, AND EQUIPMENT

» When possible, use reconditioned products and equipment.

> Determine whether or not existing building components can be used in new construction or modifications.

> Clean up and redevelop brownfields, greyfields, or other contaminated, formerly used, or impacted sites for a new facility.

» Use locally appropriate design that takes into account local resources and weather patterns.

» Work to eliminate possible sources of toxicity (e.g., polychlorinated biphenyls (PCBs) in lighting ballasts, paints, caulks, and sealants; lead in caulk; lead and cadmium in paints; and asbestos) and enhance energy and water efficiency while using existing facilities, products, and equipment.

FLEXIBLE INSTALLATIONS

» Create main systems with varying purposes and lifespans to encourage disentanglement, which is the dismantling and reuse of materials rather than demolition at the end of their lives.

> Create disassembly connections and provide access to them.

Include re-configurable, changeable interior systems.

> Dismantle, reassemble, and reuse interior systems.

» Use recycled-content building materials.

APPLICATION OF THE MATERIAL

» Optimize functional linkages between program areas and circulation, adhere to goal utilization rates (number of square feet per person or unit), and design individual spaces to accommodate various uses to reduce total building size.

« To save resources and prevent waste, design buildings with conventional commercially available material sizes.

PREFERENCE FOR THE ENVIRONMENT

>> Buy things that are better for the environment.

» Use a product with EPA-designated recycled material.

> Use materials and assemblies that have the largest amount of post-consumer or post-industrial recycled content available.

> Purchase products with an extended warranty, upgradeability, spare parts, service information, and mold resistance to improve product durability.

When specifying items, take into account the EPA's guidelines for environmental performance requirements and ecolabels.

» Analyze the effect offsets that can be achieved when the product is utilized in place of virgin material in another building or infrastructure to capture the benefits of reuse, repair, upgrading, and/or recycling.

» Examine how material selection affects the building's total environmental performance over its lifecycle and specify materials that will provide the maximum environmental benefit.

« In a material specification, key impact locations (or "hot spots") should be given more weight.

When considering environmental preferability, consider trade-offs among numerous environmental impacts.

> Use tools to make the process easier and produce more reliable outcomes.

MATERIALS FOR C&D

» During the design phase, a Construction Waste Management Plan should be developed and implemented to maximize the reuse and recycling of C&D materials generated by the project.

> Choose items and assemblies that have the least amount of disposable packaging and require the least amount of storage space.

» If possible, choose manufacturers and sellers who offer take-back programs when purchasing building supplies and products.

> Look for materials with a high Solar Reflective Index in pavement and roofing (SRI).

« Content that has been reused.

MATERIALS THAT ARE SUSTAINABLE

> Use timber products that have been certified by third-party organizations as being from sustainably managed forests.

» Consider replacing inert or non-recycled materials or products with bio-based materials or products (such as agricultural-fiber sheathing).

> Choose materials that can regenerate in 10 years or fewer (such as bamboo, cork, wool, and straw).

MATERIALS THAT ARE TOXIC

When specifying items, take into account the EPA's guidelines for environmental performance requirements and ecolabels.

> Select materials and assemblies that contain the fewest volatile organic compounds (VOCs) or other pollutants that can harm indoor air quality.

» Asbestos, lead, and PCBs must be removed from all products and assemblies.

« Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as refrigerants should be phased out.

HVAC stands for heating, ventilation, and air conditioning.

» Assess the usage of manufacturing materials and assemblies that do not harm the environment or expose workers to hazardous situations.

» Stay away from things on the "red list."

> Avoid flame retardants/softeners including short-chained chlorinated paraffins (SCCPs), Polybrominated diphenyl ethers (PBDEs), or Hexabromocyclododecane in paints, coatings, plastics, rubbers, and seals (HBCD).

Fluorotelomer-containing product coatings should be avoided.

> Avoid benzidine and benzidine-congener-based dyes in textiles, paints, printing inks, and paper.

Nonylphenol Ethoxylates (NPE) and Alkylphenol Ethoxylates (APE) are surfactants that should be avoided in detergents.

> Invest in products that list the chemicals utilized in the manufacturing process as well as those found in the finished product.

« In structures, ground-level ozone should be avoided.

MATERIALS MADE IN THE LOCAL AREA

> Use locally made products to boost local economies while lowering transportation costs and greenhouse gas emissions.

» Choose materials and assemblies that require the least amount of "embodied" energy to acquire, manufacture, transport, install, and utilize raw materials.

RECYCLING OF WASTE

> Work with building owners to develop an operational waste management plan that encourages recycling.

> Designate enough area(s) for ongoing recyclables collection during the design and construction phase.

> Look at setting up organic waste composting areas on the project site.

CONSIDERATIONS ABOUT MONEY

It's critical for CMs to look into financial options for energy efficiency and renewable energy projects, such as incentives, credits, and other cost-cutting measures.

ANALYSIS OF RETURN ON INVESTMENT/LIFECYCLE COSTS

While meeting energy efficiency and renewable energy targets can help owners meet their goals and meet sustainability certification standards, the savings in utility expenses, offsets from energy generation, and lower operational costs are all important factors to consider. A lifecycle cost estimate for the primary energy efficiency and renewable energy components of a project should be developed as part of the design phase.

The major standards for are included in the worldwide environmental management standards ISO 14040 and ISO 14044.

GRANTS, INCENTIVES, AND TAX CREDITS

Utility and other incentives, government tax credits, and accessible subsidies are all important contributions to the financial advantage of energy efficiency and renewable energy projects. While most public sector clients will not be able to take use of tax credits directly, they will be able to take advantage of grant funds and incentives specifically for the public sector. Additional information and guidance can be found in the following resources: xix

« The Department of Energy's Database of State Incentives for Renewables and Efficiency (DSIRE) xx is the most comprehensive and up-to-date database of state, federal, local, and utility incentives and regulations supporting renewable energy and energy efficiency projects.

« The best method to learn about any utility incentives or rebates available for energy efficiency renovations is to contact the utility that services the project.

BENEFITS OF NET ENERGY METERING

Many utilities provide solar and other renewable energy customers a net metering bonus. Net energy metering is a sort of distributed generation in which consumers with a qualified power generator can use energy they export to the grid to offset the cost of their electric usage. The difference between the electricity the customer purchases and the electricity the customer exports to the grid is measured by a specially programmed net meter. The mechanisms for applying credit for exported energy differ depending on the program and the size and kind of plant.

PERMANENT EDUCATION

It is critical for CMs to stay up to date on new construction technology and techniques, particularly those related to sustainability. The CM is in charge of introducing and advocating for methods that will benefit both the project and the environment. Below are some concepts that should be investigated further to see if they may be used to future or current projects.

BIOMIMICRY

"Biomimicry is a practice that learns from and mimics the strategies found in nature to address human design challenges—and find hope along the way," according to the Biomimicry Institute. It is an emerging technology that CMs can implement along with innovative, tunable white light

LED products to simulate the qualities of natural light inside buildings. The goal is to create products, processes, and policies—new ways of living—that solve our greatest design challenges sustainably and in solidarity with all life on Earth."

RETROFITTING DEEP ENERGY

Deep Energy Retrofit (DER) is a concept used frequently in public and private construction projects that involve existing structures. A DER, according to the US Department of Energy, is "a total building study, construction, or renovation that would lower energy expenses by 40% or more while producing more energy," and it can also improve the health of those who live there.

Instead of a traditional retrofit, deep energy retrofits necessitate a "systems thinking" approach. Systems thinking is a means of assessing the interactions between the building's various isolated components, as well as all of the building's energy needs and inhabitant activities. By focusing on limiting space conditioning loads by reducing outdoor air infiltration and heat transfer via the building shell, significant savings can be realized. LED lights, occupancy sensors, and energy-efficient appliances are used to reduce internal gains. Deep retrofitting a building is a critical first step in making it "net zero ready."

Deep energy strategies have been implemented by the DOE to aid in its mission to reduce greenhouse gas emissions, increase renewable and alternative energy use, comply with the Federal Guiding Principles for High Performance Sustainable Buildings (HPSB), and convert existing buildings to net zero energy status.

THE HEALTH OF HUMAN BEINGS

The National Institute of Environmental Health Sciences (NIEHS) suggests addressing environmental concerns that can also help people's health. Creating surroundings that favor biking and walking for transportation, for example, reduces greenhouse gas and hazardous air

pollution emissions while also increasing physical activity (environmental benefit) (health benefit). It's also vital to keep in mind that some policies, practices, and technology aimed at promoting sustainability and economic development may have unforeseen negative consequences for the environment's health.

The Center for Active Design (CfAD) is a non-profit organization that uses the Fitwel Certification System to improve design and development techniques to support better health. Fitwel offers certification processes for new and existing projects that prioritize health in the design, development, and operation of buildings and communities.

The WELL Building StandardTM, developed by the International WELL Building InstituteTM (IWBITM), is a global rating system that focuses solely on how buildings may increase comfort, drive better choices, and improve health and wellness.

EQUITY IN SOCIETY

Sustainability is more than merely adhering to rules in order to obtain a certification. It's a multifaceted strategy to enhancing a community's or region's livability and viability, with social fairness as an important component. Fair access to resources and opportunities, as well as full involvement in a community's social and cultural life, are all aspects of social justice. Any construction project should consider incorporating this approach.

Planning for Climate Adaptation and Resilience

Local site characteristics and climate variables should always be considered while making project decisions. The CM should assist in the project planning process by assisting in the identification, evaluation, selection, and implementation of design elements that take into account local climatic conditions and reduce project vulnerability to extreme weather occurrences. The climate resilient project attributes outlined in these guidelines are intended to encourage the CM/PM to

think about and include techniques for adapting to climatic variability as well as the protection of persons and property.

The ability of a system to perceive, anticipate, and protect against the changing shape and timing of risk before negative consequences materialize is referred to as resilience. It's also about having the adaptability to recover rapidly and the ability to tolerate significant disruptions with acceptable degrees of degradation and recovery within reasonable time, cost, and risk constraints.

Adaptive capacity is typically characterized as a system's ability to adjust as the environment in which it operates changes. Climate Adaptation and Resilience (CA&R) is a practice that combines risk and vulnerability assessments, mitigation planning, emergency response, and project development for site hardening and infrastructure strengthening with known components of regional climate and geological information.

PLANNING

Before an incident occurs, planning addresses the approach needed to safeguard and upgrade infrastructure, essential facilities, systems, and services to ensure resiliency, endure stressors to retain operational functionality, and support human health, welfare, and safety. Energy generation/transmission/distribution facilities, water wells, reservoirs, aquifers, aqueducts, stormwater and sewer systems, fuel refineries/storage and gasoline pumping stations, telecom systems, highways and roads, bridges, tunnels, railways, airports and air traffic control, harbors and marinas, military bases, police and fire stations, and command centers are all examples of vital infrastructure assets.

DATA RESOURCES

The collecting of regional climate and geology information, which includes historical weather, oceanic, and seismic data for the region where the project is being built, is the foundation for

designing a resiliency approach. This data will be used as a standard for future project estimates. Depending on the past climate influences on buildings and infrastructure, it may be essential to expand the scope of climatic studies to a larger region.

The United States Geological Service (USGS), California Institute of Technology (Caltech), NOAA, major universities in the region, State Land Commissions, and State Sea Grants can provide CMs with historical and projected data on temperature change, precipitation, sea levels, coastal land subsidence, storm surges, and seismic activity. Potable water sources, storm water storage and conveyance, wastewater treatment assets, electrical, natural gas, and building and transportation assets that are vital to water protection and conveyance may all be affected by these factors.

There are a variety of methods for conducting resiliency assessments, some of which are open to the public, such as those produced by the US Army Corps of Engineers (USACE). These tools provide a structured approach for assessing water infrastructure assets as well as risk, hazard, and vulnerability evaluations for any other assets, structures, and systems within the project's scope.

ORGANIZATION OF THE ASSESSMENT TEAM

A CA&R evaluation, as well as the development and execution of the implementation plan through the construction project's conclusion, will require an expert team.

Typical team members should include:

» Risk analysts for adaptation

» Architects

» CMs

Professionals who deal with emergency situations

Engineers of all disciplines are welcome to apply.

« Environmental experts

Managers of facilities

» Geologists

« Experts in risk assessment

» Hydrologists

» Meteorologists

> Program directors

» Experts in regulatory affairs

« Risk takers

» Seismologists

Internal risk assessors and insurance industry resources will be required to conduct risk management assessments that will provide key information on probability projections of potential loss resulting from system damage and loss of operations, as well as their short- and long-term impacts on human health and safety.

ASSESSMENT OF RISK REQUIREMENTS

Risk assessments should be carried out prior to the commencement of design development to identify vulnerabilities, potential hazards, and important facilities. The goals of a vulnerability assessment are to:

> Calculate the likelihood of a significant climate event affecting a certain location.

> Figure out how many times the site has been harmed in the past, and how severe the repercussions were.

> Evaluate recent site enhancements that may give protection from future events.

> Write down particular lessons from previous events.

> Prior to the next event, identify specific weak points in the site that need to be fixed.

In an evaluation of possible hazards, the assessment team should identify the historical hazards of the region and the historical frequency of major events combined with an estimate of the potential for significant change in the future in part based on a progression of change of frequency over time. For example, substituting "100-year flood" with "extreme hydrologic event" is a good example of using terminology that aren't misleading. Other notable events include:

» Earthquakes

« Flooding or heavy snowfall

» Fires

Surges caused by storms

« Tornadoes and hurricanes

» Super-storms

« Extremes of temperature

It's crucial to concentrate on what makes a site or facility critical, as well as what will happen if the facility is unable to run for varied amounts of time, and to identify critical operations inside facilities such as:

« Command and control centers

« Computer data centers

« Power in an emergency

« Switchgear main

» Telephone booths

STRATEGIES FOR CLIMATE ADAPTATION DEVELOPMENT

The results of the historical and anticipated weather information can then be combined with the risk and vulnerability assessments of important systems and facilities by the project team. Within the framework of the planned program, this should provide a thorough picture of present conditions, points of vulnerability, points of strength, and measures required to improve adaptive capacity of the project's systems and infrastructure.

The following are some of the strategies that are available:

» Strengthen sea walls, improve bridge supports, and make electrical distribution systems more resistant to water and snow impacts: This strategy improves the site's adaptive capacity through prudent measures such as strengthening sea walls, improving bridge supports, and making electrical distribution systems more resistant to water and snow impacts.

» Soft measures: Regulations and processes for dealing with inclement weather, such as emergency plans, evacuation protocols, strong enforcement of no-smoking policies, and procurement procedures that improve emergency readiness.

» Increase redundancy: If key facilities or systems do not have redundancies, it may be beneficial for the owner to build them to defend against long-term outages and business disruption.

« Relocation: If a site or system is discovered to be in danger on a regular basis during the risk assessment process, it may be best to transfer the site or system to a less vulnerable area.

« Abandonment: When the site is no longer needed or the expenses of site hardening or other techniques are too high to justify continuing to use the site, abandonment can be used.

« Divestiture: Divestment, like abandonment, refers to the sale or exchange of the site or building to third parties.

« Prioritization of projects: This method makes the best use of available finances.

» Maintain and manage in place: This is a technique for resiliency that involves managing and maintaining an existing site or project while taking no new measures. If the facility or project is obsolete and is slated for abandonment, divestment, or demolition and re-construction in the near future, this may be the ideal solution.

CLIMATE ADAPTATION AND RESILIENCE IN WATER SYSTEMS IS AN EXAMPLE OF A PROJECT.

Improvements in the protection and preservation of potable water supplies from climatic hazards such as droughts, storm surges, and regional flooding are one of the essential factors of resiliency in water systems. It's critical to undertake adequate research and give reports on case studies and comparable programs, as well as precise recommendations for project development and implementation that would improve regional storm water management, watershed protection, and, eventually, water quality. Improvements in these areas will necessitate assessments of alternatives to existing systems, flow patterns, and ecological implications of both present systems and suggested alternatives, in addition to research and case studies.

Floods have exposed flaws in storm water runoff systems for metropolitan streets around the United States. To assess the adaptive capability of those systems, one viable way is to combine historical and anticipated meteorological data with existing data from the region on the placement and capacity of storm drains and utility corridors. This will allow the CM to make recommendations on infrastructure projects including storm drain extensions, drain size, and green infrastructure enhancements like bio-swales, retention ponds, and curbside natural stormwater filtration systems.

The time, intensity, and source of environmental impacts on systems can all be different. The influence on all parts of water systems will strengthen as a region's population grows, emphasizing the necessity for continuing conservation strategies. The CM should use data from water districts to identify all current and future conservation approaches, as well as those in development or considered innovative. The CM can then report on the estimated effectiveness of previous programs as well as the potential effectiveness of future programs in mitigating the impact of rising population and the resulting water demands.

Water districts are becoming more aware of the importance of wastewater treatment plants not only in terms of high energy consumption, but also in terms of the potential to generate significant amounts of energy through on-site renewable energy sources such as digester gas, which can be used in turbines, fuel cells, and photovoltaic solar installations.

The CM may be required to provide information on current flow rates and waste produced by the systems in use. This study identifies prospective improvements that could lead to reduced energy consumption, waste utilization, and higher energy production, as well as any environmental consequences of any project proposals.

In addition, a complete report of the numbers and types of greywater systems now in use, including on-site wastewater treatment systems, in towns that are active leaders in the development of innovative technologies in these areas may be required. The CM may be asked to offer recommendations that will improve greywater and on-site wastewater treatment, as well as prospective technological advancements and the use of technologies from other parts of the world.

DESIGN AND CONSTRUCTION OF LOW-IMPACT DEVELOPMENT

Low Impact Development (LID) is a method of project development (or redevelopment) that collaborates with nature to manage stormwater as close as possible to its source. LID design and construction principles include preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater

as a resource rather than a waste product, and treating stormwater as a resource rather than a waste product. Bio-retention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements have all been employed to conform to these principles. Water is managed in a way that limits the influence of constructed areas and encourages the natural circulation of water within an ecosystem or watershed by following LID principles and methods.

Any building or infrastructure project that aims to improve resiliency and adaptive capacity should use LID design and construction methodologies.

The following are some instances of LID development design and construction:

« Bioswales and natural stormwater filtering systems design and construction.

« Making use of recycled or high-recyclable-content materials.

« Building waste minimization and construction material recycling

QUIZ

QUESTION 1

The following are the common features of a sustainable project except one

a) Water management and conservation systems.
b) Energy-saving features or measures that employ both passive and active tactics.
c) Procedures for operational and maintenance optimization

QUESTION 2

Sustainability is a crucial component of project and construction management

a) Yes
b) No
c) Partially

QUESTION 3

One of a successful CM's major responsibilities in terms of sustainability is to?

a) Assist in the hiring of qualified designers and contractors. Some designers, contractors, and consultants may encounter requirements that are novel or specific to projects incorporating sustainability characteristics
b) Standard cost management systems
c) None of the above

QUESTION 4

Planning, organizing, executing, monitoring, and documenting a system of rules and procedures that assign, coordinate, and direct relevant project resources and activities in a manner that achieves project objectives and performance standards is known as?

a) Time management
b) Quality management
c) Project plan

QUESTION 5

Any building or infrastructure project that aims to improve resiliency and adaptive capacity should use?

a) The time, intensity, and source of environmental impacts
b) Filtration systems
c) LID design and construction methodologies.

QUESTION 6

The following government agencies have a strong interest in and influence on sustainability issues except one;

a) Environmental Protection Agency of the United States (EPA)
b) Department of Guidance and Control (DGC)
c) Department of Energy of the United States (DOE)

QUESTION 7

_____also pertains to the features that contribute to sustainability in many projects with sustainability features.

a) Making
b) Safety
c) Manual

QUESTION 8

The CM's role as "communicator-in-chief" is to ensure that project participants understand the importance of safety and the measures in place to protect life and property

a) Yes
b) No
c) Partially

QUESTION 9

What is Risk Management?

a) The systematic application of management methods to mitigate the negative impact of uncertainties on a project's cost, schedule, and quality expectations
b) Advice on how to implement a project that is sustainable, green, resilient, and/or high performing.
c) The efficiency in utility usage, resource, and waste management

QUESTION 10

Throughout the life of a _____, it is critical to maintain a focus on time management.

a) Design guide
b) Quality management
c) Project

MODULE 2

PRE-DESIGN PHASE

The pre-design phase may be the first time the CM uses the construction management process to define and achieve the goals of a sustainable project. The project is started, and the program is developed during the pre-design phase, which occurs before schematic design begins. This is the stage of planning and conceptualization.

Sustainability Plan

The CM's first priority is to assist the owner in establishing long-term goals and objectives. This could be included in a project owner's criteria (OPR). Before a project satisfies the owner's time, cost, quality, sustainability, and other performance goals, many conceptual design and estimation iterations may be required. Once the owner has identified and agreed these requirements, the team must commit to completing the project within those parameters. Follow the steps below to build a Sustainability Plan.

Establish the goals, objectives, and requirements for the owner's sustainability.

1. Create sustainability goals, objectives, and requirements that will guide future decisions and management systems and aid in measuring the project team's success throughout the project.

The strategy could include the following elements:

» Intentions to pursue a specific rating based on design guidelines such as LEED, Envision, and others.

ENERGY STAR or Green Globes.

« Whole-building commissioning and/or envelope commissioning specifications.

« Achieving energy or water efficiency performance that is above code in some way.

« Dedication to achieving off-grid or net-zero energy performance.

« Implementation of a cloud-based project/document management system.

» Using BIM to improve design, construction, and facility operations efficiency.

« A commitment to purchase materials and products from an environmentally preferred purchasing database authorized by a reputable green product certification program such as the US Environmental Protection Agency, Green Seal, EcoLogo, Scientific Certification Systems, or MBDC Cradle to Cradle.

» Monitoring based on continuous or repeated commissioning is included.

« Dedication to achieving local workforce employment or development goals (and other environmental justice goals).

« Development and integration of an adaptation and resiliency plan.

2. Create a sustainability plan for the business owner, which may include:

» A component of the construction management strategy (s).

» As part of the sustainability benchmarking requirements for Integrated Project Delivery, a multidisciplinary effort for team building and communication can be incorporated (IPD).

« Goals and desired results must be articulated, as well as impacts and mitigation techniques identified, and monitoring and control systems relevant to the sustainability program established.

» How will sustainability criteria be factored into quality?

« A management strategy.

› Procedures and processes to be included in procedure manuals.

3. Assemble your team as follows:

» Include a party in charge of coordinating project participants' collaboration and performance in order to achieve sustainability goals and objectives.

» Use specialty subconsultants or subcontractors to help you achieve your sustainability goals and objectives.

» Develop and implement training to increase team members' understanding of available materials, equipment, and procedures for achieving sustainability goals and objectives.

4. Staff development is essential.

5. Create strategies and procedures.

6. Establish a project budget and suitable contingency levels.

7. Create master schedules and workflow diagrams.

8. Create a purchase strategy.

The Sustainability Plan must be included in a document that explains the sustainability program's strategy as well as a preliminary sustainability scorecard. Both documentations should be included in the designer's programming. Time should be set out for producing and analyzing both deliverables, as they will have an impact on the process and the budget.

DESCRIPTION OF SERVICES

Contract documents for consultants, subconsultants, contractors, and subcontractors that have already been generated should be updated to reflect the following:

« This is an OPR document.

« Sustainability aims, targets, and prerequisites

» If relevant, contract specifications for a sustainability rating or certification (LEED, Envision, Green Globes, etc.).

If applicable, project sustainability performance standards.

« Project sustainability features or measurements, where appropriate, with a focus on those that necessitate additional verification or documentation.

« Documentation is essential to certify the accomplishment of tasks or the achievement of sustainability goals and objectives.

« Third-party or independent verification responsibility matrix for certain systems and/or tasks.

Contract papers for projects with sustainability standards should include the following:

« Specific guidelines and codes are referenced.

> Instructions and provisions for determining project goals and participant roles and duties.

> Procedures that are applicable.

« Risk distribution.

SELECTION OF THE DESIGN TEAM

The owner must create a team of design and construction management professionals to define and develop the project, as well as organize project participants' actions.

The owner should be urged to seek design consultants with experience and particular duties for the sustainable design and construction program, such as:

« A/E with experience in sustainable design and construction in the systems or solutions being examined. Technical subconsultants with the necessary experience, including BIM expertise if necessary.

CxA is in charge of planning and directing the building commissioning process as well as specific commissioning activities. The CxA is designed to offer the owner with unbiased third-party advice.

Despite the fact that they are not part of the design team, involving them early in the process might help meet quality, sustainability rating system, or even code criteria. The CxA can assist in defining the OPR and vetting the design against it.

• A good CxA must have a combination of lead engineering design knowledge as well as substantial field experience installing and testing mechanical and electrical equipment and systems.

• Envelope CxA may be a different team member with competence in curtain wall, masonry, concrete, and roofing systems. Owners should consider requiring a recognized certification or credential for the CxA. The following are some common techniques to arranging commissioning roles and responsibilities:

Independent Agent as CxA (most common) - In some circumstances, such as when seeking a third-party independent expert who is only responsible to the owner, the CxA as a third-party independent expert may be desired.

LEED certification is a green building certification program.

CM as CxA - When the CM is outside of the contractor's team (not "at-risk") and has the necessary technical competence, this is a successful and cost-effective strategy.

A/E as CxA - Cx services are provided by many engineering businesses. BECx services are provided by several architecture firms.

When hiring an architect or engineer as a CxA, the CM must be aware of any constraints on the CxA's credentials, experience, or relationship to the project.

» Coordination of project participants' participation on sustainability project deliverables, goals, recordkeeping, and verification methods by a sustainable design consultant or GBF. This could be the CxA, a member of the project team, or a distinct consultancy.

Consultants should be chosen based on their general suitability and proven previous performance on similar projects. In A/E, CM, CxA, and GBF contracts, responsibilities and requirements for sustainability assessments and document production should be explicitly stated.

QUALIFICATIONS OF COMMISSIONING AGENT

A commissioning expert (CxA) has a technical background and extensive knowledge of the commissioning process, including verification procedures, functional performance testing, system equipment, and operations and maintenance (O&M). Building commissioning experience, including technical and management skills on projects of similar scale, size, and kind, is required of the CxA. The CxA should provide a comprehensive building commissioning perspective to the project, as well as understanding of national building codes, fire detection systems, LEED, building energy and water use systems, and controls, such as thermostats. BAS stands for Building Automation Systems. Building envelope commissioning is becoming more common in sustainable projects, as the envelope is increasingly considered as a component of the energy system. The CxA could also be a qualified owner's employee. The Building Commissioning Association and others offer CxA certificates.

Many federal, state, and local governments have produced design principles having regional and local relevance, which CMs should be aware of. Green design regulations may differ amongst agencies in larger towns. School districts have a tendency to adopt their own set of rules.

High-performance facility requirements have been adopted by federal government entities. The General Services Administration (GSA) requires LEED Silver certification for all new construction and large renovations, while the GSA encourages project teams to go above LEED Silver and attain LEED Gold.

A National Performance Building Design Guide is maintained by the National Institute of Building Sciences (NIBS). Its main goal is to establish a performance baseline that meets minimum code requirements, as well as three higher degrees of performance. It offers a full menu for service providers and, in particular, building owners to select which specific building performance should be focused.

There is a wealth of information available on how to apply sustainable design and resilience concepts to various facility types.

Project Management Techniques

To achieve sustainable design and construction goals, the owner's legal counsel must establish a proper governing contract strategy. The owner and owner's counsel must define risk allocation techniques in contract papers regardless of the contracting type. (For more information, check the CMAA Standards of Practice.)

Contracts should include the following provisions:

> Determine who is responsible for achieving sustainability goals.

« Clearly defined responsibility provisions.

> Classify damages as incidental, so that they can be handled more thoroughly under the underlying governing contracts.

> Define and provide for losses that the owner could legitimately suffer if the project fails to meet specified sustainability criteria.

« May also establish project performance metrics, such as a specified EUI.

DESIGN-BID-BUILD

D-B-B (Design-Bid-Build) is a classic process that involves an architect or engineer designing and producing contract paperwork, then competitively bidding the project to a third-party contractor. Clear and full contract and bid agreements that identify sustainability features can reduce the risks of a project's sustainability features being realized.

AT-RISK CM

CM at-risk is a delivery technique in which the contractor is hired to complete the project within the owner's budget, sometimes under the terms of a Guaranteed Maximum Price (GMP). On a CM at-risk project, the CM facilitates and coordinates design on behalf of the owner, and then works as a general contractor during the construction phase. A CM must have a solid awareness of associated cost, schedule, and quality factors, as well as a clearly defined certification target, if applicable, to limit the CM's exposure to risks on a CM at-risk project with sustainability characteristics.

DESIGN-BUILD

Design-Build (D-B) is a project delivery method in which the owner assigns contractual responsibility for design development, engineering, and construction to a single entity, allowing

the design and construction phases to overlap and encouraging collaboration between the builder and the architect/engineer. This system is advocated in order to reduce project risk and speed up delivery. D-B assists in the achievement of project sustainability features by bringing the builder's practical knowledge to bear on the early planning and design of the sustainability aspects. D-B also allows for changes to the material/equipment plan to take advantage of changes made during design and construction.

DELIVERY OF AN INTEGRATED PROJECT

IPD is a method for aligning stakeholder goals and improving collaboration. The builder's practical experience in planning and designing sustainability aspects can be incorporated early in the process using this method. Few projects include all of the IPD features, although other project delivery methods can make use of any or all of them to improve collaboration.

Although there are many differences, most IPD projects have some of the qualities listed below.

« Instead of separate contracts for each party, a multi-party contract signed by the owner, an architect (or A/E), and a CM (or general contractor). It's possible that other essential consultants or subcontractors will be added.

« A management committee comprised of members from the core team, including the owner.

« Core team members share risks and incentives based on collaboratively set goals.

« Open-book financials and transparent processes.

« A focus on team-based decision-making.

Waivers and dispute resolution ladders are examples of strategies for reducing litigation.

« Significant design collaboration by the builder(s).

« The concepts of lean construction.

« The usage of collaborative software like BIM and PMI (PMIS).

« Project team co-location and open communication

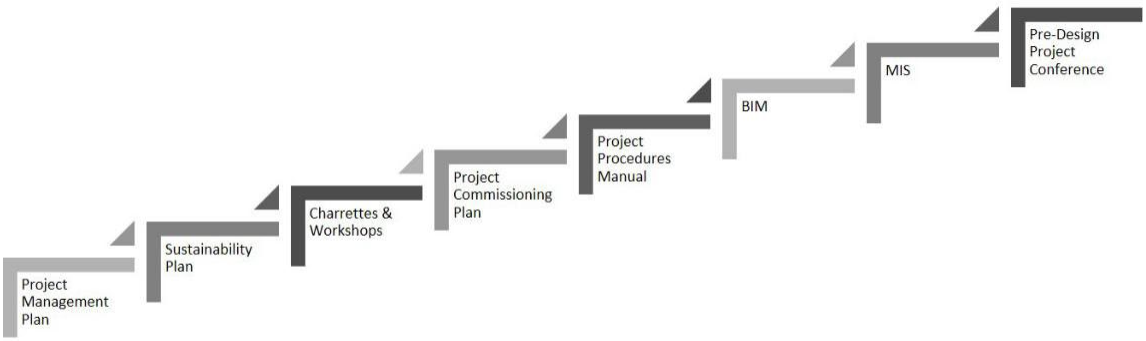
CONTRACTING FOR ENERGY PERFORMANCE

Energy performance contracting is a type of procurement that is becoming more popular for some energy efficiency projects. Clients can leverage future energy cost savings to pay for new energy-efficient equipment and services through this method. Several states have used energy performance contracts to reduce energy usage in state-owned buildings by 15-35 percent. Over the course of the contract, energy performance contracts often ensure that cost reductions will meet or exceed payments for equipment and services. Owners put together an in-house team, frequently with the help of a third-party energy expert, and undertake a preliminary assessment to determine which facilities have the most energy-saving potential. Following the completion of the preliminary assessment, the owner seeks for an energy service company (ESCO) with the required experience and selects one through competitive bidding and qualification processes. The owner undertakes an investment-grade energy audit after selecting an ESCO to discover potential energy-cost-saving options.

The audit results, if accepted, can be used to create a complete action plan. The ESCO submits this proposal to the agency, along with the estimated expenditures. The performance contract is based on this plan (PC). Owners can work with ESCOs to ensure that the PC spells out the contract's length, each party's roles and obligations, maintenance requirements, staff training, the process for measuring and verifying savings, a savings guarantee, and financing terms, among other things. An efficient PC requires a well-defined process for calculating energy cost savings. If energy cost reductions are to be shared, all parties must understand how they will be quantified and validated.

Management Instruments

To communicate project needs to all stakeholders and move the project forward in an organized manner, the CM often use a variety of management tools. Each of these tools should be tweaked to clearly define sustainability goals and objectives, as well as project features and metrics, as well as roles and duties. The tools will progress in a natural order, with some overlap and cross-references.



PLAN FOR PROJECT MANAGEMENT

The CM should make certain that the Project Management Plan includes the following information:

Goals, objectives, requirements, reporting information, and milestones for the project's sustainability.

› Roles and responsibilities for coordinating sustainability operations to produce sustainability features, deliverables, recordkeeping, and verification measures, among other things

« Risk management techniques

PLAN FOR SUSTAINABILITY

The Sustainability Plan is project-specific, allowing the CM to coordinate efforts, track progress, and focus energies on deliverables and milestones in order to meet the project's sustainability goals and standards. A Sustainability Plan serves as both a guide and the basis for a reporting system.

The strategy should be as simple as feasible and include the following information:

« Goals, objectives, and prerequisites for project sustainability.

« A preliminary checklist or assessment for sustainability.

« Roles and duties for the coordination of yield-oriented sustainability actions. Features such as sustainability, deliverables, documentation, and verification mechanisms, among others.

› Reporting criteria and deadlines for sustainability.

« Risk management techniques

The Sustainability Plan should be one of the first papers developed by the project team because the project's sustainability standards must be integrated into all other management and contract documents. It should be concise and incorporate all of the team's measurable requirements.

TEAM CHARRETTES AND WORKSHOPS INTEGRATED

One thing that all green building rating systems have in common is the use of an integrated approach to the design and construction phases of a project, as well as the requirement to involve a wide range of stakeholders in the design process in order to achieve high-performance and breakthrough improvements. During the pre-design phase, collaborative team meetings, workshops, or charrettes are required, with follow-up sessions extending until the building phase. These sessions must be documented in order to confirm the OPR and establish the design foundation.

A charrette is a multi-disciplinary, high-intensity collaborative design exercise. Because students at L'Ecole des Beaux Arts would finish their group projects at the last minute while riding in a hired waggon to school, the name comes from the French word "waggon."

The first workshop should be devoted to determining the project's high-performance objectives and assessing the site analysis data and conclusions in order to incorporate them into viable design methods. Examining the practicality of green building rating systems and their

prerequisites, as well as identifying any opportunities or obstacles in satisfying these standards, should be part of this process.

The following are examples of possible objectives:

Orientation, shape, massing, usage, occupancy type, and occupancy schedule are all characteristics of a building.

« Glazing percentage, glazing performance, external shading, wall performance, roof performance, and infiltration are all aspects of building envelope design.

« Natural/passive cooling systems, efficient mechanical systems, and mixed mode systems are examples of ventilation and conditioning technologies.

« Building monitoring and/or sub-monitoring, building automation systems, and building performance dashboards are all examples of energy management.

Solar electric, wind systems, and flex energy/solar ready are examples of alternative energy options.

» Daylighting - appropriate fenestration layout (windows, light shelves, skylights), glare control and shading devices, daylight solutions for overhanging areas, awning windows, eaves, porches/lanais

« Lighting fixtures, lighting controls, external lighting, and recreational field lighting are all examples of lighting design.

« Kitchen equipment and appliances for food service.

Solar hot water systems and domestic hot water systems are two types of hot water systems.

Irrigation and control systems, indoor plumbing fixtures, water metering, flow control or pumping systems, hazardous waste treatment systems (e.g., for lab waste), on-site water sources (e.g., ponds, wells) and municipal supply, rainwater capture, greywater, and wastewater systems are all examples of water systems.

« Landscaping includes softscape and hardscape design, as well as techniques to limit heat gain, give shade from harsh weather events, wind, or deflect undesirable noise.

« Stormwater management - on-site or off-site solutions, detention or retention, and LID techniques

» Materials - durability and performance, particularly in coastal schools with high humidity, moisture, and extreme weather events, minimal maintenance, low-emitting materials, and environmental performance reporting

« Space acoustic performance criteria

« A master plan and/or a blueprint for future expansion.

« Disaster management or resiliency strategies (weather, tsunami, flood, seismic, etc.).

> An approach to cost analysis that considers all aspects of a product's lifecycle.

> Determine the project's EUI aim.

PLAN FOR PROJECT COMMISSIONING

The owner's needs are documented and created as the foundation for design, building, and occupancy during the pre-design phase in the form of the OPR. The OPR also serves as the foundation for the commissioning strategy.

The commissioning plan outlines the commissioning process's organization, timetable, resource allocation, and documentation requirements, which is a quality-focused approach for improving project delivery. The process focuses on ensuring that the facility, as well as all of its systems and assemblies, are planned, developed, installed, tested, operated, and maintained in accordance with the OPR.

The commissioning plan establishes the structure for commissioning management and execution. All commissioned projects require a preliminary commissioning plan. It gives all project participants a framework for anticipating and planning commissioning requirements and

milestones. The plan is created during the pre-design phase and modified at or near the end of the design period. The commissioning plan focuses on incorporating the owner's performance requirements into the construction papers at the pre-design phase. Construction phase commissioning plans include details on system tests and processes, assembly-specific checklists, and testing and documentation responsibilities.

The following sections or topics are often included in commissioning plans:

› Overview of the project.

« Project commissioning overview and scope.

> Protocols and communications for commissioning.

« The commissioning process includes the roles and duties of the team.

» Commissioning timetable

› Documentation for the commission.

» Appendices:

• Plans for testing and inspection.

• Procedures for change management.

• Procedures for pre-functional and functional testing.

• Checklists for construction.

• Produces logs.

This procedure should be attended by all project stakeholders, who should become acquainted with the program. With each subsequent phase, the CxA must verify that the program's objectives are being met or document how the program's scope has changed using change management methods that require all stakeholders' approval. The commissioning process

activities must meet the prerequisite requirements for essential building commissioning in order for a project to be LEED certified.

MANUAL OF PROJECT PROCEDURES

Procedures relevant to sustainability must be included in the Project Procedures Manual. All other project procedures for all phases of the project must reflect sustainability-specific challenges.

The Project Procedures Manual usually covers the following topics:

« A look to the future.

› Change management or configuration management.

> Requirements for commissioning at all stages

« Requirements for C&D waste management

Controls for indoor air quality.

> Document control for long-term projects.

» BIM processes, all phases, all stakeholders

MODELING INFORMATION BUILDING

BIM stands for Building Information Modeling, which is the process of creating and managing building data throughout its lifecycle using three-dimensional, real-time, dynamic building modeling software to boost productivity in building design and construction. Building information modeling (BIM) is made possible by modeling software that takes into account

building geometry, spatial linkages, geographic data, and the quantities and attributes of building components. Because calculations and trade-off analyses are enabled early in the process, supporting earlier design decisions, and enhancing cooperation and coordination, BIM has the potential to save project time and expense on a sustainable project.

Rework and construction errors can both be reduced by using the same characteristics. The data entry into a single model provided by BIM helps to manage inconsistency and inaccuracy caused by manual and multiple input. All project participants have access to the data once it has been input or changed in the single current model. BIM can be used to "rehearse" construction processes, such as project sustainability features, as well as detect and resolve issues before spending actual construction money. BIM can also help with the data collection required for project sustainability certification (s).

It's vital to make a choice about the scope and process of BIM use as early as feasible in the project so that BIM processes may be communicated to all stakeholders and implemented into contractual papers.

If BIM is to be used on the project, development, modification, and management procedures should be documented separately and included into all other project management procedures. It should be expected that BIM would interact with data management and reporting systems.

INFORMATION SYSTEM FOR MANAGEMENT

The Management Information System, or MIS, should allow for the secure and efficient capture and output of project data needed for reporting and forecasting, as well as meeting the data management and reporting needs of a project with sustainability goals and objectives that may necessitate distinct reporting. Many projects opt to employ a cloud-based document management database to make information movement between team members easier. After the building phase is completed and the operations phase begins, this might be a beneficial tool for the owner.

On projects implemented by ESCOs or other parties with carbon footprint or GHG reduction targets that are important to financing mechanisms, the MIS's data capture, storage, and reporting functionalities are critical.

Project workers who are familiar with sustainability and commissioning reporting needs should be contacted as soon as possible on formats, data management requirements, report distribution and frequency, and records preservation policies.

CONFERENCE ON THE PRE-DESIGN PROJECT

A pre-design project meeting should be planned, conducted, and documented by the CM to ensure that all project participants understand their roles, responsibilities, goals, and process requirements as outlined in the project management plans and procedures. As a mission-critical part of the project, sustainability goals and objectives should be clearly specified. Participants should be informed about the risks and ways for mitigating them in order to ensure the project's long-term viability.

The following items should be on the pre-design conference agenda:

« Defining the scope and description of the project.

» Cost, schedule, quality, and long-term sustainability goals for the project.

» Control.

« Those who have the power to make decisions.

» Project participants' roles and duties

« Management reporting and responsibilities

Frequency of meetings and deliverables

TITAN UNIVERSITY

QUIZ

QUESTION 11

A commissioning expert (CxA) has a technical background and extensive knowledge of?

a) System equipment
b) Legal counsel
c) None of the above

QUESTION 12

What is Design-Build?

a) Design-Build is a project delivery method for aligning stakeholder goals and improving collaboration
b) Design-Build is a multi-disciplinary, high-intensity collaborative design exercise
c) Design-Build is a project delivery method in which the owner assigns contractual responsibility for design development, engineering, and construction to a single entity, allowing the design and construction phases to overlap and encouraging collaboration between the builder and the architect/engineer

QUESTION 13

The commissioning plan establishes the structure for?

a) Change management or configuration management.
b) Commissioning management and execution
c) Project delivery

QUESTION 14

BIM stands for?

a) Building and information management
b) Building Intensive Model
c) Building Information Modeling

QUESTION 15

_____who are familiar with sustainability and commissioning reporting needs should be contacted as soon as possible on formats, data management requirements, report distribution and frequency, and records preservation policies.

a) Project discovery workers
b) Project workers
c) Pre-design workers

QUESTION 16

What is the CM's first priority?

a) To ensure peace
b) To assist the owner in establishing long-term goals and objectives
c) Formulate business plans

QUESTION 17

A _____ has a technical background and extensive knowledge of the commissioning process, including verification procedures, functional performance testing, system equipment, and operations and maintenance

a) Commissioning expert
b) Safety officer
c) None of the above

QUESTION 18

A National Performance Building Design Guide is maintained by the ?

a) Department of Energy of the United States (DOE)
b) National Department of Building and Control (NDBC)
c) National Institute of Building Sciences (NIBS)

QUESTION 19

The owner's legal counsel must establish_____ to achieve sustainable design and construction goals

a) Risk
b) Proper governing contract strategy
c) System

QUESTION 20

What is BIM?

a) Is the process of creating and managing building data throughout its lifecycle using three-dimensional, real-time, dynamic building modeling software to boost productivity in building design and construction
b) Is to translate the owner's wishes and the design team's suggested solutions into a thorough set of specifications and drawings
c) None of the above

MODULE 3

DESIGN PHASE

The design phase's purpose is to translate the owner's wishes and the design team's suggested solutions into a thorough set of specifications and drawings. The design phase produces a set of documents that explain the project in terms of all required characteristics and can be used for construction or submitted for bid to a third-party contracting community. Sustainability aims and objectives are extensively integrated into the design process and documented as any other program requirement through drawings, details, contractor instructions, specifications, and references, just like any other program requirement.

As the design progresses from schematic to final, the team must analyse the lifespan cost vs. benefit in relation to the desired or mandated sustainability goals or standards on a regular basis. The sooner a choice about the acceptable first costs of sustainability elements can be made early in the design phase, the more cost-effective the design process will be. Periodic trade-off analysis, lifespan and sustainability assessments, value engineering, alternatives analysis, and energy performance modeling are used to optimize first costs of sustainability and lifecycle benefits.

Design in accordance with the principles

Many proponents of sustainable development and design recognize that not all effects can be quantified and hence easily factored into a standard cost-benefit analysis. The prevalence of negative externalities includes "global commons," like as the atmosphere, which is subject to GHG and for which no easy recompense can be obtained through usage fees or taxes. Regardless of their contribution to GHG levels, everyone bears the effects of unregulated emissions.

The high seas, the atmosphere, Antarctica, and outer space are the four global commons.

Carbon dioxide (CO2) emissions, the most well-known greenhouse gas, have few regulations since they have no short-term negative impacts at ground level. CO2 and other greenhouse gas accumulations in the atmosphere will have a substantial impact on global temperatures and climate cycles.

Participants in the project should look beyond typical cost-benefit analysis to ensure that broader sustainability goals are realized based on principles rather than traditional ROI calculations.

Benchmarks in Design

Matching goals to a practice or benchmarking system (as indicated in the Energy Efficiency section of the Introduction) can provide design and construction direction to achieve the owner's aims. It provides a well-defined path to the desired result, as well as evaluation and verification of the degree to which the goals have been reached.

The number and depth of these practices and benchmarking systems is growing all the time. Whereas LEED or Green Globes may come to mind quickly, the CM should keep up with alternative sustainable methods. It's also vital to keep in mind that not every project is a construction project. Other project types include HVAC or building control system retrofits, retro-commissioning, industrial turnaround projects, facility maintenance, and infrastructure projects.

Rating Systems for Sustainability

Because there are as many different green building rating systems as there are different sorts of projects, the first step should always be to match the building project type and owner desire with the right rating system. Here are several examples:

» CHPS

« Consider this: (Sustainable Infrastructure)

« Globes of Green

LEED is a green building certification program (Leadership in Energy and Environmental Design)

The Challenge of the Living Building

» SITES

WELL Building Standard (WELL Building) (International WELL Building Institute)

Some of these rating systems require the party designated as the project administrator to register early in the design phase. It's possible that this is the CM, A/E, GBF, or CxA. Contract contracts and project management plans should specify who is responsible for these activities. To calculate a preliminary standing, most rating systems allow project teams to submit design phase prerequisites and credits separately from the building phase. The project team will have several days after receiving the preliminary rating system review document stating the expected credit achievement to provide revisions and other supporting documentation as a supplementary submittal to the application.

Administration and Management of Design

The A/E contract should specify the various design phases. During each of the following phases, the A/E is responsible for developing deliverables and papers that reflect the work output of their professional service to industry standard standards of completeness:

» Conceptual

» Schematic

» Conceptualization

« Plans and specifications

« Construction assistance

All other project metrics, as well as the status of sustainability goals, objectives, and requirements, should be reviewed by the project team (cost, schedule, quality).

Those who are not directly involved in design development but have the potential to make a substantial contribution to the project's sustainability goals should be kept informed about the project's progress and asked to provide feedback. This is especially critical as the design and bid phases of the project approach 90 percent completion. Prior to the issue of bid documents, the design team may need to coordinate feedback from the CxA, O&M, facility users, and others. In some cases, the CM and possibly the owner may request that particular contract associates sign off on progress papers and the final design submission in order to exclude the possibility that full coordination has not been achieved. The participation of the GBF-designated party is required.

At each step of design completion, the CM should include sustainability in the thorough checklists that confirm or verify the attainment of design goals in plans, specifications, and estimates.

OWNER APPROVALS AND AUTHORIZATIONS

Procedures for obtaining the owner's authorization and approval to keep the project moving forward must take into account the project's long-term viability. This is a complicated issue since there may be a conflict between sustainability goals and cost and schedule limits, as well as other performance targets, particularly if sustainability goals were not adequately specified during the pre-design process. Explicit reviews of the impact of scope schedule or budget changes or adjustments on sustainability objectives—and vice versa—should be conducted, with triggers in place to bring any conflict to the attention of the appropriate authority for resolution.

QUALITY MANAGEMENT SYSTEM

A system of rigorous checks and evaluations amongst members of the design team ensures quality control. These are used to verify the completion of required actions such as the viability

of the design and design assumptions, computations, and cross-discipline coordination. Measures for verification and validation of tasks that safeguard and maintain a project's sustainability standards should be included in the quality control system. Quality assurance activities ensure that quality control activities are carried out in a way that protects and maintains the sustainability requirements of a project. The quality control system includes internal A/E team quality control, as well as CM and CxA reviews and checks. (Quality Management is another option.)

CHANGES IN THE SCOPE OR CRITERIA OF THE DESIGN

The project's design is an iterative procedure. Change is unavoidable during the project. The CM must keep track of the changes and inform the owner of any cost or time implications. The designer's notification, together with a check of the progress records, will reveal any deviations from the previously agreed-upon design standards. Variances might affect the project's cost or schedule in either a good or negative way. As part of the variance review process, the status of project sustainability performance and pledges must be assessed.

Every change in the project's cost must be properly tracked and monitored. When sustainability is a key component of the project, the CM must first ensure that suitable requirements are incorporated in the design papers, and then identify and mitigate the effects of changes on the project's sustainable features. When it comes to determining the impact of a change on a project's LEED credit profile, Green Globes score, or the integrity of any other sustainable design assessment system, vigilance is especially important.

When a change in scope or design criteria jeopardizes sustainability goals, the design team must be notified and given enough time to mitigate or amend in response to the owner's priorities for the project. All modifications to the design criteria and their consequences must be disclosed to the entire project team.

CONTROL OF DOCUMENTS

All project communications are routed through the CM. Document control and management information systems (MIS) should be developed from the start of the project to identify items that are crucial to the project's sustainability program. This is especially important when working on a project that requires documentation for LEED or another green building rating system.

DOCUMENTS RELATING TO CONTRACTS

Contract contracts should clearly outline the parts of the job that will result in the project's long-term viability. Specific sustainability requirements should, ideally, be spelled out in the contract terms. Documentation, monitoring, independent agents, and other requirements should all be specified in the contract terms.

The CSI's standard formatting is used to format construction specifications in building contracts throughout the construction sector. The format makes it easier to find specific sorts of data. The MasterFormat of CSI is divided into 50 divisions, each with several sections. General, products, and execution are the three parts of the sections. A consistent framework of articles and paragraphs organizes each section.

The following procedures can be performed to efficiently include green building criteria into CSI MasterFormat:

» Adding an environmental procedures section to division 1 that describes the project's environmental aims as well as other environmental standards such as general recycled content requirements and a C&D Waste Management Plan.

> At the pre-construction conference, include a statement requiring contractors to develop a C&D Waste Management Plan.

> Including technical standards for high-performance building materials in divisions 2 through 50, including material kinds and installation procedures.

« Including language that specifies that work is carried out in accordance with the project's environmental aims. If a green material fails to perform as intended owing to incorrect installation or becomes polluted as a result of negligent treatment, it may not contribute to the project's greening.

» Defining and distinguishing contractual sustainability requirements from sustainability goals.

If verification and documentation are required to achieve a certain sustainable facility rating, this should be specified in contract documents. The desire for a project to be LEED certified with the USGBC, for example, should be clearly stated in the bid documents. If the owner and designer do not want the project to be legally registered with the USGBC but want it to be a LEED equivalent project, this must be specified in the bid documents as well. The prerequisites for BIM should also be clearly stated.

PERMITS

The CM should make certain that a list of project-specific permissions is compiled. The list must include any federal, state, and municipal permits that are required, as well as who is responsible for getting them. There should also be a submittal timeline for any applicable sustainability rating system, such as LEED or Green Globes to identify where such rating system achievement is part of a project’s permit or regulatory requirements.

Design Evaluations

The CM should review the design documents on a regular basis, paying special attention to the need for clarity, consistency, and coordination among the contractors (s). According to the CM's contract, the CM must participate in a sustainability review of the documents to ensure that sustainability goals, objectives, and requirements are addressed, to assess the reasonableness of

constraints imposed on the contractor, and to ensure that the documents are sufficiently clear on these points.

REVIEWS OF SUSTAINABILITY

As the project progresses, the sustainability checklist or scorecard should be reviewed and modified to reflect specific measures and features. The checklist should be evaluated after each design review and before each design phase's sign-off to ensure that sustainability measures have been included or that sustainability standards have been met. This procedure usually has little impact on the schedule, but the results of this review and update may prompt the team to reassess the sustainable program's objectives and methodologies, which could have an impact on the schedule.

The CM should check the construction documents on a regular basis to see if relevant and appropriate criteria are well defined. When a project is expected to satisfy specified sustainability criteria or rating levels, the CM should double-check that the construction documents appropriately specify the certification and required documentation, as well as the party or parties responsible for related actions. Periodic sustainability evaluations should be specified in the A/E contract throughout design to ensure that sustainability objectives and standards are met.

REVIEW OF CONSTRUCTABILITY

The CM is frequently called upon to analyze design papers for constructability, rationality, and construction efficiency, with the goal of making the construction process as simple and efficient as possible. For the most cost-effective installation and availability of materials, the examination

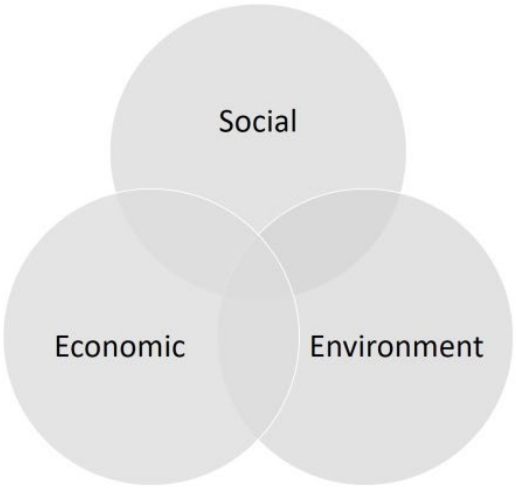
of the design, bid, and contract papers for constructability should also contain particular parts of the sustainability program.

REVIEW OF THE COMMISSIONING AUTHORITY'S DESIGN

As part of the design review process, the CxA should review the basis design and specific design milestones for alignment with the OPR, as well as commission ability and serviceability.

Cost-control

CM establishes and maintains cost control procedures during the design process to monitor and control project expenses, both current and projected, within the assigned budget. Sustainable initiatives have higher capital—or initial—expenses, which are generally mitigated by reduced lifecycle costs. Several assessments may be required to match goals and requirements with budgets and timelines in order to correctly analyze the expenses of a project with precisely stated sustainability goals, objectives, and needs.



STUDIES ON OTHER OPTIONS

Alternate analysis is a standard process for identifying alternative approaches to achieving project goals. When done early in the project lifecycle, alternative analysis is more successful and efficient.

It's possible that conflicting strategies for achieving sustainability goals will be discovered in a project. When a complex and interconnected range of environmental, social, and economic issues must be considered, and where objectives are competing, trade-offs are unavoidable, multi-criteria analysis (MCA) is a valuable tool to aid decision-making. It is especially useful in sustainability assessments where a complex and interconnected range of environmental, social, and economic issues must be taken into consideration. MCA can be used at all levels of decision-making, from evaluating project alternatives to making large policy decisions that guide a transition to sustainability and the green economy.

MCA and other sophisticated alternatives studies may necessitate the assistance of a knowledgeable consultant. This requirement should be identified early in the budgeting and design process.

ASSESSMENT OF THE LIFECYCLE

The purpose of lifecycle assessment (LCA) is to compare the environmental and social costs of products and services in order to select the least expensive solutions. The term "lifecycle" alludes to the idea that a fair, comprehensive assessment must consider raw material production, manufacturing, distribution, usage, and disposal, as well as all intervening transit stages required or caused by the product's existence. The product's lifecycle is the aggregate of these steps. The notion can be used to a single product or an entire project to improve its environmental performance.

The LCA process is divided into four stages:

1. Goals and scope are established.

2. Inventory that lasts a lifetime.

3. Assessment of the lifecycle impact.

4. Interpretation.

LCA may require an expert facilitator, similar to alternative analysis for sustainability projects, who must be found early to anticipate financial requirements and retain a dependable service provider capable of delivering feedback in a timely manner.

MODELING OF ENERGY

The virtual or digital simulation of a building or complex that focuses on energy consumption, utility bills, and the lifecycle costs of various energy-related products such as heating, cooling, lighting, ventilating, and hot water systems is known as energy modeling. It's also used to figure out how long solar panels, photovoltaics, wind turbines, and other high-efficiency appliances will pay for themselves. As part of the permit process, energy modeling is likely to be required, and sustainability rating systems may demand modeling to verify energy efficiency. For example, to earn the Optimize Energy Performance credit under the Energy & Atmosphere category, LEED needs energy modeling for a project.

« The US Department of Energy provides a number of free products, as well as a number of paid software programs. Acceptable programs may be specified by code or sustainability rating systems, and the CM and A/E should be aware of these criteria.

« Assigning responsibility for energy modeling and simulation to the A/E is a good idea. The A/E team should undertake energy studies on a regular basis to ensure that the design solution is valid.

« The contracting strategy determines who is responsible for achieving energy performance results, which must be addressed in the project's contractual instruments.

ASSESSMENT OF RISK

Uncertainties about the design and construction team's experience, the performance of a unique design solution, equipment, or means and methods may exacerbate the cost, scheduling, technical feasibility, and other risks on a project with sustainability goals, objectives, and requirements.

Risk management is to reduce the amount of uncertainty about future events. Risk assessment is a technique for predicting the possibility of future events as well as their consequences. Risk mitigation is the proactive management of risk based on the results of the risk assessment. The project team should ensure that sustainability features and goals are safeguarded and retained as key project elements throughout the design and construction process when applying risk assessment and mitigation approaches.

ALTERNATIVES, VALUE ENGINEERING, VALUE ANALYSIS

Value engineering (VE) is a systematic approach to increasing the value of a project by examining cost-cutting solutions or functional enhancements that improve the function-to-cost ratio. One of the major tenets of VE is that basic project functions must be kept, not reduced, as a result of VE. The CM's primary task is to ensure that the project's sustainability aspects are not surrendered in the name of initial cost during VE efforts in design or construction.

Sustainable planning, design, and building processes aim to reverse the tendency of focusing on facility first expenses and undervaluing or ignoring the facility's operations costs, which can be significant in terms of energy investment. Identifying the cost of the facility over its whole lifecycle, including first costs, costs of replacements and adjustments, and O&M, which in most circumstances is by far the most expensive stage of a facility's useful life, is part of defining the project budget for the VE exercise. As a result, VE is an excellent tool for accomplishing sustainability goals.

When there are real or perceived additional expenses associated with sustainability features that are not explicitly recognized as functional requirements, VE poses a threat to sustainability. Energy efficiency targets that are clearly stated are a good safeguard against VE exercises that delete sustainability aspects.

Not all sustainable approaches produce the best benefits for the least amount of money. This is evident in the USGBC LEED process, where capturing many points adds no or very little cost to the project, while securing others will result in a significant premium cost.

Trade-off analyses are a standard aspect of VE, and time must be set aside in the schedule to examine the sustainable strategy in terms of cost-effectiveness and good value for money while satisfying sustainability targets. It's especially vital to do this during the schematic design stage, when it's easiest to change the scope of the project with the least amount of disruption to the timeline.

ESTIMATES FOR THE PROJECT

The CM is in charge of estimating lifecycle/sustainability costs, and anybody involved in the process should have the necessary skills to represent the cost of sustainability components.

Projects requiring sustainability, for example, can include technologies with restricted pricing and installation information. In these situations, it is critical to build suitable contingencies.

Commissioning

The owner's project sustainability requirements are converted into construction papers throughout the design phase. Verifying that the OPR and the owner's sustainability criteria are captured in the design papers that explain the design intent and scope are among the design phase commissioning objectives. This should ensure that design methods are used to include commissioning requirements in construction documents, as well as establish training and acceptance requirements and conduct a commissioning-focused design review.

The commissioning requirements, which must be synchronized with the other specification sections and contract papers, describe the contractor's duties for commissioning. The CxA takes the lead in commissioning process planning and coordinates with the design team to develop the commissioning specification. In the commissioning plan, which specifies the Cx process throughout the project, the CxA details the roles and duties of the contractors and other team members. A draught Cx plan should be included in the commissioning specification, along with a set of system readiness checklists and verification test procedures, to communicate to the bidding contractor the sustainability requirements to be verified and the level of rigor that is expected during the commissioning testing phase.

Measurement of the Sustainability Certification System

During the design phase, the CM's job is to identify and accelerate the submission of all essential and/or required paperwork by the contract in order to meet the contract's sustainability rating system and level. When green building rating systems allow for an initial submittal at the end of the design phase and a second submittal at the end of the construction phase, this "split review" approach is frequently used to give project teams an early indication of their likelihood of meeting rating system targets.

The A/E or the GBF is usually in charge of compiling the submittal. When one must be chosen for the project's overall submission, the CM may serve as owner's agent. The CM should be informed of any decision points that should be discussed with the owner if the agent position is allocated to someone else, such as the GBF. Contract contracts and project management plans should specify who is responsible for which tasks.

The project team must offer revisions and additional supporting documentation as a supplementary submittal for the application for credits after receiving the preliminary review document from the certifying agency identifying the status of credits earned, anticipated, pending, and/or rejected.

QUIZ

QUESTION 21

Matching goals to a practice or benchmarking system can provide?

a) Design and construction direction to achieve the owner's aims.
b) Sustainable infrastructure
c) Challenge of the Living Building

QUESTION 22

Those who are not directly involved in design development but have the potential to make a substantial contribution to the project's sustainability goals should be kept informed about the?

a) Plans and specifications
b) Conceptualization
c) Project progress and asked to provide feedback.

QUESTION 23

Procedures for obtaining the owner's authorization and approval to keep the project moving forward must take into account?

a) Filtration system
b) The project's long-term viability
c) None of the above

QUESTION 24

A _____ of rigorous checks and evaluations amongst members of the design team ensures quality control

a) System
b) Work
c) Body

QUESTION 25

Document control and management information systems (MIS) should be developed from the start of the project to identify items that are crucial to the

a) Project's sustainability program
b) Build up
c) Project delivery

QUESTION 26

What should the cm keep up with?

a) Alternative Sustainable Methods
b) The Government
c) The Status Quo

QUESTION 27

What is the purpose of the design phase?

a) To Test The Product
b) To translate the owners' wishes and the design teams' suggested solutions into a thorough set of specifications and drawings
c) To Design The Product

QUESTION 28

What are extensively integrated into the design process and documented as any other program requirement through drawings, details, contractor instructions, specifications, and references?

a) The Project Manager
b) The Client

c) Sustainability Aims And Objectives

QUESTION 29

_____ can provide design and construction direction to achieve the owners aims.

a) Code Of Ethics
b) Blueprints
c) Benchmarks

QUESTION 30

Who can the design phase submit bids to?

a) Department Of Defense
b) Department Of Energy
c) Third-Party Contracting Community

MODULE 4

PROCUREMENT PHASE

The procurement phase's goal is to carry out the procurement process in a way that complies with and supports the achievement of sustainability goals, objectives, and requirements; secure service providers and suppliers capable of meeting contract documents; and result in the successful and timely award of construction contracts.

Although an added layer of complexity in the contract documents may result in a bigger number of bid questions, larger or additional addenda, and a reduced number of eligible bidders, sustainability in the procurement phase will have little impact on the timetable. Bidding, bid review, and award durations should take into account the design and CM team's expertise handling bid difficulties linked to sustainable work scopes.

It is critical to identify long-lead products at the procurement planning process in order to avoid building delays. The contractor may file a delay claim if construction is hampered by a special-order component given by the owner rather than the contractor. In some cases, sustainability

goals may be implemented in order of significance to avoid charges of lateness or failure to fulfil deadlines. In the worst-case scenario, sustainability targets become optional rather than mandatory.

Depending on the project delivery style, the procurement phase allows the CM to work with multi-disciplinary crafts and professions. This phase's planning can enable the CM to integrate the efforts of the design and construction teams to provide a sustainable project that not only achieves the anticipated end outcomes, but also continues to do so throughout the project's existence. For additional information, go to www.oecd.org and look for "Going Green: Best Practices for Sustainable Procurement."

Planning for Procurement

The project or construction management strategy identifies sustainability. As the design progresses, sustainability goals, objectives, and needs are incorporated into the contract terms. The CM should ensure that the master schedule allows enough time for procurement provisions and market conditions that are relevant to sustainability, notably for advertisement, bid, and award, as well as any additional clearances required during the award cycle.

The project delivery method chosen should also be considered during the procurement planning process, which could be as follows:

« Design-Bid-Build allows the owner and CM to examine not only the project's initial cost during the design phase, but also the influence of the energy efficiency or sustainable building systems to be installed on the return on investment. If performance measures are established, the designer and contractor may be held accountable after the project has been occupied for the period of the contract.

› Design-Build (also known as "turnkey") allows the CM to manage the sustainable project's trade-offs within the design-build entity and choose how they will satisfy the owner's sustainability goals (may be EUI goals established in the contract, for example, and D-B team determines how they will achieve the required EUI). The CM has the authority to regulate and establish the compatibility of sustainable building systems in order to meet specific short- and long-term programmatic and budgetary needs. The CM must be aware of the specific systems that must be weighed against the project's general sustainability standards.

« Integrated Project Delivery enables the CM to represent the owner by promoting long-term goals through a shared vision. The IPD technique is a project delivery approach that not only strengthens the team's commitment to long-term goals, but also involves participation from all stakeholders in order to achieve those goals. The IPD team may be reliant on the CM's leadership to guarantee that they meet or exceed the owner's expectations. If warranted, the CM must be skilled at implementing standards and rating systems in order to offer methods for exceeding baseline sustainable criteria or rating systems.

SOLICITATION OF BIDS AND ADVERTISEMENT OF BIDS

In the advertisement and solicitation for bids, the requirements for project sustainability elements and measurements such as LEED or Green Globes performance rating and energy efficiency requirements must be explicitly stated.

The following are some instances of language:

› Design Services - Demonstrate your knowledge of sustainable design principles. Identify your firm's experience with an integrated design approach, lifetime assessment, lifespan cost analysis, and other sustainable design approaches. Identify team members that have relevant expertise working on a project with similar sustainability goals. Provide proof of qualifications when using a rating system like LEED or Green Globes.

» Construction - Demonstrate experience implementing and documenting sustainability during construction, based on the project's criteria. Identify relevant experience with C&D waste management, on-site recycling programs, use of sustainable materials with high recycle content, use of low-emitting materials, air monitoring, efficient use of equipment and utilities during construction, commissioning, and documentation of sustainability features.

> Identify the members of the participating construction site team who are responsible for sustainability implementation and their experience with it. Demonstrate an awareness of the design's interconnected character in terms of sustainability. Demonstrate knowledge of the process of assessing the impact of changes on cost and the building's intended use. Demonstrate that the suggested team members are well-versed in the idea of lifecycle analysis. Provide documents demonstrating staff and craft training in sustainability and/or LEED implementation.

All pre-bid meetings, site inspections, and addenda preparation should include the CM to clarify project elements related to sustainability goals, objectives, and needs. (See Appendix –Document Samples for examples.)

SELECT A LIST OF BIDDERS

Many owners may select and prequalify bidders they believe are qualified to seek employment in their market if applicable bidding laws and regulations allow it. Prior to advertising for bids, the CM should support the owner in handling any prequalification steps or creating acceptable requirements. The CM should verify that the prequalified bidders have a track record of practicing sustainability and/or have experience implementing projects with sustainability standards through reference checks.

BIDDERS' INSTRUCTIONS

A solicitation's Instructions to Bidders section should be thorough and provide clear, succinct information that complements the advertisement or solicitation statement. The CM should check the instructions to bidders to ensure that the document adequately reflects sustainability standards. Bidders should be informed of the methods and requirements for submitting an acceptable proposal for the owner's consideration in the instructions.

The following are examples of possible language:

› Design Services - Proven experience with sustainable design approaches is required. Identify your firm's experience with employing an integrated design approach, lifecycle cost analysis, and other sustainable design approaches. Determine which team members have the necessary experience.

« Construction - Demonstrated experience in the construction of sustainable projects is required. Find out whether you have any experience integrating sustainable design criteria in the construction of projects. Identify individuals of the building team who have the necessary experience.

CONFERENCE PRIOR TO THE BID

All members of the design or construction team, as well as contractors being recruited by an owner, should attend a pre-bid conference. The CM/PM should define the project's sustainability certification and experience criteria, as addition to the pertinent scope of work, scheduling information, and important contract terms.

PROTOCOL FOR PROPOSAL DOCUMENTATION AND PROPOSAL/BID OPENING

Each proposal/bid should be reviewed by the CM and the owner's team to decide which has the necessary sustainability experience. When completing the overall selection, the proposer/bidder is ranked, and the sustainability ranking score is taken into account.

Award of a Contract

By letter, the owner or CM should formally tell the winning bidder that they have been selected as the contract's selected contractor and the most responsive bidder. A formal Notice to Proceed (NTP) direction to the contractor may or may not be included in the award letter. Some owners give the contractor a second NTP letter that legally defines the project's start date.

CONFERENCE/SCOPE REVIEW MEETING PRIOR TO CONSTRUCTION

The owner and CM should hold a pre-construction meeting with the winning bidder to examine and discuss the contract's terms, conditions, costs, and scope of work, as well as the contract's sustainability criteria. During the building phase of the project, it should be structured so that all parties have a clear understanding of the contract and the extent of sustainable design and implementation.

QUIZ

QUESTION 31

The _____ goal is to carry out the procurement process in a way that complies with and supports the achievement of sustainability goals, objectives, and requirements; secure service providers and suppliers capable of meeting contract documents; and result in the successful and timely award of construction contracts.

a) Design-Build

b) Procurement phase

c) System equipment

QUESTION 32

Depending on the project delivery style, the procurement phase allows the CM to work with multi-disciplinary crafts and professions.

a) Yes
b) No
c) Partially

QUESTION 33

The project or construction management strategy identifies?

a) Objectives
b) Progress
c) Sustainability

QUESTION 34

In the advertisement and solicitation for bids, the requirements for project sustainability elements and measurements such as LEED or Green Globes performance rating and energy efficiency requirements must be explicitly stated.

a) Yes
b) No
c) Partially

QUESTION 35

A _____to Bidders section should be thorough and provide clear, succinct information that complements the advertisement or solicitation statement.

a) solicitation's Instructions
b) project delivery
c) sustainability

QUESTION 36

_____ will have little impact on the timetable.

Rate Question

I. Sustainability

II. Speed

III. Distance

QUESTION 37

_____ are incorporated into the contract terms as the design progresses.

Rate Question

I. The company’s sales Goals

II. The company’s budget

III. Sustainability Goals, Objectives, And Needs

QUESTION 38

If _____ is established, the designer and contractor may be held accountable after the project has been occupied for the period of the contract.

a) Payment
b) Performance Measures
c) Quality

QUESTION 39

_____ has the authority to regulate and establish the compatibility of sustainable building systems.

a) The Fm
b) The Cm
c) The Nm

QUESTION 40

Read the following statements carefully:

Statement I: The cm should ensure that the master schedule allows enough time for procurement provisions and market conditions that are relevant to sustainability, notably for advertisement, bid, and award, as well as any additional clearances required during the award cycle.
Statement II: The cm has not the authority to regulate and establish the compatibility of sustainable building systems in order to meet specific short- and long-term programmatic and budgetary needs.
Statement III: Integrated project delivery enables the cm to represent the owner by promoting long-term goals through a shared vision.

Which of the above Statement(s) is/are correct?

a) I and III.
b) II only.
c) All Statements are Correct.

MODULE 5

PHASE OF CONSTRUCTION

The goal of the construction phase is to complete the project in compliance with the contract documents' requirements, applicable codes and regulations, and the contract documents' sustainability goals, objectives, and requirements.

First, based on the Project Sustainability Plan, the Project Procedures Manual, which was started during the pre-design phase, should be examined for any necessary changes and adjustments. Contractor work plans and submittal criteria linked to the project's five sustainability goals, objectives, and requirements should also be included in the manual.

Phase of Construction

The project team members, roles, and duties for tasks directly linked with the five best practices for executing project sustainability standards should be included in the project and construction management plans. (For further information, go to www.astm.org and look up Greener Cleanup Guide E2893-13.)

EXAMPLES OF BEST PRACTICES

The CMP's five best practices are as follows:

1. Reduce total energy consumption and increase the use of renewable energy. An example of this would be to reduce as much energy as possible using energy efficient equipment.

2. Reduce the number of pollutants in the air and greenhouse gas emissions. Some examples include reducing the number of airborne pollutants and dust produced and transported, consider diesel emission reduction plans, and using machinery with modern emission reduction plans.

3. Reduce the amount of water used and the impact on water resources. Examples include reducing the consumption of water as well as the depletion of natural water resources, reuse water by capturing, reclaiming, and storing it, reduce the amount of water used for replanting by using native species, and use best storm water management practices.

4. Material and waste should be reduced, reused, and recycled. For instance, reduce the amount of virgin materials used, reduce the amount of waste produced, make use of recycled and locally sourced materials, reuse waste sources in a beneficial way and separate material goods and infrastructure for reuse or recycling.

5. Land and ecosystems should be protected. Examples would include reducing the number of areas requiring action or impose restriction such as destroying contaminant sources, minimize unnecessarily disturbed soil and habitats, and keep noise and lights to a minimum

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) OF CONTRACTORS

The CM keeps track of the contractor's adherence to the project's quality standards. By using the indicated materials to create the project, the contractor meets the stipulated construction quality requirements. The contractor must install the materials using qualified craftspeople and implement a formal construction quality assurance (QA) program that establishes quality control requirements, means, and procedures (QC). The QC program should be based on a written document that comprises procedures (or instructions) and controls that effectively address the type of work required by the contract agreements. The contract documentation should include the project's sustainability requirements, with the QC program expressing the methods and controls for attaining quality execution of the characteristics that make project elements sustainable, as stated in the QA program.

If the contractor is expected to provide inspection and testing services, the QC program should provide a list of testing consultants (with relevant expertise working on sustainability projects), as well as their qualifications and certifications.

The Pre-Construction Conference is a meeting held before to the start of construction.

If sustainability certification aims are expected, the pre-construction meeting should include a full discussion of the project's sustainability goals, objectives, and standards. The project team or chosen lead contractor should be requested to offer a strategy for achieving these goals, as well as an outline of the sustainable construction methods that will be used.

During the pre-construction meeting, the CM should:

> Review each project team member's tasks and responsibilities during the construction phase. To satisfy sustainability certification/green cleanup effort and compliance, A/E, CM, contractor, owner (and others if relevant) should be labelled as responsible.

> Determine the prerequisites for submitting documentation, such as:

• Plans for Contractor Sustainability.

• Requirements for material and equipment submittals for sustainability documentation.

• Requirements for monthly or other reporting.

• Requirements for payment applications.

• Detailed waste disposal manifest

• Information on local vendors.

• The use of repurposed materials.

> Determine whether or not the equipment was provided by the owner and how it was installed.

> Identify on-site sustainable activities that are required, such as:

• Demolition vs. deconstruction

• A waste management strategy.

• Reuse of materials.

• There will be no idling of the engine.

• Noise reduction.

• There is very little waste.

• No smoking is permitted.

• Minimize paper usage in the office (e.g., electronic media, double-sided printing) and enhance efficiencies like power usage.

The CM must be aware of numerous project features that require special operations control, such as sustainability elements, especially if the project is pursuing sustainability certifications or green cleanup requirements. These aspects could be related to heavy construction field activities, as well as those related to manufacturing facilities, treatment plants, operations control centers, and other facilities that deal with instrumentation and control systems or other systems as specified in the contract.

To ensure that the project meets an acceptable level of quality for these facilities, the CM should examine the work specification criteria with the contractor to ensure that the contractor and its suppliers are focused on quality and the contract's specific requirements. The impact on the environment, as well as any long-term requirements, should be considered. They should be aware of the requirement to install these pieces during the project's completion in such a way that they can be used for their intended purpose.

Construction Scheduling and Planning

The contractor must produce a work plan and CPM timeline that are realistic and meet the contract's specifications. The timetable must include enough time for quality work to be completed, as well as time for submission, approval, procurement, testing, commissioning,

inspection, and verification. The CM should also work with the owner and designer to make sure they understand their roles in keeping the project on track.

The contractor's schedule should contain tasks linked to sustainability and should account for additional material lead times or longer construction durations. Adaptive reuse of buildings and components, as well as the reuse of existing materials, will add to the complexity of development. Securing products from a regional source may limit material procurement, causing delays in the timetable. For example, specific sustainable products may require a longer lead time for purchase and installation than more common products.

Although equipment startup is technically a part of commissioning, it might happen before the project is finished and must be coordinated with the design engineering and commissioning teams. Other interim inspections, testing, and documentation submittals may be required as part of enhanced commissioning and other quality-focused activities, which must be coordinated with the construction timetable.

While startup is usually a one-time event with a brief length, commissioning periods should be long enough to allow for a full battery of testing, training, and documentation prior to occupancy. The commissioning program job for each major component should be listed on both the construction and master schedules to remind everyone that it is a critical and time-sensitive phase of the development process. The CxA should assess the duration and logic of these actions and provide feedback. Too often, projects are scheduled for occupancy at substantial completion without proper commissioning planning, when commissioning planning would have resulted in a better product at occupancy.

If one of the project's goals is to attain a given degree of third-party verification sustainability, the schedule should contain an activity with a duration that reflects the time between final documentation assembly and receipt of the certifying entity's decision. It could take several months, if not a year, to complete this task. This timescale should be communicated to the owner in order to align expectations with reality. The key to reducing the effort's duration is active management (including careful document control).

Construction Administration and Management

CMs should be aware of the tools, methods, and procedures that may be involved when managing sustainability parts of a construction project. (See Examples of Checklists.)

Checklist for Sustainability

- Schedule for the Commissioning Plan
- Workplace Changes
- Documentation for the project
- Control and distribution of documents
- Payments in Advance
- Information Requirements
- Acceptance Testing is a type of testing that is used to
- Work that is non-conforming or has to be corrected
- Substantial Completion/Beneficial Occupancy
- Documentation for QC Inspection and Testing
- Training
- Audits on the Quality of Sustainability
- Completed to a large extent
- Commissioning
- Acceptance in its final form

CHECKLIST FOR SUSTAINABILITY

The project team and CM should use the sustainability checklist or scorecard, which is included in contract agreements, to track the status and progress of work aspects that are critical to the project's sustainability goals.

WORKPLACE CHANGES

Change management procedures should clearly define a thorough scope review process and approval authorities to prevent construction changes that jeopardize sustainability goals, objectives, and requirements. This can be done with the use of a change review board, panel, or procedure that involves the A/E and CM as reviewers.

It's very crucial to document and manage changes or adjustments to materials and equipment specified for achieving sustainability goals. Any specifications and equipment selections that were left open on purpose during earlier phases to take advantage of technological or logistical developments are effectively planned change orders, and the effects on time, cost, quality, and scope must be considered.

Any changes in the work must be documented and approved by the owner, as specified in the contract agreements. When modifications occur, the contractor's QA/QC program should describe procedures that staff must follow. The CM is usually tasked with assessing the impact of any changes, deletions, or additions to the contract work on construction time, cost, quality, and long-term sustainability.

The CM, review board, or GBF should confirm what effect any proposed project change orders would have on the project's targeted sustainability goals, objectives, and standards, especially for projects aiming for sustainability certification. Any impact should be conveyed to the project team in writing with the goal of obtaining alternative solutions that do not have a negative impact on the targeted sustainability measures while keeping the project budget and schedule in mind. Throughout the project, the CM or GBF should compile any executed change orders and backup

paperwork that affect the planned sustainability measures level for submission to the proper authorities.

CONTROL AND DISTRIBUTION OF DOCUMENTS

Document routing and management procedures should be explicitly stated in the CMP to alert all parties to project status, progress, and requirements.

The contractor risks having his or her work rejected if he or she performs work without adopting the current appropriate design. To assess if the program is in compliance, the CM should evaluate or audit the contract document control part of the contractor's QA/QC manual. A check of document holders at the construction site should be included in the audit to ensure that contractors are using the most up-to-date drawings, specifications, and other relevant information.

Third-party verification documentation requirements may be rigid, therefore adequate documentation control and delivery are critical. All current documentation must be received in a timely way by the parties responsible for sustainability certification, as well as important designated team members. Document control and distribution procedures should include provisions for distributing documents to the firm in charge of third-party sustainability certification.

APPLICATIONS FOR INFORMATION

Some project participants may be unaware of the relationship between any project aspect and the sustainability program. Standard document processing must be used to notify the integrated team.

All requests for information (RFIs) should be reviewed by CMs and routed to the CxA, GBF, or A/E as needed, so that clarification and guidance to the contractor reflects actions to conserve the project's sustainable features. Specific RFI requirements should be reviewed by the CM, especially if they are to be submitted for third-party assessment or certification.

CORRECTIVE AND NON-CONFORMING WORK

Nonconforming and corrective work has the potential to have a detrimental influence on facility performance as well as the sustainability certification that is being sought. Non-conforming work must be corrected, and deviations from the contract documents must be properly documented, according to the project team, which includes the CM. The GBF should lead the review and, if necessary, include the documentation in the submission package for sustainability certification.

DOCUMENTATION FOR QC INSPECTION AND TESTING

The inspections and testing that are required for projects are detailed in most government agencies and many major organizations' procedures. The contractor's QA/QC program must at the very least include procedures to ensure that specified inspections and tests are performed at the right times during the construction process. The CM should validate that the findings of the inspections and testing, as well as any sustainability criteria and paperwork, are in conformity with the contract specifications.

The CM must ensure that the contractor's quality assurance program meets the requirement.

that the products that were submitted and approved are the same ones that were used on-site. When it comes to VOC limitations, attention to detail is crucial, as products considered to be the

least critical are the most important. PVC glues, building adhesives, primers/sealers, finish installation glues, and paints/coatings are examples of such goods.

The contract documentation should be reviewed by the CM for evidence that appropriate test and measurement devices have been selected, calibrated, and utilized correctly. The CM should also evaluate contractor procedures to ensure that the program is being implemented properly.

The CM should request that the CxA, consultants, and contractors in charge of testing and monitoring review the calibration of controlled testing instruments according to the item's defined timetable.

QUALITY AUDITS FOR SUSTAINABILITY

An audit of sustainability criteria can be used to ensure that quality management systems are in place to meet the goals. QC is often performed by the contractor, with QA control provided by the CM or a selected outside agency. Much of this QA function might be performed by the GBF or CxA in a long-term project.

COMMISSIONING

Commissioning operations are critical for ensuring that sustainability goals are accomplished throughout construction.

The following are examples of owner project requirements:

» During the procurement period, changes were made.

« Updates to the commissioning plan to incorporate new or updated elements introduced during the construction phase.

« Procedures for testing and inspection development and distribution.

> Activities including performance testing and inspection.

« Testing and inspection actions must be documented.

« Commissioning activities are integrated into the construction timetable.

« System and training manual development

> Commissioning reports and training requirements in accordance with the commissioning plan.

SCHEDULE FOR COMMISSIONING

The CM and CxA should collaborate closely with the project team to integrate commissioning into the overall construction timeline, keep commissioning off the critical path, and plan site inspections that focus on system O&M. The commissioning timetable is created as part of the commissioning strategy and is revised as the project progresses. Maintaining project milestones and confirming that sustainability standards are satisfied necessitates detailed integration of commissioning operations and tasks with the building schedule.

DOCUMENTATION FOR THE PROJECT

The responsible party—typically the CM, CxA, or GBF—must appropriately manage the supporting documents when a project is to be certified under any sustainability certification method. This requirement should be communicated to the project team by the CM as early as practicable in the project.

If the CM hires an independent CxA, the CxA should produce necessary documentation throughout the project's life cycle, particularly during the construction period. If the owner

employs an independent CxA, the CM shall notify the owner if the CxA fails to provide the necessary papers in a timely manner.

Documentation should be kept up to date throughout the project's submittal, procurement, and construction, rather than being compiled at the end. From the start of construction, the CM should establish a system for collecting paperwork that will last the duration of the project.

Throughout the construction process, responsible parties should maintain a rigorous system of documenting sustainability initiatives. Waste management and recycling, pollution mitigations, noise and vibration mitigations, dust reduction measures, and correct material storage and handling should all be covered by documentation protocols. For example, when ducting is built, the CM should note that it is capped until it is permanently ended; document that sheetrock has been stored appropriately so that it is protected from moisture, which can lead to mold growth.

PAYMENTS IN PROGRESS

Unless the contract documents provide otherwise, the CM should only approve requests for payment for accepted materials/items or completed/accepted construction. Any sustainability standards should be included in the progress payment procedure. The contractor should include a line item for these criteria in their schedule of values and be paid a percentage when work is completed.

NOTE: Payments for sustainable equipment and installations may be conditional on the contractor supplying the required sustainable documentation for that equipment and installation, in order to ensure that the documentation is kept up to date. If the contractor has specific sustainability goals to reach, the value must be identified in a schedule of values, and adequate payments must be withheld until the sustainability goal is met.

TESTING FOR ACCEPTANCE

Specific parts of equipment or systems can be subjected to acceptance testing for reasons of owner acceptance when a comprehensive commissioning program is not justified. This shortened version of commissioning can be used to ensure that particular sustainability goals or requirements are met. To ensure that equipment or systems satisfy performance objectives, the CM or another designated party designs test procedures and acceptance criteria. Contractor staff are typically used to conduct tests, which are seen by the CM and/or the owner. The acceptance test includes training of owner staff in operation and maintenance. When all elements of the test procedure are deemed to match the criteria, they are executed and signed off on. Before final acceptance, the CM checks that all tests have been satisfactorily completed.

SUBSTANTIAL COMPLETION/BENEFICIAL OCCUPANCY

The construction quality program should include reviews of incomplete work, corrective actions to resolve nonconformance, and other quality needs, such as documentation, as the project approaches beneficial occupancy/substantial completion. Requirements for long-term viability should be included in reviews.

The CM should not recommend advantageous occupation to the owner until the project team has completed the project punch list, which has been approved by both the CM and the owner, and all spaces are ready to use. All open review comments pertaining to sustainability elements should be included with an appropriate level of priority if the project is to be certified under any sustainability program.

This may be especially difficult for a CM at risk who is under pressure to obtain a substantial completion certificate in order to meet contractual deadlines for occupancy. Following owner occupation, the CM and owner should be aware that punch list operations frequently result in conflicts, necessitating a distinction between punch list labor and damage or changing circumstances caused by the owner's usage of the property.

TRAINING

Project maintenance trainees should be given all of the information they need to operate and maintain the facility according to the owner's specifications and maximize the project's sustainability features in a reasonable amount of time.

Providing digital records of training sessions to project management staff can considerably boost the value of the training by providing a reference for future post-project training of new workers, as well as future reference for procedures that aren't utilized regularly.

COMPLETION OF THE MAIN PROJECT

The contract documentation should specify the parameters that must be met in order to meet the milestone for a project's sustainability elements. The CM should go over the contract and the work that has been accomplished to ensure that the contractor has met the contract's milestones and make suitable recommendations to the owner. The owner and the designer should both agree that the goal has been met. Minor punch list work that does not impair the owner's use of the facility may be left unfinished with the owner's and CM's consent for major completion.

FINAL APPROVAL

With the approval of the A/E, CM, and CxA, final acceptance is given after considerable completion and the completion of punch list work. If final acceptance is to come before final certification by any sustainable certification procedure, the contract terms should make this apparent.

Prior to final acceptance, all punch list work must typically be done to the satisfaction of the owner, A/E, CM, and CxA. (and associated payment). Offseason commissioning or receiving notification of the final certification are examples of activities that must be completed many months after the conclusion of typical punch list work on a project with sustainable certification

standards. This can be addressed contractually by including late-breaking requirements as items in the schedule of values.

QUIZ

QUESTION 41

The goal of the _____ is to complete the project in compliance with the contract documents' requirements, applicable codes and regulations, and the contract documents' sustainability goals, objectives, and requirements

a) Sustainability
b) Quality management
c) Construction phase

QUESTION 42

The _____ must install the materials using qualified craftspeople and implement a formal construction quality assurance (QA) program that establishes quality control requirements, means, and procedures (QC).

a) CM
b) Contractor
c) None of the above

QUESTION 43

The Quality Control program should be based on

a) a written document that comprises procedures
b) controls that effectively address the type of work required by the contract agreements
c) All of the above

QUESTION 44

The following are checklist for sustainability except

a) Workplace Changes

b) Documentation for the project

c) Control

QUESTION 45

_____trainees should be given all of the information they need to operate and maintain the facility according to the owner's specifications and maximize the project's sustainability features in a reasonable amount of time.

a) Project maintenance

b) Project delivery

c) Construction

QUESTION 46

Prior to final acceptance, all punch list work must typically be done to the satisfaction of the ow ner, A/E, CM, and CxA.

a) Yes
b) No
c) Partially

QUESTION 47

The contract documentation should specify the _____that must be met in order to meet the milestone for a project's sustainability elements

a) Parameters
b) Project
c) Plan

QUESTION 48

_____should be given all of the information they need to operate and maintain the facility according to the owner's specifications and maximize the project's sustainability features in a reasonable amount of time.

a) CM
b) Project maintenance trainees
c) Project

QUESTION 49

The CM or another designated party designs test procedures and acceptance criteria to ensure that

a) There's sustainability
b) None of the above
c) That equipment or systems satisfy performance objectives

QUESTION 50

An audit of sustainability criteria can be used to ensure that quality management systems are in place to meet the goals

a) Yes
b) No
c) Partially

MODULE 6

POST-CONSTRUCTION PHASE

The post-construction phase allows for the evaluation of the sustainability efforts, as well as the adjustment of assumptions and system operation in order to increase modeling accuracy and efficiency. A third-party review, system performance evaluation through measurement and verification, accumulating lessons learned from building operators, and a post-occupancy evaluation based on occupant experience are all possible strategies.

The scope of the CM's post-construction phase tasks will vary depending on the owner's early project goals. Even if longer-term assessments are not included in the project, measurement, verification, and commissioning may be included. As part of the organization's QA history, third-party review and lessons learned should be documented.

Checklist for After-Construction

The CM's role during the post-construction phase is to identify and accelerate the submission of paperwork needed and/or required to attain the designated third-party certification, as well as to coordinate the relevant participants in the process. Roles and responsibilities will have been set at the project's earlier stages. It's possible that incomplete information or submittals were made early in the process. The key to reducing the duration of this procedure is active management.

Commissioning

A new construction project's commissioning phase begins before the post-construction period. It could involve reviews during the design phase, as well as a pre-functional review during the construction phase. Although the exact requirements for the link between commissioning and significant completion may vary, the functional testing portion of commissioning is often

completed after testing and balancing at the end of construction. It should include offseason testing to ensure that systems work effectively in the circumstances in which they are expected to operate (for example, summer air conditioning testing and winter heating testing). Commissioning activities should, at the very least, continue until the conclusion of the contractual warranty/correction period. Commissioning should, in theory, continue throughout the duration of the facility's life. Throughout the commissioning period, the operation, maintenance, and modification of facility systems and assemblies, as well as accompanying documentation, are checked against updated owner project requirements, including sustainability criteria.

The following are examples of different forms of commissioning:

« Commissioning that is ongoing or continuing

» Re-commissioning

» Retro-commissioning

» Commissioning for the season/offseason

ONGOING/RECURRING COMMISSIONING OR RE-COMMISSIONING

Dynamic systems and equipment, as well as static systems, assemblies, and components, will tend to degrade over time from their as-installed state. Furthermore, during the use of a facility, the needs and demands of facility users and procedures are likely to alter. Maintaining a project's sustainability elements may necessitate periodic review and revision.

The major goals of re-commissioning are to ensure that an OPR accurately represents changes in the facility's use and functioning, as follows:

» Periodic appraisal of performance in relation to the project objectives set forth by the owner.

> Keeping the system manual up to date with changes in the OPR.

> Ongoing training for O&M workers and building occupants on current system and assembly changes

RETRO-COMMISSIONING

When an owner implements commissioning on a project during the operation stage of the facility lifespan, this is known as retro-commissioning. While it performs commissioning-related tasks, it is distinct enough from the commissioning process to be regarded a separate process.

Major energy-consuming features like HVAC systems, lights, and communications are all improving at a rapid pace. Five years ago, "state of the art" might have been outmoded. Retro-commissioning a five or ten-year-old building, as well as replacing equipment or components, can result in significant energy savings. This may encourage a business owner to revisit commissions on a regular basis. xxv

COMMISSIONING DURING THE SEASON (OR OFFSEASON)

Seasonal commissioning refers to full-load testing during peak heating and cooling seasons, as well as partial load testing in the spring and fall. Initial commissioning, on the other hand, occurs as soon as the contract work is completed, regardless of the season. Seasonal commissioning entails evaluating equipment and systems during peak seasons in order to evaluate peak load performance, with heating equipment being tested during winter extremes and cooling equipment being tested during summer extremes with a fully occupied facility. Contractor participation in seasonal commissioning should be specified in construction contracts to accomplish and/or verify sustainable targets.

Asset/Facility Management—Lifecycle Management

Technology is advancing at a breakneck speed. Fluorescent light tubes and fixtures that are five years old may be energy guzzlers when compared to contemporary technologies. After a few years, such developments may drastically affect a lifetime analysis. Monitoring building component efficiency improvements can be a cost-effective way to save money in older buildings.

The best time to train the owner's operation and maintenance staff is during construction. Some training should be postponed until the building's owner has assumed responsibility for its sustainability features. Such training should be identified in the commissioning plan, and the CxA may be in charge of reviewing and implementing the training plan. Maintenance requirements for the continuing operation of sustainability features should be clearly stated in training. These standards should be represented in the contractor's Operation and Maintenance Manual and the Systems Manual (by CxA). Some contracts require that the training process be recorded in order to ensure that the material is available for future reference.

Maintenance & Operation

It may be challenging for the CM to persuade an owner to accept that the facility management team must assume ownership of the new facility. Contractors may argue that a given issue is an owner's maintenance issue, while owners may believe it is a warranty issue.

CMs should make sure that both parties' obligations are clearly outlined in the bid documents, as well as the owner's maintenance responsibilities after occupation. While the contractor may be required to provide a one-year warranty, the owner's construction cost at bid time may be lower if bid documents clearly state that the owner will be responsible for changing failed light bulbs, replacing clogged filters, and worn belts, and adjusting door hardware after substantial completion. Contractors may view bid papers more favorably if they limit attic stock for maintenance reasons to a set number of standard goods such as ceiling tiles, floor coverings, and wall coverings for the duration of the guarantee period.

FOR RESPONSIBLE PARTIES: WARRANTY CALL-BACK PROGRAM/OWNER'S CONTACT INFORMATION

Contractors should be required to give the owner with the names of certified personnel who can be contacted if a warranty-related problem arises during the warranty period in close-out submittals.

Designated contacts should be available for equipment and building components that are vital to the building's operation. Many building management systems are monitored by an outside, independent third party; these companies should be given the names and contact information of the many contractors whose work they are monitoring.

The owner should establish a similar point of contact that is open 24 hours a day to allow a contractor to enter the plant to quickly rectify or mitigate a problem, avoiding potential environmental damage and minimizing waste.

NOTE: At the conclusion of the building's usable life, the owner should look for building components that can be reused. This could include structural elements, furniture, and materials that are recyclable. The owner can reduce the building's input to landfill garbage and continue to contribute to sustainable construction projects by carefully deconstructing it.

Verification and measurement

To analyze the real performance of the building's energy-using systems, CMs should apply measurement and verification (M&V) methodologies. This can be done across the entire facility

or by individual systems like lighting, HVAC, and plug load. If the amount of information required is greater than that necessary for whole-building energy usage, the requirements must be stated early in the design phase to ensure efficiency, i.e., circuits must be planned to reduce the number of meters required to measure each use.

This information can be used by owners to improve operating efficiency. In addition, LEED provides points for designing an M&V process, in addition to whole-building energy usage.

Recalibration of the Energy Model

Energy modeling produced early in the project as a design tool or for third-party evaluation can be reassessed after a period of building operation under completed conditions, usually at least one year. Actual energy usage, occupancy, and use of the building can be used to amend the energy model and develop a new, more accurate energy model that predicts the facility's predicted energy use.

Post-Occupancy Assessment

More often than not, sustainable buildings strive to be more than merely energy efficient. The occupant/user experience is frequently a major component of the effort, and it is frequently a driver for the owner's long-term sustainability goals. Lighting, daylighting, thermal comfort, perceived air quality, i.e., scents, and even things like wayfinding and workplace ergonomics may fall under this category. A post-occupancy review may be included in the Sustainability Plan, and it may even be part of the LEED approach, as post-occupancy evaluation is eligible for a LEED credit. It could also be a decision taken after the structure has been in use.

The instruments to conduct such an evaluation, as well as the parties accountable for implementation, should be identified well before the project's finish, as should the criteria to be reviewed. When necessary, the strategy should include a plan for corrective action. Building users provide input during post-occupancy reviews. As a result, evaluations are inherently subjective, and the corrective action plan should reflect this. There are technologies and organizations dedicated to post-occupancy assessments.

A survey of occupant indoor environmental quality is available from the UC Berkeley Center for the Built Environment. Where post-occupancy review is part of the project LEED strategy or is otherwise part of the CM's obligations, the CM should make sure the timetable for formulating the plan corresponds with the project timeline.

Operation of a Sustainable Building on a Long-Term Basis

Given the amount of planning and documentation that goes into creating a sustainable project, the CM should inform the client that professional standards for quality building environments should be followed during the building's operation and maintenance.

The following items should be included in these standards, but are not limited to:

» Having a well-trained building operations staff that knows how to operate and maintain all equipment.

> Educating the user groups on the project's sustainability measures and the rationale behind the strategy.

» Creating inspection, preventive maintenance, cleaning, and repair protocols for every equipment.

> Establishing and maintaining a resource center for the purchase of sustainable-sourced additional equipment and maintenance supplies.

» Read the Material Safety Data Sheets (MSDS) on cleaning chemicals and pesticides and avoid using products that may release toxic chemicals into the air by doing so.

« Waste materials are recycled.

» Establishing a phone center to track tenant concerns and provide follow-up. Early detection of problems may save money in the long run.

> Maintaining indoor air quality monitoring in accordance with the most recent requirements.

> Changing light levels based on space usage and occupancy.

« Creating and implementing sustainability guidelines as part of any refurbishment project.

» Requiring that all moves into or out of the facility follow sustainability standards and best practices.

QUIZ

QUESTION 51

What is the post-construction phase?

a) The post-construction phase enhances quick project delivery and efficient project maintenance system
b) The post-construction phase allows for the evaluation of the sustainability efforts, as well as the adjustment of assumptions and system operation in order to increase modeling accuracy and efficiency
c) None of the above

QUESTION 52

Sustainable buildings strive to be more than merely energy efficient

a) Yes
b) No
c) Partially

QUESTION 53

_____ produced early in the project as a design tool or for third-party evaluation can be reassessed after a period of building operation under completed conditions, usually at least one year.

a) Quality assurance

b) Quality control
c) Energy modeling

QUESTION 54

To analyze the real performance of the building's energy-using systems, CMs should apply?

a) measurement and verification (M&V) methodologies
b) filtration system
c) solicitation's Instructions

QUESTION 55

Seasonal commissioning refers to?

a) Full-load testing as soon as the contract work is completed, regardless of the season
b) Full-load testing during peak heating and cooling seasons, as well as partial load testing in the spring and fall
c) When an owner implements commissioning on a project during the operation stage of the facility lifespan

QUESTION 56

Dynamic _____and _____, as well as static systems, assemblies, and components, will tend to degrade over time from their as-installed state

a) Procurement, plan
b) Systems, equipment
c) None of the above

QUESTION 57

The following are examples of different forms of commissioning except one;

a) Re-commissioning
b) Retro-commissioning
c) Reverse commissioning

QUESTION 58

A new construction project _____phase begins before the post-construction period.

a) Commissioning

b) Dedication
c) Renewal

QUESTION 59

The scope of the CM's _____tasks will vary depending on the owner's early project goals

a) Post-construction phase
b) Re-commissioning
c) Parameters

QUESTION 60

When is the best time to train the owner's operation and maintenance staff?

a) During system management
b) During construction
c) During project

GLOSSARY

When a full commissioning program isn't necessary, certain components of equipment or systems can be subjected to "acceptance testing" for owner acceptability. Contract contracts spell out the requirements for acceptance testing. The acceptance test usually includes training of owner staff in operation and maintenance.

Adaptive Capacity - A system's ability to adjust when the environment in which it operates changes.

ASHRAE is an acronym for the American Society of Heating, Refrigeration, and Air Conditioning Engineers, which was founded in 1894. The objective of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) is to develop "heating, ventilation, air conditioning, and refrigeration to serve humanity and promote safety."

research, writing standards, publication, and continuous education to create a more sustainable world." The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) provides authoritative guidance on energy load calculations, equipment performance,

commissioning, and a variety of other areas important to the design, engineering, and construction of sustainable facilities. www.ashrae.orgxxvi

Biomimicry is the process of designing and manufacturing materials, structures, and systems that are inspired by biological entities and processes.

BREEAM stands for Building Research Establishment Environmental Assessment Methodology. Since its inception, Environmental Assessment Methodology has become the world's leading environmental assessment method and rating system for buildings, with 425,000 certified BREEAM assessment ratings and two million buildings registered for assessment.

in the year 1990

BREEAM is one of the most thorough and widely recognized assessments of a building's environmental performance. It sets the bar for best practice in sustainable building design, construction, and operation. It encourages designers, clients, and others to explore low-carbon and low-impact design before considering energy efficiency and low-carbon technologies.

A BREEAM assessment evaluates a building's specification, design, construction, and use using recognized performance indicators that are compared to established benchmarks. From energy to ecological, the metrics employed cover a wide range of categories and criteria. They cover energy and water consumption, the internal environment (health and well-being), pollution, transportation, materials, waste, ecology, and management procedures, among other things.

The Building Research Establishment (BRE) initially released BREEAM in 1990, and it is the world's oldest method of measuring, rating, and certifying building sustainability. Over 250,000 buildings have been BREEAM certified, with over a million more on the way – many in the United Kingdom and others in more than 50 countries around the world. www.breeam.com

Building Commissioning (Cx) is the process of starting up, calibrating, and certifying a facility. Testing and verification of HVAC and other systems against design intent or criteria is part of this activity or combination of activities. The production of system operation manuals and training of

building maintenance workers may also be part of the commissioning process. (For more information, see "commissioning.")

Construction and demolition (C&D) trash or debris is described as the portion of the solid waste stream produced by land clearance and excavation, as well as the construction, demolition, remodeling, and repair of structures, roads, and utilities. Waste prevention, waste reduction, recycling, and reuse are all management practices.

Carbon Footprint - The total amount of greenhouse gas (GHG) emissions produced by an organization, event, or product over a given time period.

CHPS (Collaborative for High Performance Schools) - CHPS provides schools, school districts, and professionals with resources on all areas of high-performance school design, building, and operation. CHPS creates tools that address the most important aspects of school sustainability. A six-volume best practices manual, training, conferences, a high-performance building rating and recognition scheme, and other tools for CMs are among the resources available. www.chps.com

"A quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies fulfils stated targets and standards," according to ASHRAE. The National Institute of Building Sciences defines commissioning as "an all-encompassing process for the development, delivery, verification, and risk management of important tasks performed in or by buildings." Peer review and in-field or on-site verification are used to improve building quality and increase energy efficiency, environmental performance, and occupant safety. By ensuring that building components function properly, commissioning can improve indoor air quality. It's a system for documenting project implementation in terms of design intent.

The Commissioning Agent (CxA) is in charge of planning and organizing the commissioning plan's implementation, as well as observing and documenting performance, that is, assessing if systems are operating in line with the stated design intent and contract papers. Design idea, design criteria, code compliance, design, or general construction scheduling, cost estimating, or

construction management are not the responsibility of the CxA. (Commissioning agent and commissioning authority are sometimes used interchangeably.) The CxA should be a completely independent third-party consultant who reports directly to the owner.

ASHRAE and the Building Commissioning Institute offer credentials for commissioning specialists.

ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers): www.ashrae.org

www.bcxa.org is the website of the Building Commissioning Association.

Contingency - A contingency is a sum of money set aside by a party in case of unforeseen changes in the scope of work or cost increases.

Building deconstruction - The selective disassembly of building components for C&D waste management solutions such as reuse and recycling. Deconstruction is distinct from demolition, which emphasizes the quick removal of a structure from its location.

Deep Energy Retrofit - An energy-saving technique in an existing building that also improves the facility's overall performance.

A whole-building study and construction/renovation procedure that saves far more energy and money than traditional energy retrofits, sometimes by more than half. Deep retrofits also tend to increase building tenant satisfaction and health. http://www.energy.gov

ENERGY STAR - A voluntary labelling program established by the US EPA and the US Department of Energy in 1992 to identify and promote energy-efficient products in order to reduce greenhouse gas emissions. The ENERGY STAR certification was recently expanded to include new houses, as well as commercial and industrial structures. www.energystar.gov xxx ENERGY STAR PROGRAM

Envision is a rating system that gives advice on how to plan, design, and build infrastructure that is both sustainable and resilient. The system has objectives and performance indicators that take the user through a project evaluation and, potentially, a sustainability award. www.asce.org

Estidama is a building design methodology for more sustainable construction and operation of buildings and communities. The program is an important part of the "Abu Dhabi Vision 2030" initiative, which aims to create the emirate of Abu Dhabi according to cutting-edge green standards. The Arabic term for "sustainability" is "estidama." The program is not a green building grading system like LEED or BREEAM, but rather a set of values imposed in the form of an optional building code.

The Pearl Grading System, a green building rating system inside Estidama, is used to evaluate sustainable building development methods in Abu Dhabi.

In Abu Dhabi, the Estidama program is mandated, with all buildings requiring a minimum 1 Pearl Rating and all government-funded structures requiring a minimum 2 Pearl Rating.

The system can be used in communities, buildings, and villas, each with its own set of requirements. estidama.upc.gov.ae

The LEED certification program is administered by the Green Building Certification Institute (GBCI), which conducts third-party technical assessments and verification of registered projects to determine if they meet the LEED rating system's standards. http://www.gbci.org

Green Building Facilitator (GBF) - Consensus

The Green Building Addendum (GBA) in DOCS 310 establishes a role for a Green Building Coordinator (GBC) to coordinate or implement the project's green building aims. It establishes the GBF's roles as the process manager and the project participants' responsibilities.

Green Building Initiative (GBI) - The GBI is a non-profit organization whose mission is to promote credible and practical green building approaches for residential and commercial construction in order to accelerate the adoption of building practices that result in environmentally sustainable buildings. www.thegbi.org

Green Globes - The Green Building Institute's Green Globes is a development and management tool that contains an assessment process, a grading system, and a guide for incorporating environmentally friendly design into new and existing commercial buildings. www.greenglobes.com

Greywater is wash water, which includes bath, dish, and laundry water but does not include toilet waste or garbage. A greywater system is meant to keep greywater collection and treatment separate from blackwater (sewage), which includes greater nitrogen and bacteria concentrations.

Building that integrates and improves all important high-performance building qualities, such as energy efficiency, durability, lifetime performance, and occupant productivity.

Integrated Project Delivery (IPD) - A project delivery method that involves a team-based approach that includes the designer, owner, construction manager, key technical consultants, the contractor, and key subcontractors. Project risks are distributed evenly among stakeholders who collaborate to achieve faster delivery, lower costs, and avoid lawsuits.

ISO 14000 - The International Organization for Standardization (ISO) is a non-governmental organization that develops and publishes voluntary International Standards all over the world. ISO is a global network of 159 national standards institutes, each with one member, that is coordinated by a central secretariat in Geneva, Switzerland. The American National Standards Institute represents the United States (ANSI). Companies and organizations of various types can use the ISO 14000 family of standards to manage their environmental responsibilities. Environmental management systems are addressed in the first two standards, ISO 14001:2015 and ISO 14004:2004. (EMS). ISO 14001:2015 specifies the standards for an environmental management system, while ISO 14004:2004 provides generic EMS recommendations. Labeling, performance evaluation, lifecycle analysis, communication, and auditing are among the other ISO 14000 standards and guidelines. http://www.iso.org/xxxii International Organization for Standardization

LEED (Leadership in Energy and Environmental Design) - The LEED green building rating system uses design and construction as well as a tiered performance-based rating system to encourage and accelerate global adoption of sustainable green building and development techniques. It provides independent verification of sustainability goals, with points awarded for achieving four more difficult levels of achievement: Certified, Silver, Gold, and Platinum. The Green Building Certification Institute establishes and administers LEED, a consensus guideline.

LEED AP - LEED Accredited Professional, a professional credential offered to someone who has passed the LEED AP test and demonstrated a complete mastery of the LEED green building rating system. The Green Building Certification Institute, an independent organization that provides third-party certification, administers the LEED professional credential program. xxxiii

http://www.usgbc.org/green-building-certification-institute/

Beginning with the procurement and manufacture of raw materials and continuing through fabrication, manufacture, construction, use, and depletion, and concluding with any of a range of recovery, recycling, or waste management choices, the lifecycle of a product is defined.

Lifecycle Analysis (LCA) is a strategy for analyzing the effects of a product's life cycle from cradle to grave (i.e., raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

All expenditures associated with the planning, design, building, operation, maintenance, and demolition of a structure or system over the course of a particular life expectancy, expressed in present value.

The International Living Future Institute, www.living-future.org, launched the Living Building Challenge in 2006 as an international sustainable building certification scheme.

Net Zero - A net zero energy building is one that consumes no net energy and emits no carbon dioxide annually.

The Pearl Rating System is a green building rating system created by the Abu Dhabi Urban Planning Council as part of its Estidama sustainable development strategy.

The Pearl Rating System, like LEED, includes different levels of certification ranging from one to five pearls. A minimum certification of one pearl is required for all new development projects in

the emirate of Abu Dhabi (two pearls for government buildings). The Executive Council of Abu Dhabi imposed this certification requirement, which went into force in the fall of 2010.

With the Pearl Rating System, there are three levels of certification. The first stage entails

The success of the Pearl Design Rating is determined by the building permit. The Pearl Construction Rating is the second stage, and its success is determined by the certificate of completion. The Pearl Operations Rating is the third level, which has yet to be established.

For all of the Pearl Rating Systems, training sessions of varying lengths and technical depths are available. WSP Group and Oger International are now delivering training seminars on behalf of the Abu Dhabi Urban Planning Council.

Individuals interested in working on Pearl Rated projects should become Pearl Qualified Professionals (PQPs); each project in the emirate of Abu Dhabi requires at least one PQP. Prometric created the PQP test, which is given at the CERT center in Abu Dhabi and the AMIDEAST testing center in Dubai.

Up to five pearls may be granted after an evaluation by Abu Dhabi's Urban Planning Council (UPC). All developments are required to have one pearl, which is based on the building code. All Abu Dhabi government projects must attain two pearls, according to Information Bulletin No. 1 dated December 6, 2010. All of the essential requirements, as well as additional optional credits, are included in two pearls.

The Abu Dhabi Midfield Terminable Building and ten unnamed Abu Dhabi Education Council (ADEC) schools are the only projects to date to receive three pearls.

http://estidama.upc.gov.ae/pearl-rating-system-v10.aspx?lang=en-US

Rainwater Harvesting is a sustainable water management strategy that diverts rainwater to collecting and treatment systems shortly after it rains.

Building materials with substances that are dangerous to humans, animals, or the environment are listed on the red list.

Renewable energy is energy derived from natural and easily regenerated renewable resources such as sunshine, wind, rain, tides, and some geothermal uses.

Green tags, Renewable Energy Credit, Renewable Electricity Certificates, or Tradable Renewable Certificates (TRCs) are tradable, non-tangible energy commodities in the United States that represent proof that 1 megawatt-hour (MWh) of electricity was generated from an eligible renewable energy resource (renewable electricity).

Resilience is a system's ability to adapt, grow, and survive in the face of unpredictable changes (climate variability) and/or catastrophic events. A system that has the adaptive capacity to recover swiftly and sustain significant disruptions while maintaining acceptable levels of degradation and recovery within reasonable time, cost, and risk parameters.

Retro-Commissioning (RCx) is a systematic procedure for identifying operational and maintenance improvements in existing buildings with the goal of increasing energy efficiency. RCx mainly focuses on mechanical equipment, lighting, and controls, and instead of replacing equipment, it usually enhances current systems. An energy audit, diagnostic monitoring, and functional tests are usually included in RCx. The EPA's ENERGY STAR program provides information on retro-commissioning.

SITES - The SITES sustainability initiative, www.sustainablesites.org, integrates land development and management with creative sustainable design.

Sustainability Plan (SP) - A written project-specific plan that allows the construction manager to coordinate efforts, track progress, and focus energies on the deliverables and milestones needed to meet project sustainability goals and standards. A Sustainability Plan serves as both a guide and the basis for a reporting system. It must be as brief as feasible.

Sustainable - The ability to meet the requirements of current generations without jeopardizing future generations' resources.

Sustainable Airport Management (SAM) - SAM is a comprehensive guidance manual developed by the Chicago Department of Aviation (CDA) to incorporate and track sustainability in administrative procedures, planning, design and construction, operations and maintenance, concessions and tenants, and concessions and tenants with minimal impact on project schedules and budgets. SAM is in charge of implementing sustainability programs at O'Hare and Midway International Airports in Chicago, as well as several other airports across the world.

The CDA was the first in the country to adopt sustainable principles for airport design and construction. The Sustainable Airport Manual was developed as part of Chicago's ongoing attempts to integrate more environmentally sustainable measures into all aspects of airport operations. http://www.airportsgoinggreen.org/sustainably-operating-airports-manual.aspx

Sustainable Design and Construction - A type of construction project in which the design, engineering, and construction processes prioritize resource conservation and occupant health and well-being.

Sustainable Development - A resource-use pattern that attempts to meet human needs while maintaining the environment, so that these needs can be addressed not just now, but also in the future. Sustainable development is a goal that tries to balance natural systems' carrying capacity with the physical, social, and cultural demands of the system's inhabitants. Sustainable development, as described by the Brundtland Commission in 1983, is "development that meets current demands without jeopardizing future generations' ability to satisfy their own needs."

Sustainable Forest Management is the practice of managing forests in accordance with the ideals of long-term development. This necessitates determining how to use a forest in practical ways today in order to ensure equal benefits, health, and production in the future. To generate solid forest plans, forest managers must examine and integrate a wide range of sometimes opposing factors—commercial and non-commercial values, environmental considerations, and a community's worldwide impact. Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) non-profits offer voluntary sustainable forestry management assistance and certification (SFI).

Sustainable Building Materials - Rather than nonrenewable resources, sustainable building materials are made from renewable ones. When the effects of sustainable materials are assessed

over the product's lifetime, they are environmentally responsible. The use of sustainable construction materials can help to lessen the environmental implications of these source materials' extraction, transportation, processing, fabrication, installation, reuse, recycling, and disposal.

Sustainable Remediation is a phrase used internationally to identify sustainable approaches to the investigation, assessment, and management (including institutional controls) of potentially contaminated land and groundwater, as defined by the Brundtland Report.

"Sustainable Remediation preserves human health and the environment while maximizing environmental, social, and economic benefits throughout the project lifecycle," according to the Sustainable Remediation Forum (SURF).

With the goal of balancing economic viability, conservation of natural resources, biodiversity, and the enhancement of the quality of life in surrounding communities, SURF promotes the use of sustainable practices during the investigation, construction, remediation, redevelopment, and monitoring of environmental cleanup sites. www.sustainableremediation.org

The Systems Thinking Approach - Provides a framework for comprehending complicated challenges and structuring difficulties in order to get better results and reduce delays in building construction projects.

John Elkington coined the term "triple bottom line" in 1994 to characterize the simultaneous prioritizing of environmental, economic, and social consequences and benefits. People, planet, and profit are in a dynamic tension that effectively balances all three.

A specialized cost-control technique that employs a systematic and creative study of a project's or operation's functions to discover the optimum way to achieve the required function, performance, and dependability at the lowest lifecycle cost.

The US Green Building Council (USGBC) is a non-profit organization dedicated to moving the construction industry toward sustainability by providing knowledge and guidelines on how buildings are designed, constructed, and operated. The United States Green Building Council (USGBC) is best recognized for creating the LEED® (Leadership in Energy and Environmental Design) rating system.

Value Engineering (VE) is a systematic approach to increasing the value of a project by examining cost-cutting solutions or functional changes that improve the function-to-cost ratio.

A performance-based system for measuring, certifying, and monitoring characteristics of the built environment that impact human health and well-being through air, water, nutrition, light, fitness, comfort, and mind. www.wellcertified.com