Slide 1

EA Energy & Atmosphere

Overview

- Buildings consume ~ 40% of U.S. energy.
- Fossil fuels produce ~ 75% of our energy.
- Coal-fired power plants emit more fine particulate material than any other U.S. activity.
- Natural gas (CO_2), nuclear energy (radiation), and hydroelectric power (habitat disturbance) all have a negative impact on ecological systems.
- Improving the energy performance of buildings reduces pollution and cost and enhances comfort.
- **LEED** emphasizes integrated energy strategies

Buildings consume a large percentage of all energy and close to 70% of all electricity in the United States. As most electricity comes from polluting coal-fired power plants, buildings that reduce their percentage of energy use will have a major impact on the environment. LEED acknowledges this impact and addresses energy in buildings through reducing energy use and increasing renewable forms of energy. Less energy also means less utility costs, which can make a quick payback to any efficiency upgrades or renewable energy expenses.

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Energy & Atmosphere

Credits Overview

P1 Fundamental Commissioning of the Building Energy Systems (prerequisite)
P2 Minimum Energy Performance (prerequisite)
P3 Fundamental Refrigerant Management (prerequisite)

1. Optimize Energy Performance
2. On-Site Renewable Energy
3. Enhanced Commissioning
4. Enhanced Refrigerant Management
5. Measurement & Verification
6. Green Power

- *Establish Energy Efficiency and System Performance*
- *Optimize Energy Efficiency*
- *Encourage Renewable and Alternative Renewable Sources*
- *Support Ozone Protection Protocols*

Energy & Atmosphere credits aim to optimize energy performance in order to reduce the energy consumption of our buildings, thereby decreasing negative environmental impacts. This involves building commissioning, energy modeling, use of non-ozone depleting substances and encouragement to use renewable energy technologies.

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Energy & Atmosphere

Presentation Outline

- **Commissioning**
  (prerequisite/credit 3)
- **Energy Performance**
  (prerequisite/credit 1)
- **Refrigerant Management**
  (prerequisite/credit 4)
- **“Clean” Energy**
  (credit 2/credit 6)
- **Measurement & Verification**
  (credit 5)

This module has been organized by category rather than credit number to help make the credit requirements as clear as possible.

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Energy & Atmosphere: Prerequisite 1

Fundamental Commissioning of the Building Energy Systems

INTENT: Verify that the building's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents.

Benefits of commissioning:

- Optimized energy efficiency, IAQ and comfort
- Improved construction documents
- Identification and resolution of issues on paper
- Focus on project requirements
- Minimizing callbacks
- Lower operating costs
- May qualify a project for state assistance or utility rebates
- Successful commissioning implementation increases EE by 5-10%

Commissioning verifies that all the building equipment and systems are working efficiently together. Along with energy performance, following the measures of this prerequisite can help improve the building occupants' well-being and productivity as commissioning helps create a better indoor environment. This can equate to money savings from the decrease in employee illness and turnover. Commissioning will also lower your liability related to indoor air quality and early equipment replacement.

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Energy & Atmosphere: Prerequisite 1

Requirements

Six items to meet prerequisite:

1. Engage experienced commissioning team/agent:
   - Projects ≥ 50K sq.ft. may use someone else in the Mechanical and Electrical firm but not on the design team
   - Projects ≤ 50K sq.ft. may use someone on the design team
2. Review design intent.
3. Include commissioning in CD's.
4. Develop requirements into plan.
5. Verify installation, performance, and documentation
6. Complete commissioning report.

Requirements vary depending on the size of the project. The key to achieving the credit requirements is to plan for commissioning at project inception. If commissioning doesn't take place up-front, it will happen over the life of the building - problems will be diagnosed slowly over time, and meanwhile, energy may be wasted. Commissioning at the beginning of the project reduces callbacks, because commissioning agents act as an objective, third party; keeping the owner's best interest in the foreground.

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Energy & Atmosphere: Credit 3

Enhanced Commissioning

INTENT: Begin the commissioning process early during the design process and execute additional activities after systems performance verification is completed.

Additional commissioning – Must be experienced third party
- provides greater value for limited additional investment
- further increases productivity, energy efficiency, and health

Six additional requirements to achieve credit:
1. Engaged qualified 3rd party
2. Review design prior to mid-CD's.
3. Review contractor's equipment submittals.
4. Develop systems manual.
5. Verify that requirements for training are completed.
6. Review building operation within 10 months after substantial completion.

This credit may require additional meeting time and costs but can greatly reduce operating costs and liabilities. With additional commissioning, a building will perform as intended for the life of the building. Additional commissioning includes educational documentation and trainings to keep personnel and the owner aware of the procedures for maintaining efficiency through the building's life. Occupants can greatly benefit from indoor air quality and comfort that commissioning tests, thus improving their productivity, well-being and health. The owner will also benefit with the reduction of repairs and energy costs in the building.

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Energy & Atmosphere: Prerequisite 2

Minimum Energy Performance

INTENT: Establish the minimum level of energy efficiency for the proposed building and systems.

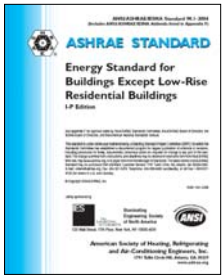
Requirement: Comply with ASHRAE 90.1-2004
(without amendments)

Environmental concerns:

- Fossil fuels (global warming)
- Nuclear power (waste processing, transportation, and storage)

Complying with ASHRAE 90.1:

- Reduces energy consumption and demand charges
- May result in lower fist costs (smaller HVAC for example)



Maximize energy performance as much as possible through lighting, HVAC, an air tight and insulated building envelope, and water heating systems. The components of ASHRAE include building envelope, heating, ventilating, air conditioning, service water heating, power and lighting. ASHRAE 90.1 is the energy standard for many states, so attaining this credit usually requires no extra planning.

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Energy & Atmosphere: Prerequisite 2

Minimum Energy Performance

ASHRAE 90.1 Compliance Methods:

Mandatory Requirements:

- Prescriptive
  - Building Envelope
  - Lighting, HVAC, and Water Heating
- Energy Cost Budget Method
  - Also used for EA credits 1-10
  - Regulated loads only

To comply with ASHRAE 90.1-2004, there is the option to do a Prescriptive Method or the Energy Cost Budget method (ECB). The Prescriptive Method includes specific line items to follow: e.g. if you have a metal building, you must have R-19 insulation in the roof. The Energy Cost Budget method exceeds some of the prescriptive measures provided there are energy cost savings in other areas. The ECB method is more flexible: if you are using extremely efficient windows, you may not need as much insulation to meet code; the designer has the ability to balance their 'energy budget'.

* If the building has an energy model to document points in Energy and Atmosphere Credit 1, the model can be used in lieu of the Energy Cost Budget Method to demonstrate compliance with the prerequisite requirements.

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Energy & Atmosphere: Credit 1

Optimize Energy Performance

INTENT: Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Option 1 – Whole Building Energy Simulation (1 – 10pts)

- Demonstrate a % improvement compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 (without amendments) by a whole building approach simulation.
- Include all energy costs in the model
- Plug loads count (process)
- Design and baseline must comply with Appendix G, ASHRAE/IESNA 90.1-2004

New	Existing	Points
10.5%	3.5%	1
14%	7%	2
17.5%	10.5%	3
21%	14%	4
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8
38.5%	31.5%	9
42%	35%	10

Optimize your building's performance through a tightly sealed building envelope and with efficient systems. By limiting the amount of energy used in a building, you are also able to save on lower energy bills and smaller, less expensive equipment.

With Energy Modeling required in Option 1, buildings can be much more efficient, saving both money and energy. Use the energy model to demonstrate an improvement between a baseline case and the design case to earn points. The minimum energy cost savings percentage for each point threshold is as listed in the table.

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Energy & Atmosphere: Credit 1

Optimize Energy Performance

Option 2 – Prescriptive Compliance Path (4 Points)

Comply with ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004**:**

- Building must be under 20,000 square feet
- Must be office occupancy
- Must comply with Advanced Energy Design Guide for the climate zone

Option 3 – Prescriptive Compliance Path (1 Point)

Comply with the Basic Criteria and Prescriptive Measures of the Advanced Buildings Benchmark Version 1.1:
(except for sections 1.7, 1.11 and 1.14)

- Must comply with Advanced Buildings Benchmark for the climate zone

NOTE: All projects registered after June 26, 2007 must earn at least two points under EA Credit 1

The second option for credit compliance provides a simplified approach for small office buildings for exceeding ASHRAE standards. The guide has recommendations relating to the building envelope, interior lighting, and HVAC systems that are climate-specific and help improve the building's energy performance by 30%.

The third credit compliance option focuses on exceeding national codes and standards with the Advanced Buildings Benchmark by the New Buildings Institute. Compliance for this LEED credit is associated with sections 5 and 6 in the Advanced Buildings Benchmark standards.

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Energy & Atmosphere: Credit 1

Design Strategies

- **Demand Reduction**
  - Overall footprint reduction
  - Improved insulation & glazing
  - Ducts inside building envelope
  - Task lighting vs. ambient
  - Occupancy sensors
  - Relax temperature design criteria
- **"Free" Energy**
  - Daylighting
  - Building orientation (passive solar)
  - Natural ventilation
  - Envelope and material choices
- **Increase Efficiency**
  - High performance lighting technology
  - State-of-the-art mechanical systems

Spray foam insulation in ceiling

Daylighting

Decreasing energy use, harnessing renewable energy, and increasing the efficiency of the building are the most effective means of achieving a higher energy performance. The most effective design strategies vary for each project, so analyze the different options early in the design process. The list provided is in order of the priorities the project should take to optimize energy efficiency.

First decrease the amount of energy used in the building. Strategies include reducing the building footprint through sharing spaces. Use continuous insulation and extend the building envelope to the roofline.

The second priority is to harness natural and free energy, such as sunlight. Passive solar design depends on the building's orientation, but can help reduce the energy use if appropriately designed with south and north facing windows.

Finally, after energy demand is reduced and free energy is harnessed, use highly efficient systems and high performance technology to achieve the best energy performance possible.

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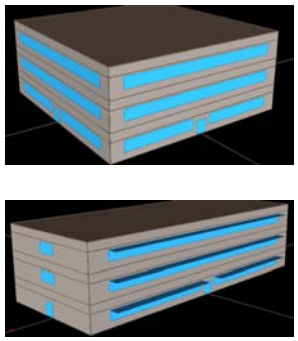
Energy & Atmosphere: Credit 1

How and When to Model

1. Schematic Design
   - Building shapes & orientation
   - Materials assessments (mass versus light, amount of glass)
   - Various types of HVAC systems

2. Design Development
   - Glass types & shading
   - HVAC strategies
   - Insulation values
   - Lighting and daylighting

3. Final Design
   - Final LEED Submission



Changing the building orientation in this example to a longer east-west axis reduced energy cost by 14%.

Only Option 1 requires an energy simulation model. Five energy simulation runs are required in order to comply with the credit requirements: one proposed design and four baseline models that are identical to each other except for the building orientations and window SHGC (Solar Heat Gain Coefficient) requirements described in ASHRAE 90.1.

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Energy & Atmosphere: Credit 1

Model Using Energy Cost Budget

Calculating the Percentage of Cost Savings

ECB = Energy Cost Budget case = (electric$ + gas$) $_{\text{Base building}}$

DEC = Design Energy Cost case = (electric$ + gas$) $_{\text{Design building}}$ – (renewable $)

% Savings = 100 x (ECB-DEC) / ECB

Example:

ECB = $75k + $25k = $100k

DEC = ($60k + $10k) – ($2k$_{\text{renewables}}$) = $68k

% Savings = 100 x (ECB-DEC)/ECB

= 100 x (100k-70k)/100k = 32%

* For new construction this would earn 7 points.

The whole building simulations are used to report the total energy costs of the building. The example above describes the calculations involved in determining cost savings. Energy consumption and peak demand are also reported in the model.

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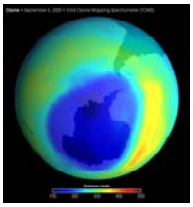
Energy & Atmosphere: Prerequisite 3

Fundamental Refrigerant Management

INTENT: Reduce ozone depletion.



REQUIREMENTS:

- No new CFC-based refrigeration equipment
- CFC conversion plan for existing equipment
- Chlorofluorocarbons (CFC)'s destroy the ozone layer and cause serious environmental & health problems including:
  - Skin cancer and cataracts
  - Weakened immune systems
  - Reduced crop yield
  - Disruption of marine food chain

- The U.S. is the largest emitter of ozone depleting substances (ODS)
- U.S. ended CFC production in 1995 (Montreal Protocol)
- Manufacturers must label products containing / made with ODS

Install equipment in the building that does not use CFC-based refrigerants. If reusing HVAC equipment, create a replacement schedule and CFC phase-out plan. Though CFCs are no longer available in new equipment, CFC based systems are still found in existing buildings. If the new building is connected to an existing building, that system must also be CFC free.

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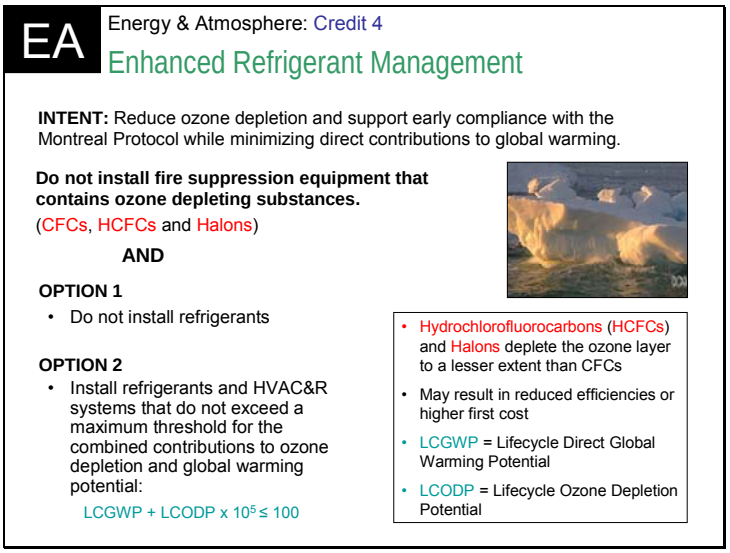

Buildings that comply with this credit eliminate the use of HVAC&R systems that damage the atmosphere with CFCs, HCFCs and Halons. Select refrigerants with low ozone depletion and global warming potential, and prevent leakage of these compounds into the atmosphere. All equipment that accompanies chlorinated refrigerants including HCFCs will be phased out by 2010. Projects should select equipment that does not depend on these chemicals to be better prepared for the phase out plan under the Montreal Protocol. Projects that have naturally ventilated buildings with no active cooling systems or natural refrigerants including water, carbon dioxide, and ammonia are eligible for this credit.

* The calculation determines the average refrigerant atmospheric impact and it must be less than 100 to comply with the credit requirements.

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Energy & Atmosphere: Credit 2

On-Site Renewable Energy

INTENT: Encourage and recognize increasing levels of on-site renewable energy self-supply in order to reduce environmental and economic impacts associated with fossil fuel energy use.

REQUIREMENTS: Supply at least 2.5% of total energy use through renewable technologies to reduce fossil fuel use.

% of Total	Points
2.5	1
7.5	2
12.5	3

Types of Renewables:

- Wind
- Photovoltaic
- Solar Thermal
- Low Impact Hydro
- Biomass / Bio-gas
- Geothermal from a geyser

A vertical wind turbine produces energy for the building.

This step is encouraged after energy efficient building measures are in place to help offset building costs most effectively. Achieve credit compliance if a percentage of the building's energy use is supplied from renewable technologies that are generated on site (see table). Make use of net metering arrangements with local utilities. Many companies not only pay for the installation of a wind generator for a facility, but will also own and maintain it. In return they sell the electricity at a fixed rate to the building.

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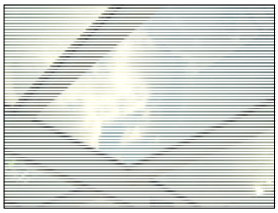
Energy & Atmosphere: Credit 2

On-Site Renewable Energy

These inventive window treatments have a double use to provide shade and supply energy (above and right).



This glazing has a transparent “peel and stick” layer of PV so it generates electricity without losing its function of a window (left). Solar shingles have the aesthetic of roof shingles, but generate electricity (top left).

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Energy & Atmosphere: Credit 6

Green Power

INTENT: Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

REQUIREMENTS: Engage in a two-year contract for Green-e certified power to provide at least 35% of the building's energy.

Types of Renewables:
- Wind
- Photovoltaic
- Solar Thermal
- Low Impact Hydro
- Biomass / Bio-gas
- Geothermal (geyser)

Three Approaches for Credit Achievement:

1. Open electrical market – select a Green-e certified power provider.
2. Closed electrical market – enroll in a Green-e accredited utility program by local utility company.
3. Tradable Renewable Certificates (RECs) – "green tags" that compensate Green-e generators for the premium of production over the market rate they sell to the grid.
   - Buying RECs will have no impact on the cost of electricity from the local utility

Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources and helps increase renewable sources of energy on the grid, rather than coal powered electricity. Businesses can purchase renewable energy through their local utility and must secure a two-year contract for a minimum of 35% of their annual electrical power consumption. The power purchased to comply with this credit's requirements need not be Green-e certified. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements such as renewable energy certificates (RECs), tradable renewable certificates (TRCs), and green tags.

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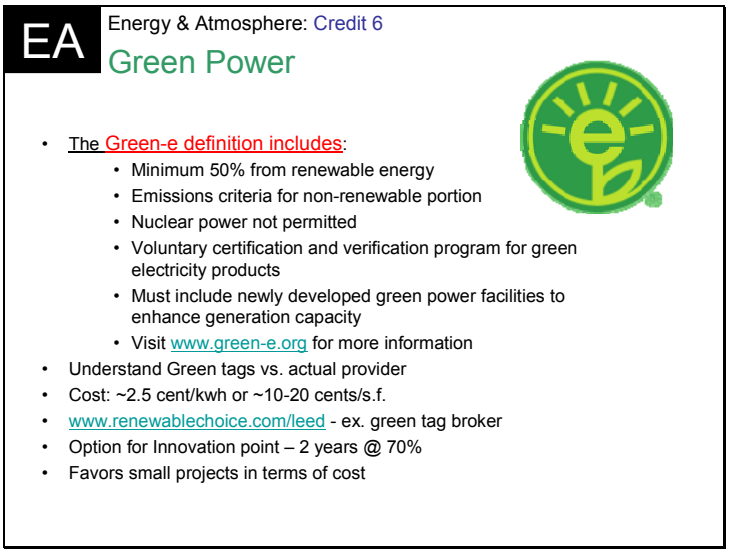

The Green-e renewable energy requirements are stated here but can be viewed in more detail on the program's website. Green tags equate to paying a subsidy to encourage renewable power generation somewhere on the grid, even if those kilowatts are not directly supplied to your building. The typical added cost for renewably generated electricity over standard electricity is $0.025/killowat. A project can attain an innovation point if a two year green power contract matches 70% of the building's electrical power consumption. Small projects are favored because it is cheaper for a small project to match 35% of the electrical output compared to a large building, creating a more affordable point.

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Energy & Atmosphere: Credit 5

Measurement & Verification

INTENT: Provide for ongoing accountability of building energy performance and water consumption over time

Install Continuous Metering Equipment for:

- Lighting and Controls
- Motor Loads and Drives
- Chiller Part-load Efficiency
- Cooling Loads
- Economizer and Heat Recovery
- Ductwork and Ventilation
- Boiler Efficiencies
- Building Process Systems and Equipment
- Indoor Water Risers and Outdoor Irrigation

Most buildings are built to last more than 50 years. When examined over that time frame, energy savings can be drastic if proper maintenance of the building is in place throughout the time frame. The goal of M &V practices is to verify that the building is performing properly and efficiently throughout the lifetime of the building and account for changes as they occur. Monitoring the building's energy use allows the owner to verify the performance level of the building and minimize long-term energy use by knowing when the building is not performing optimally.

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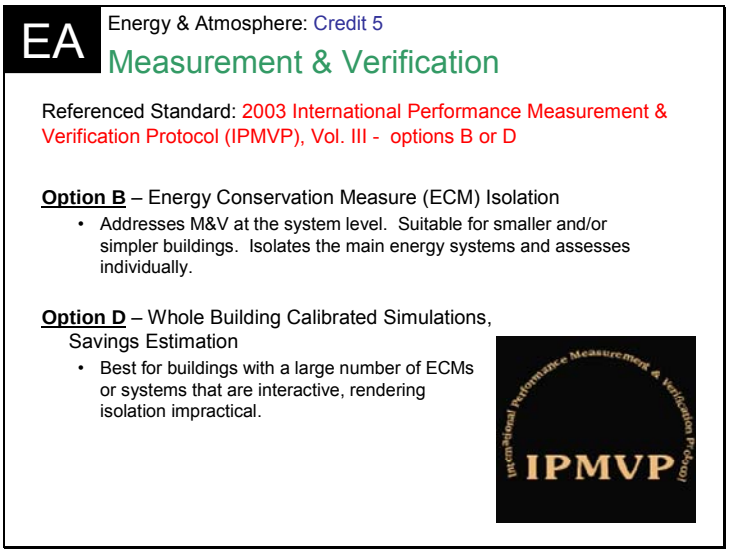

There are two different options based on the IPMVP referenced standard, and the options vary depending on the size and type of the building.

Option B isolates areas that impact performance and is better suited for a smaller building where systems are not as thoroughly connected.

Option D involves comparing (calibrating) the energy savings predicted by the energy model (simulation) with the actual savings recorded once the building is operating. If there is a discrepancy, it may indicate an opportunity for improved performance and/or the faulty operation of equipment.

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Energy & Atmosphere

Points Summary

P1 Fundamental Commissioning of the Building Energy Systems (prerequisite)

P2 Minimum Energy Performance (prerequisite)

P3 Fundamental Refrigerant Management (prerequisite)

1.	Optimize Energy Performance	1-10
2.	On-Site Renewable Energy	1-3
3.	Enhanced Commissioning	1
4.	Enhanced Refrigerant Management	1
5.	Measurement and Verification	1
6.	Green Power	1
	TOTAL	17