

# LEED v4 RATING SYSTEM REVIEW

LOCATION & TRANSPORTATION

SUSTAINABLE SITES

WATER EFFICIENCY

ENERGY & ATMOSPHERE

MATERIALS & RESOURCES

INDOOR ENVIRONMENTAL QUALITY



PRESENTED BY USGBC

# MODERATOR



**Carlie Bullock-Jones**

ASID, LEED Fellow

Owner, Ecoworks Studio



# LEED FOR BUILDING DESIGN + CONSTRUCTION

# LEED FOR INTERIOR DESIGN + CONSTRUCTION

photo credit: Paul G. Wiegman



# LEED v4 RATING SYSTEM REVIEW

LOCATION & TRANSPORTATION

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INDOOR ENVIRONMENTAL QUALITY



Identify the **intent, requirements,** and **strategies** for success with Water Efficiency credits.

Recognize ways to **reduce water** use inside and outside the building.

Implement **water metering** to support better water management.

Recognize **synergies** between multiple credits.

Identify the **intent, requirements,** and **strategies** for success with Energy and Atmosphere credits.

Recognize how the holistic approach of addressing the **reduction of energy use, energy efficient design** strategies, and **renewable energy** sources are reflected in the credits.

Realize the importance of **starting early** in the design process for most of the EA credits.

Identify **synergies** between multiple credits.

WHAT

WHY

WHEN

WHO

HOW



WHAT

WHY

WHEN

WHO

HOW

WHAT

WHY

WHEN

WHO

HOW

WHAT

WHY

WHEN

WHO

HOW



WHAT

WHY

WHEN

WHO

HOW





# WATER EFFICIENCY



## DESIGN AND CONSTRUCTION RATING SYSTEMS



presented by  
**USGBC**



# SPEAKERS



**Warren Gorowitz**

CLIA

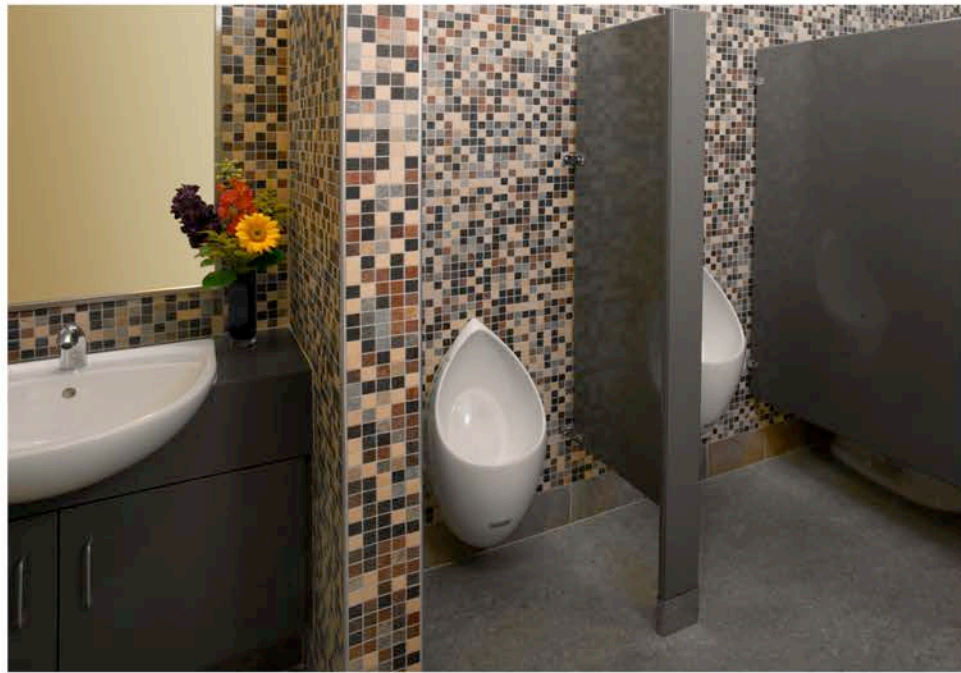
Vice President - Sustainability  
and Conservation,  
Ewing Irrigation Products



**Paul Knowles**

PhD

Sustainability Engineer  
Natural Systems Utilities



**BD+C**

All water uses

**ID+C**

Indoor water use only





# WE PREREQUISITES

	PREREQUISITE	CREDIT
Outdoor water use reduction	X	X
Indoor water use reduction	X	X
Building-level water metering	X	



## **WE** Prerequisite

Outdoor Water Use Reduction

30% reduction



## **WE Credit**

Outdoor Water Use Reduction

**1**

**POINT**

50% reduction

**or**

**2**

**POINTS**

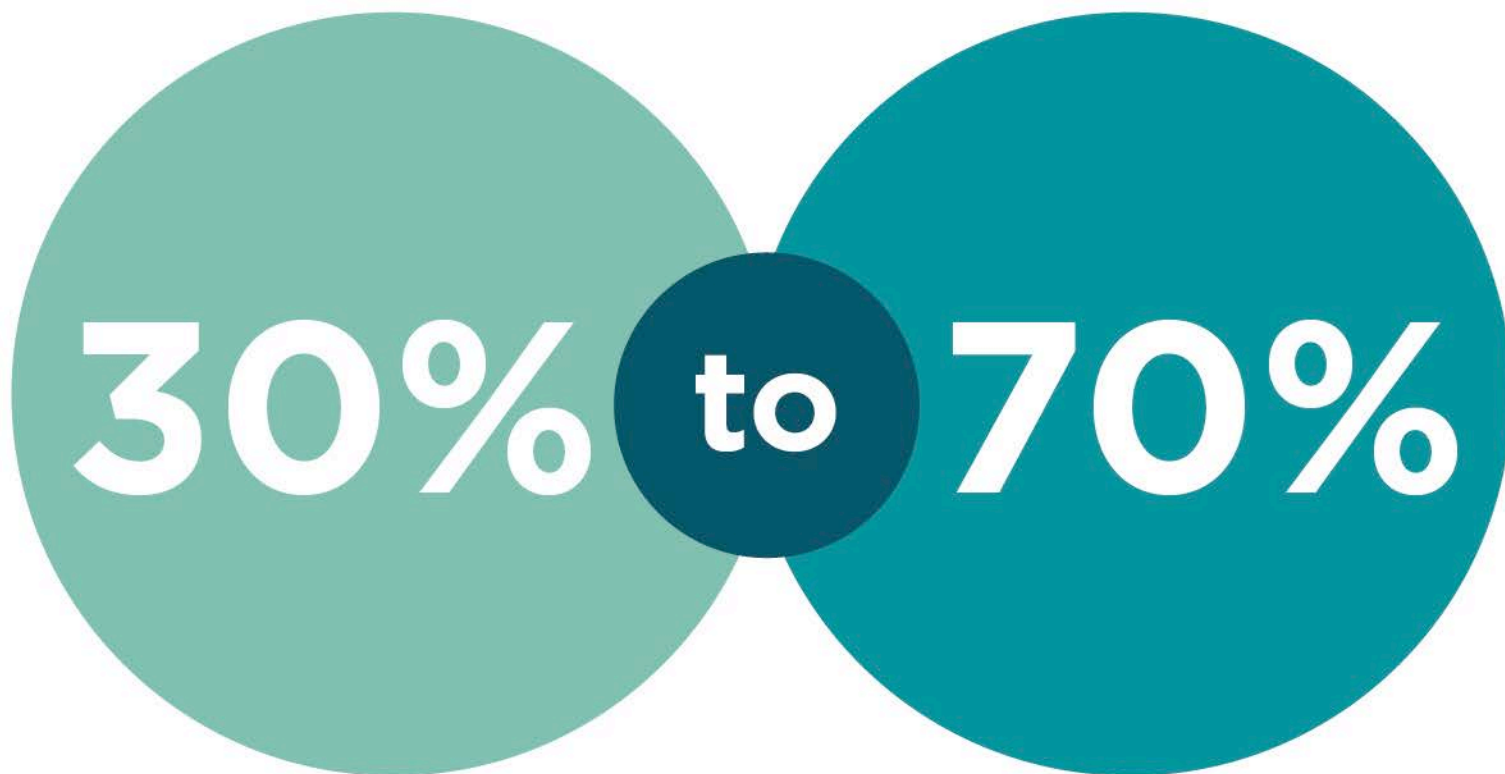
100% reduction

# HEALTHCARE



## ADAPTATION SPECIFIC CREDITS

Outdoor Water Use Reduction  
1 Point



Source: U.S. EPA

WHAT

WHY

WHEN

WHO

HOW



# **WE** Prerequisite and Credit

## Outdoor Water Use Reduction

OPTION

**1**

No irrigation  
required

or

OPTION

**2**

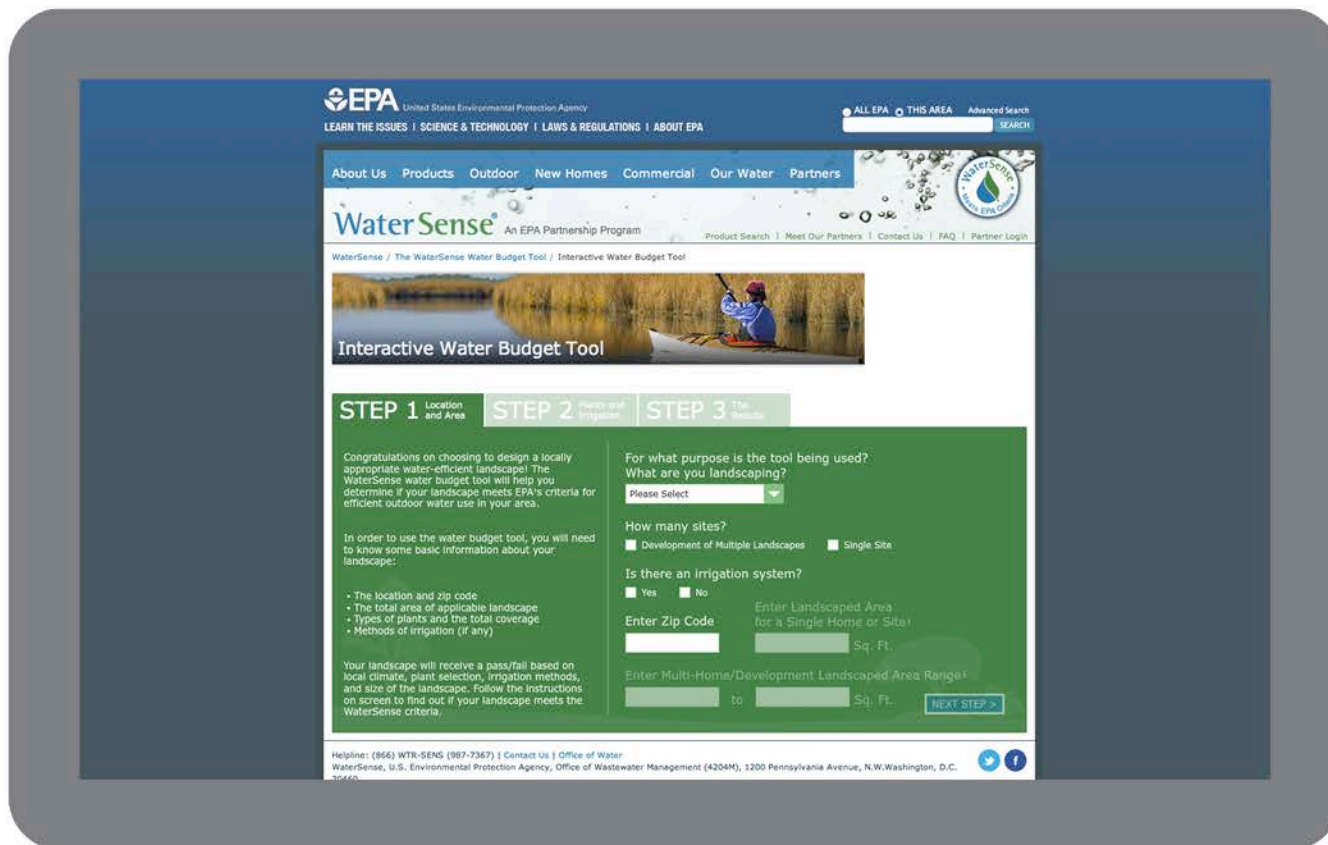
Reduced  
irrigation



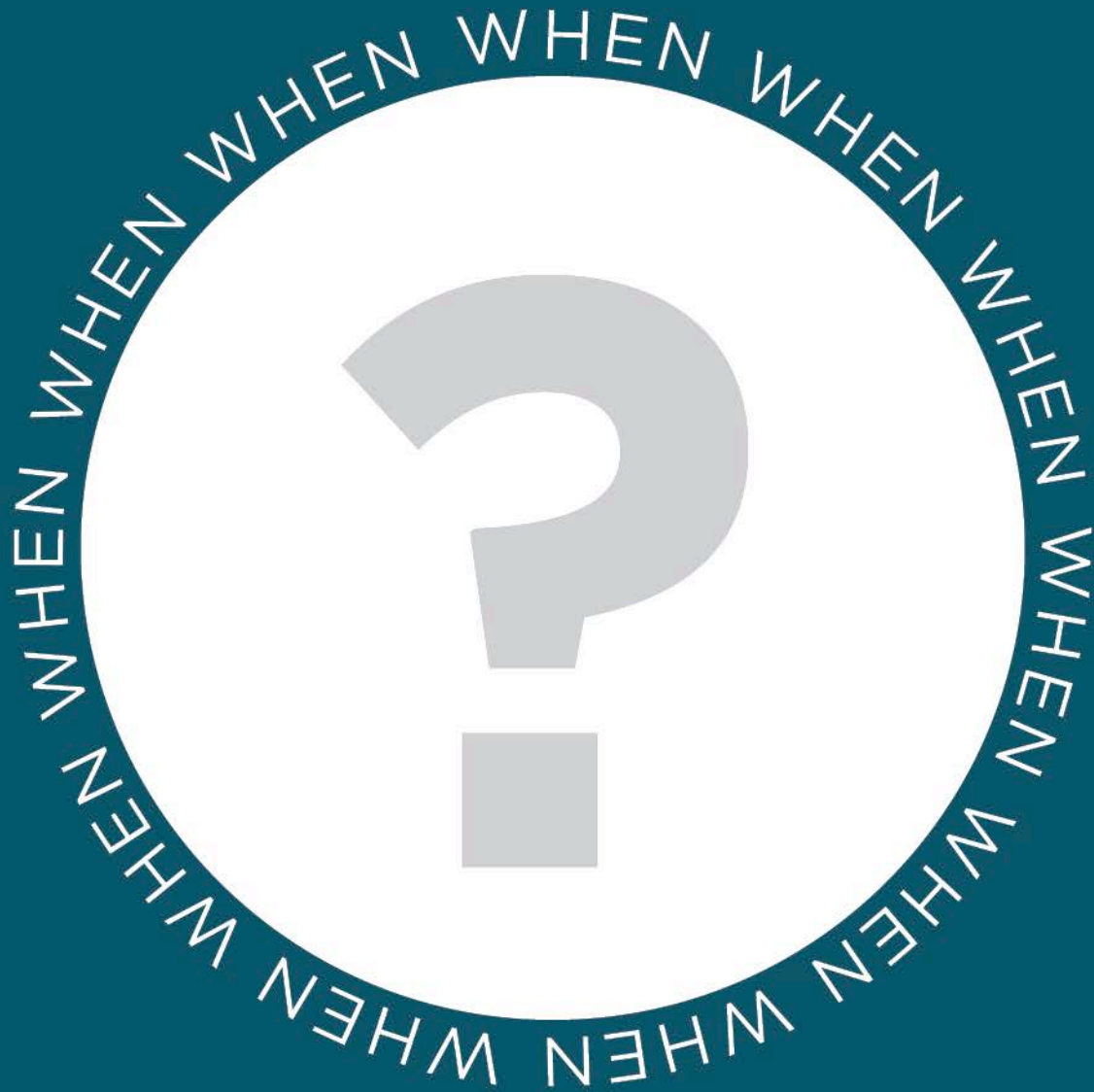


# PLANT SPECIES SELECTION IRRIGATION SYSTEM EFFICIENCY





[http://www.epa.gov/watersense/water\\_budget/application.html](http://www.epa.gov/watersense/water_budget/application.html)





# Obtain precipitation and evapotranspiration rates

WHAT

WHY

WHEN

WHO

HOW

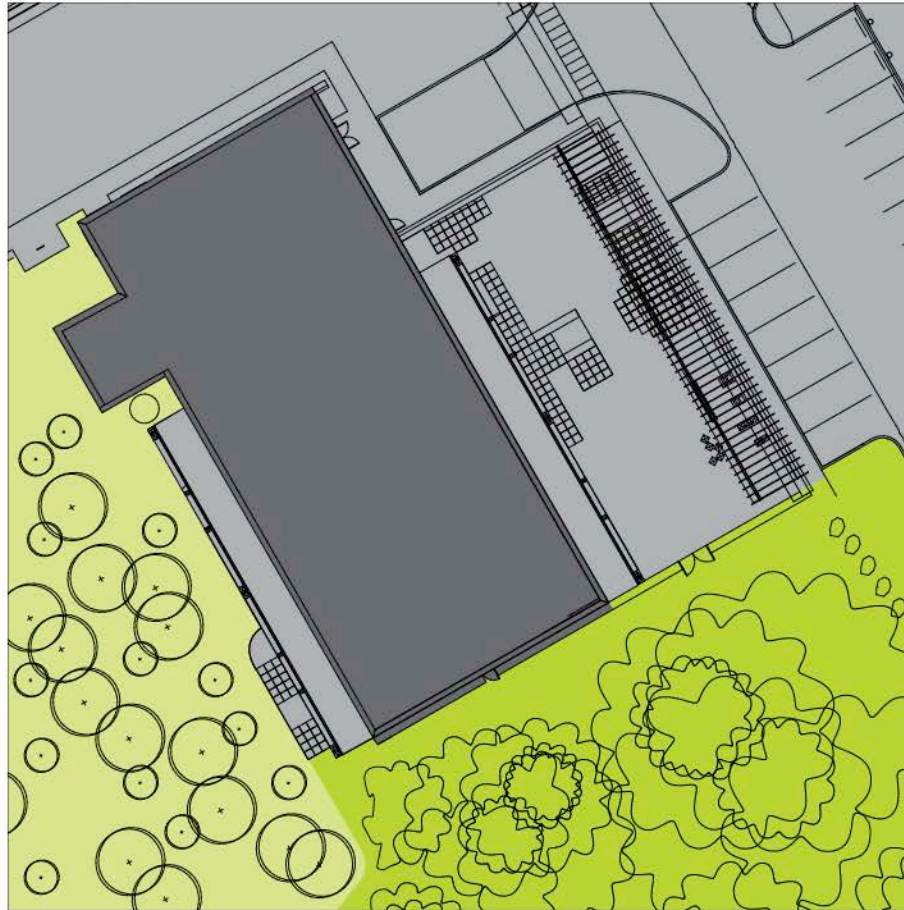


# GLOBAL LEED

World Meteorological  
Organization

Various government and  
academic sources

# INDICATE VEGETATED AREA ON PROJECT MAP



WHAT

WHY

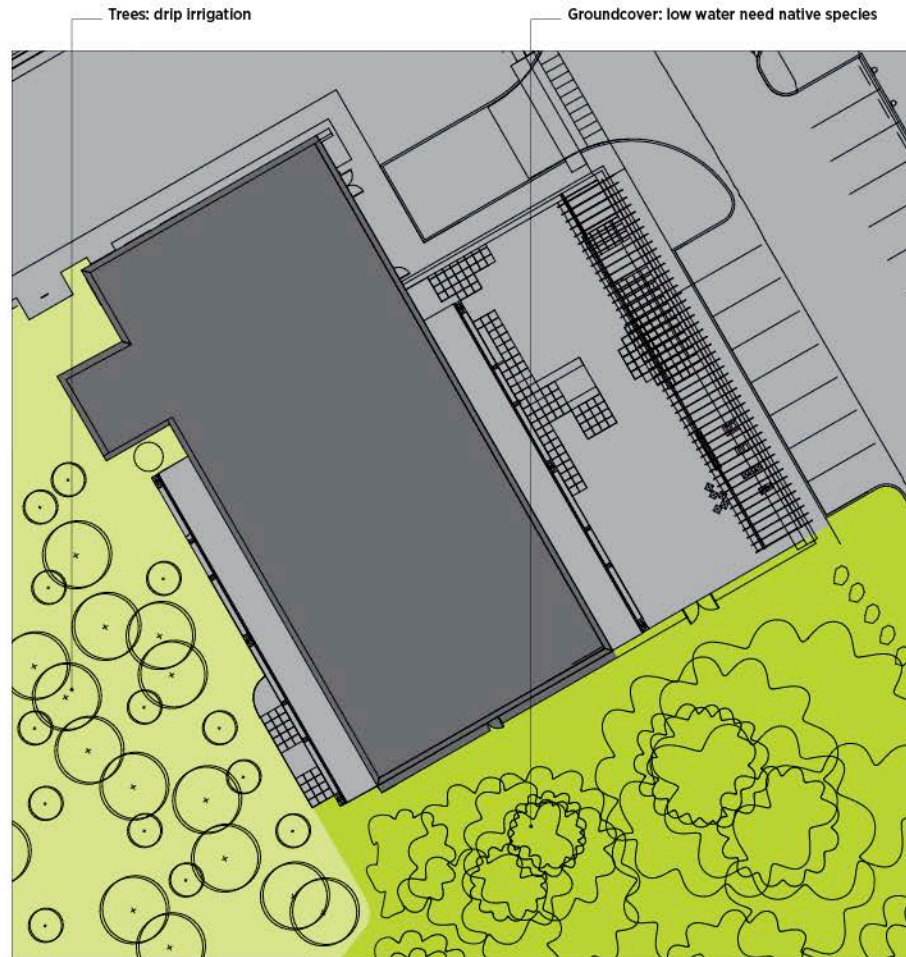
WHEN

WHO

HOW



# IDENTIFY PLANT TYPES AND COVERAGE TO OPTIMIZE IRRIGATION



WHAT

WHY

WHEN

WHO

HOW



**1**

Use grass only for playfields and similar activities

**2**

Choose native and drought tolerant plant

**3**

Plant a xeriscape landscape



USDA PLANT  
DATABASE

LADY BIRD JOHNSON  
WILDLIFE NATIVE  
PLANT CENTER

zero lot line

or

no landscape

meets prerequisite

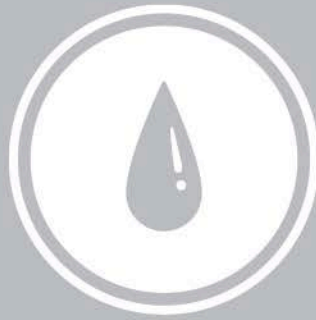
WHAT

WHY

WHEN

WHO

HOW



# **WE** Prerequisite and Credit

## Outdoor Water Use Reduction

Provide narrative describing plant species and water requirements

OPTION

1

No irrigation  
required

or

OPTION

2

Reduced  
irrigation

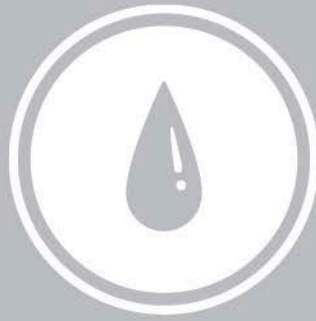
WHAT

WHY

WHEN

WHO

HOW



# **WE** Prerequisite and Credit

## Outdoor Water Use Reduction

Use Water Budget tool to calculate impact on water use

OPTION

1

No irrigation  
required

or

OPTION

2

Reduced  
irrigation

WHAT

WHY

WHEN

WHO

HOW





# EPA'S WATERSENSE WATER BUDGET TOOL

**INCLUDE** only vegetated areas

**EXCLUDE** hardscapes and softscapes

WHAT

WHY

WHEN

WHO

HOW

Test proposed  
landscape design  
before planting

WHAT

WHY

WHEN

WHO

HOW



## **WE** Prerequisite and Credit Outdoor Water Reduction

### **PREREQUISITE**

30% reduction by  
plant selection and  
irrigation efficiency

### **CREDIT**

Include alternative water sources  
and smart irrigation technologies  
for further reduction



**reduction**  
to meet prerequisite



## **WE Credit**

Outdoor Water Use Reduction

**1**

**POINT**

50% reduction

**or**

**2**

**POINTS**

100% reduction





# FIRST

**water**  
efficiency



# THEN

**alternative**  
sources

WHAT

WHY

WHEN

WHO

HOW



# ALTERNATIVE WATER SOURCES

Incorporate water collection  
and distribution systems

Use treated municipality wastewater

WHAT

WHY

WHEN

WHO

HOW

Test wastewater  
salinity

Safely store  
water

WHAT

WHY

WHEN

WHO

HOW

The background features a large, faint WaterSense logo. It is a circular emblem with a green triangle at the top and a blue semi-circle at the bottom. The text "WaterSense" is arched across the top in blue and green, and "Meets EPA Criteria" is arched across the bottom in blue.

# USE SMART IRRIGATION TECHNOLOGIES

WHAT

WHY

WHEN

WHO

HOW

Adjust water  
requirements based  
on monthly supply  
from alternative sources

WHAT

WHY

WHEN

WHO

HOW





## CALCULATE QUANTITY OF RAINWATER

$$\begin{array}{ccccc} \text{gallons} & & \text{square} & & \\ \text{per 1 inch} & & \text{footage of} & & \\ \text{of rain} & = & \text{roof or} & \times & 0.6 \\ & & \text{collection} & & \\ & & \text{area} & & \end{array}$$



## CALCULATE AMOUNT OF WATER EXPECTED

$$\begin{array}{ccccc} \text{amount} & & & & \text{average} \\ \text{available} & & & & \text{inches} \\ \text{for} & = & \text{gallons} & \times & \text{rain per} \\ \text{collection} & & \text{per 1 inch} & & \text{month} \\ & & \text{of rain} & & \end{array}$$



# CALCULATE ADJUSTED LANDSCAPE WATER REQUIREMENTS

$$\begin{array}{ccccc} \text{Adjusted} & & \text{landscape} & & \text{alternative} \\ \text{landscape} & & \text{water} & & \text{water} \\ \text{water} & & \text{requirement} & & \text{quantity} \\ \text{requirement} & \text{—} & & \text{—} & \\ \text{(volume/month)} & & \text{(volume/month)} & & \text{(volume/month)} \end{array}$$



15%

**less**

if alternative irrigation used



## **WE** Prerequisite and Credit Outdoor Water Reduction

### **PREREQUISITE**

30% reduction by  
plant selection and  
irrigation efficiency

### **CREDIT**

Include alternative water sources  
and smart irrigation technologies  
for further reduction



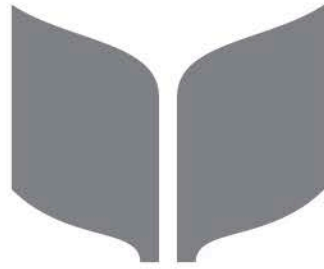


# **WE** Prerequisite and Credit

## Indoor Water Use Reduction

**PREREQUISITE**  
20% reduction

**CREDIT**  
25-50 % reduction



# REFERENCED STANDARD

EPAct 1992  
and EPAct 2005

[www.epa.gov](http://www.epa.gov)

## POINTS FOR REDUCING FIXTURE WATER USE

PERCENTAGE REDUCTION	POINTS (BD+C)	POINTS (SCHOOLS, RETAIL, HOSPITALITY, HEALTHCARE)	POINTS (ID+C)	POINTS (ID+C: RETAIL)	POINTS (ID+C: HOSPITALITY)
25%	1	1	2	2	2
30%	2	2	4	4	4
35%	3	3	6	6	6
40%	4	4	8	8	8
45%	5	5	10	10	10
50%	6	—	12	—	11

Schools, Healthcare, Hospitality: 1-2 additional  
points for reducing process water use





13.6%

**potable water**  
used by buildings

WHAT

WHY

WHEN

WHO

HOW



# **WE** Prerequisite and Credit

## Indoor Water Use Reduction

**PATH**

**1**

PRESCRIPTIVE

All installed fixtures at  
or below WaterSense  
(Prerequisite only)

**or**

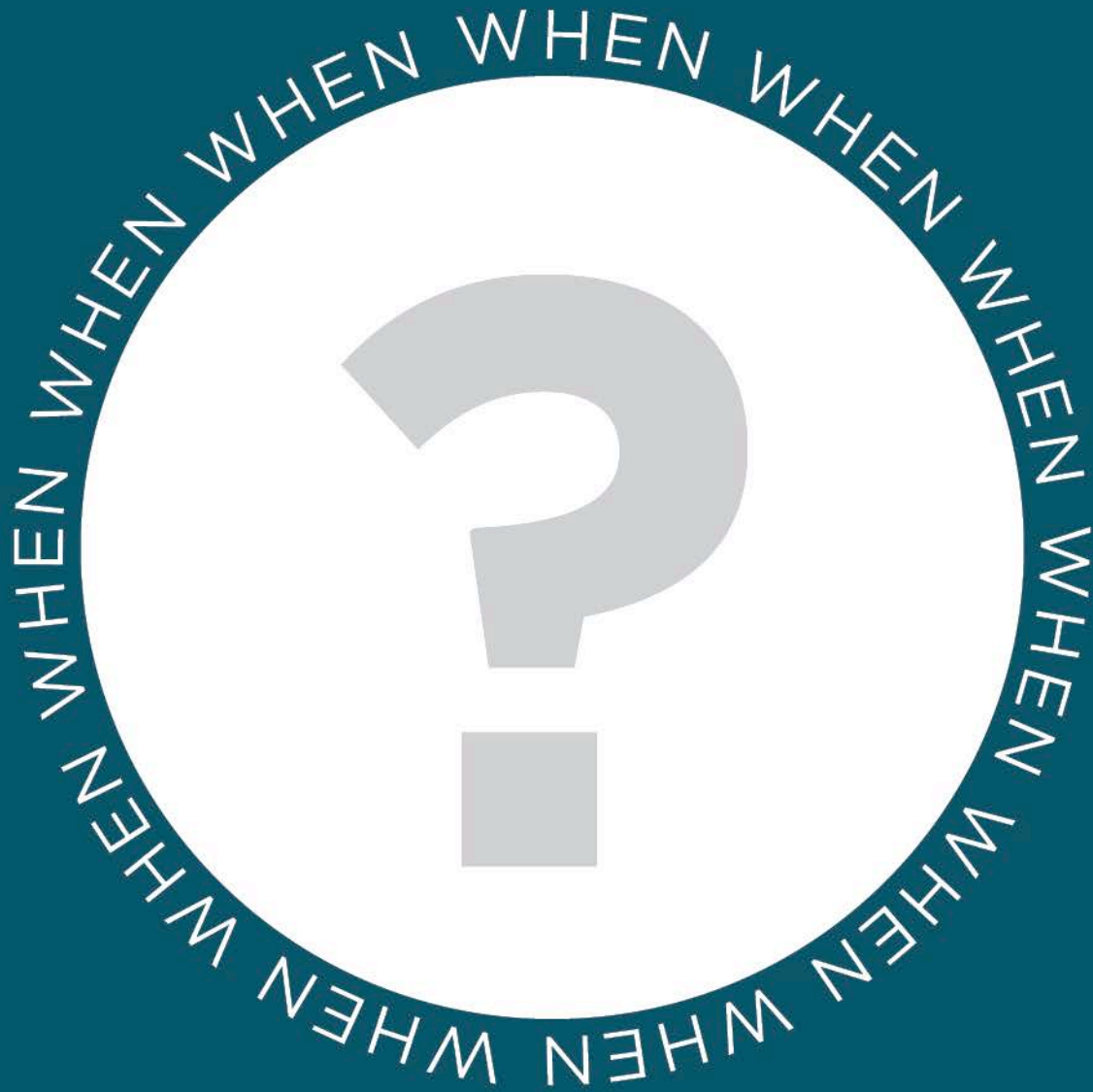
**PATH**

**2**

USAGE-BASED CALCULATION

Fixtures comply with  
requirements in aggregate  
(Prerequisite + Credit)







# PATH 1.

Ensure fixtures meet  
prescriptive flush/flow rate

Collect cutsheets for all  
fixtures and appliances

WHAT

WHY

WHEN

WHO

HOW

## PATH 2.

Use calculations to  
show compliance

Provide cut sheets and/or  
fixture schedule

Select fixtures with  
WaterSense label

WHAT

WHY

WHEN

WHO

HOW



## WATER SENSE LABEL

ELIGIBLE FOR WATER SENSE LABEL	<b>NOT</b> ELIGIBLE FOR WATER SENSE LABEL
tank-type toilets	non-tank-type toilets, non-water using and composting toilets
water-using urinals	non-water urinals
private lavatory faucets and showerheads	public lavatory faucets



# GLOBAL LEED

Refer to list of  
WaterSense equivalents

or

Select fixture performance of least  
20% below baseline of EPA Act 1992





AERATORS ALLOWED IF  
WATERSENSE LABELED

photo credit: Mark Schellhase





# AERATORS IN PRIVATE LAVATORIES

0.8 gpm at 20 psi – 1.5 gpm at 60 psi

photo credit: Mark Schellhase

- Soda machines
- Coffee making machines
- Misters for produce and bread
- Fixtures used to fill sinks for washing produce

# Classify fixtures as public or private

WHAT

WHY

WHEN

WHO

HOW



A photograph of a kitchen sink area. A chrome faucet with a coiled hose is centered above a white double-basin sink. The backsplash is made of small, square, multi-colored mosaic tiles. Two electrical outlets are visible on the wall. A semi-transparent green box with white text is overlaid in the center.

# KITCHEN

All sinks in public or private buildings  
that are used similarly to a sink in  
a residential kitchen

A photograph of a bathroom sink with a teal overlay containing text. The background shows a white sink, a chrome faucet, and a wall with glass blocks. The text is centered on the teal overlay.

# PRIVATE

Residences

Hotel guest rooms

Private rooms in hospitals  
and nursing homes

Dormitories



A photograph of a row of white ceramic public sinks with chrome faucets, set against a light blue tiled wall. The image has a teal overlay with white text.

# PUBLIC

All other applications, includes  
most office settings

U.S. Government

Federal law prohibits removal of this label before consumer purchase.

# ENERGYGUIDE

Refrigerator-Freezer

XYZ Corporation

• Automatic Defrost

Model ABC-1

Side-Mounted Freezer

Capacity: 23 Cubic Feet

Through-the-Door Ice

**SPECIFY HIGH  
EFFICIENCY APPLIANCES**

Estimated Yearly Operating Cost

**\$67**



A photograph of a Philips Achieva 1.5T MRI machine in a clinical setting. The machine's large, circular gantry is visible on the left, with the brand name 'PHILIPS' and model 'Achieva 1.5T' printed on it. A patient bed with a light-colored cushion is positioned in front of the gantry. To the right, there are medical gas outlets and a control panel. A semi-transparent green rectangular box with a white border is centered over the image, containing the text 'PROCESS WATER SYSTEM MUST ALSO MEET STANDARDS' in white, bold, sans-serif capital letters.

**PROCESS WATER  
SYSTEM MUST ALSO  
MEET STANDARDS**

photo credit: U.S. Navy



G L O B A L   L E E D

ENERGY STAR

or

Equivalent criteria

## ENTER FTE INTO WATER USE CALCULATOR

	EMPLOYEES (FTE)	STUDENTS	VISITORS	RETAIL CUSTOMERS	RESIDENTIAL
Total	0	0	0	0	0
Male					
Female					

Percent of males expected to use restrooms with urinals	
---	--

Annual days of operation	
--------------------------	--

WHAT

WHY

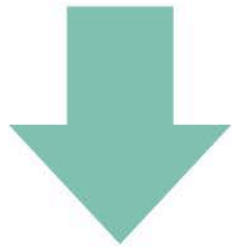
WHEN

WHO

HOW



One or multiple  
sets of occupants  
using fixtures the  
same way



Enter data on  
all of their fixtures  
at once

Different occupant  
groups using  
fixtures differently



Calculations done  
separately for each  
sub-group





# VISITORS DO NOT NEED SEPARATE CALCULATION



WHAT

WHY

WHEN

WHO

HOW



50/50

**gender mix**

unless justifiable different ratio

WHAT

WHY

WHEN

WHO

HOW



# ENTER ANNUAL DAYS OF OPERATION

WHAT

WHY

WHEN

WHO

HOW



# Fixture and Fitting Water Use Calculator

WHAT

WHY

WHEN

WHO

HOW

## **BASELINE CASE**

If exactly code compliant  
fixtures selected

## **DESIGN CASE**

Actual fixtures selected



**1**

Fixture type

**2**

Flush or flow rate

**3**

Manufacturer and model

**4**

Percentage of occupants using this fixture model

WHAT

WHY

WHEN

WHO

HOW





**percentage**

occupants using each fixture type

# INDOOR WATER USE REDUCTION CREDIT

Consider alternative  
water sources

WHAT

WHY

WHEN

WHO

HOW



# FIRST

**water**  
efficiency



# THEN

**alternative**  
sources

WHAT

WHY

WHEN

WHO

HOW

- Reclaimed water
- Greywater
- Rainwater
- Storm water
- Condensate foundation dewatering water
- Seawater
- Used process water
- Reverse osmosis reject water

---

# reclaimed wastewater

*(noun)*

treated wastewater derived  
from residential, commercial,  
and industrial sources



START WITH ALTERNATIVE  
SOURCES THAT REQUIRE  
LEAST TREATMENT





## TOTAL WATER SAVINGS

$$\begin{array}{l} \text{project \%} \\ \text{improvement} \\ \text{from baseline} \end{array} = \frac{\text{baseline volume} - \text{performance volume}}{\text{baseline volume}} \times 100$$

- Source of nonpotable water
- Plumbing system design drawing
- Supply and demand calculations

WHAT

WHY

WHEN

WHO

HOW

# Plan for alternative water use from outset

WHAT

WHY

WHEN

WHO

HOW

# HEALTHCARE, RETAIL, SCHOOLS, HOSPITALITY



## ADAPTATION SPECIFIC CREDITS

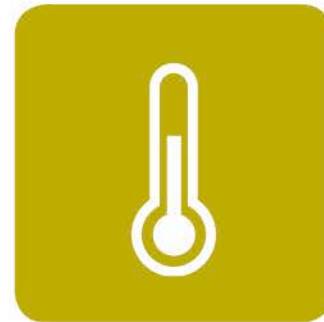
Additional 1-2 points for meeting appliance  
and process water use requirements



# **WE** Prerequisite

## Building-level Water Metering

**You can't  
manage  
what you  
don't  
measure.**



WHAT

WHY

WHEN

WHO

HOW



The background of the slide is a photograph of industrial water infrastructure. In the foreground, there are several blue and silver water meters mounted on pipes. The pipes are made of metal and some have blue painted sections. In the background, there are rows of similar meters and pipes, and a red metal structure, possibly part of a building or a large container. The overall scene is industrial and related to water management.

# METER BUILDING WATER AND ASSOCIATED GROUNDS' WATER TOGETHER OR SEPARATELY

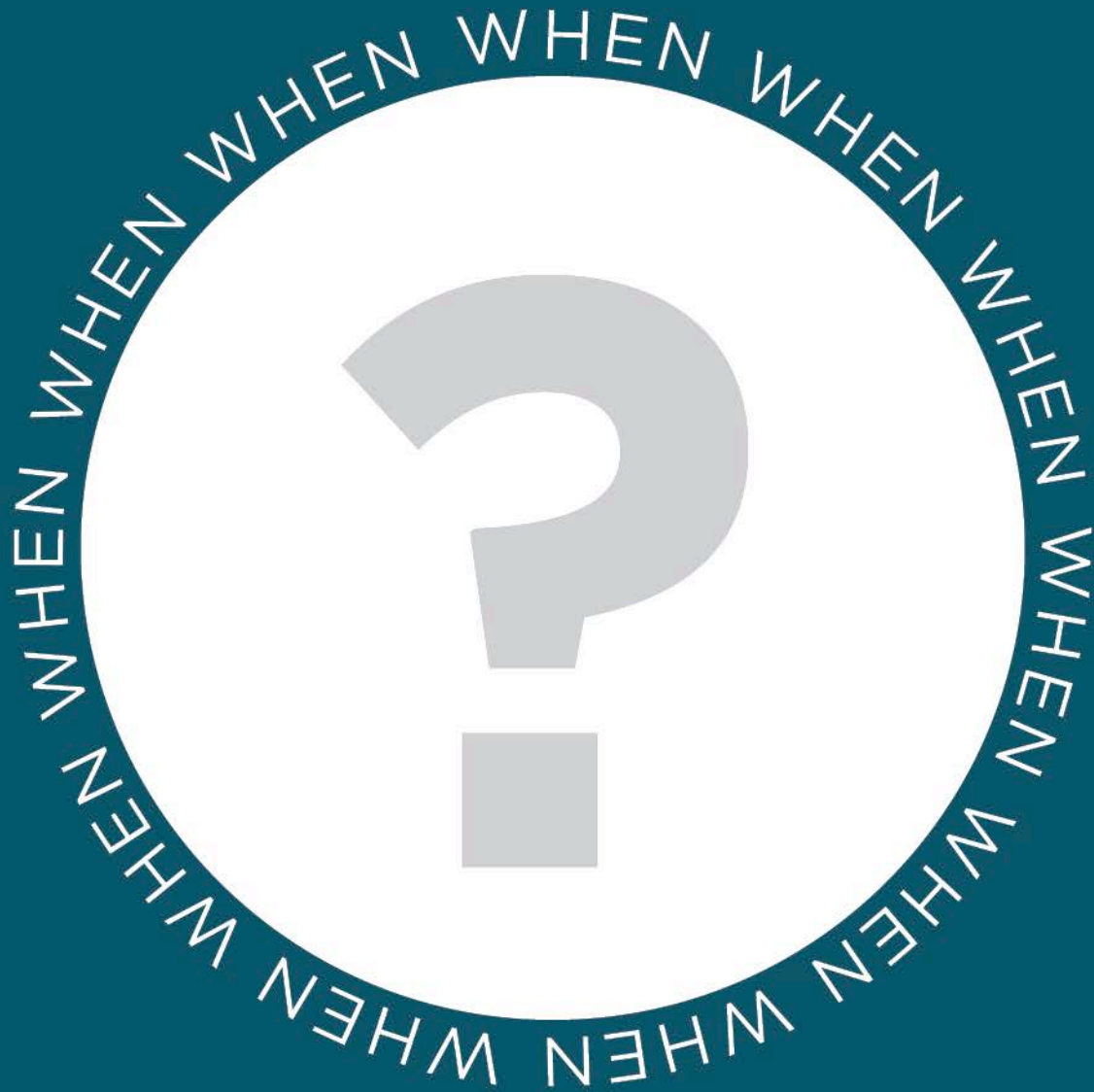
WHAT

WHY

WHEN

WHO

HOW





Identify all potable  
water end uses

WHAT

WHY

WHEN

WHO

HOW

# IF ALL WATER SUPPLIED BY PUBLIC WATER SUPPLY

Use single water meter  
provided

Confirm location, accessibility,  
and reporting

WHAT

WHY

WHEN

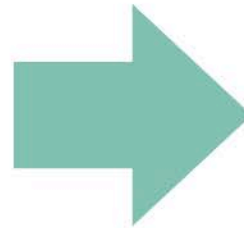
WHO

HOW



# DETERMINE METERS FOR YOUR PROJECT

multiple  
sources of  
potable water



multiple  
meters

WHAT

WHY

WHEN

WHO

HOW





# LOCATE METERS FOR EASY READING AND MAINTENANCE

WHAT

WHY

WHEN

WHO

HOW



# SHARE WATER CONSUMPTION DATA WITH USGBC ON MONTHLY BASIS

WHAT

WHY

WHEN

WHO

HOW



# **WE** Credit

## Water Metering



## **WE** Credit

### Water Metering

Install submeters on two or more systems

**1**  
**POINT**

Irrigation

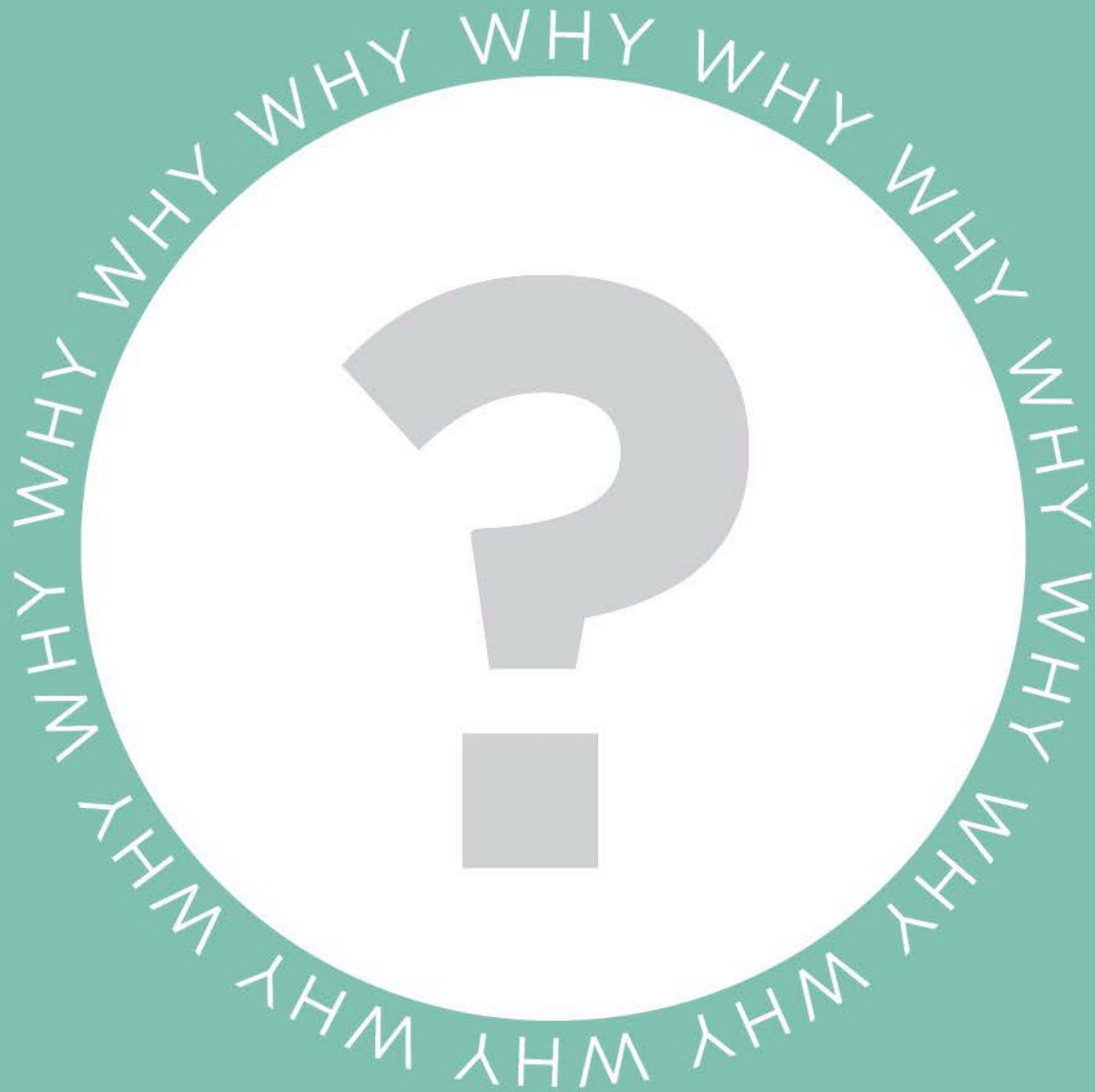
Indoor plumbing fixtures and fittings

Domestic hot water

Certain types of boilers

Reclaimed water

Process water



**at least**



**80%**

**of subsystem  
must be metered**

100% of the source must be metered for  
reclaimed water and boiler water metering

WHAT

WHY

WHEN

WHO

HOW



# POSSIBLE SYSTEMS TO SUBMETER

Greatest consumers

Most expensive to operate

Most closely aligned with goals

WHAT

WHY

WHEN

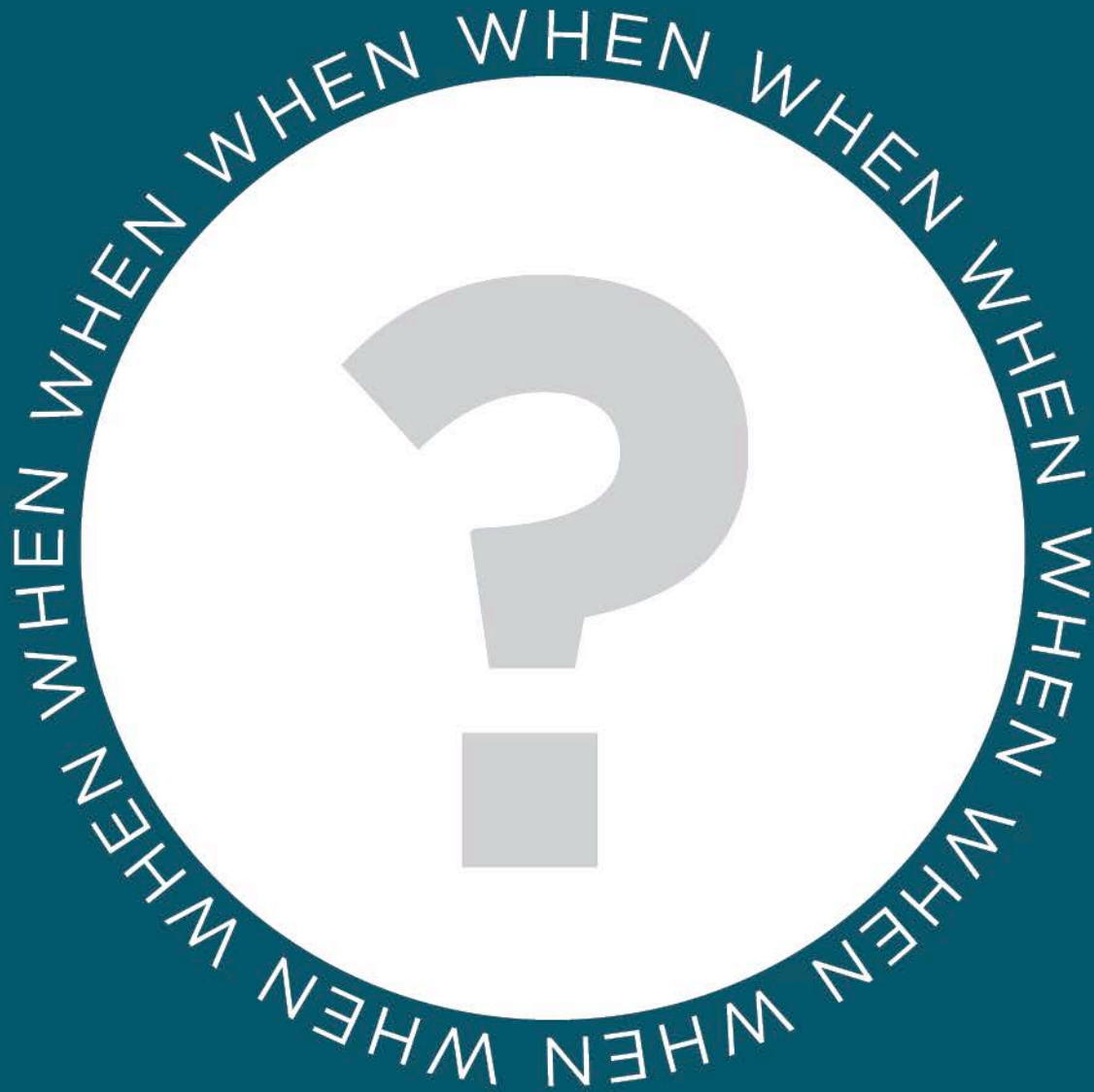
WHO

HOW

## ALSO CONSIDER

---

- Number
- Types
- Size
- Effort required to read





## MINIMUM ALLOWABLE PERCENTAGE METERED PER SUBSYSTEM

$$\frac{\text{metered irrigated landscape area}}{\text{total irrigated landscape area}} \geq 0.8$$

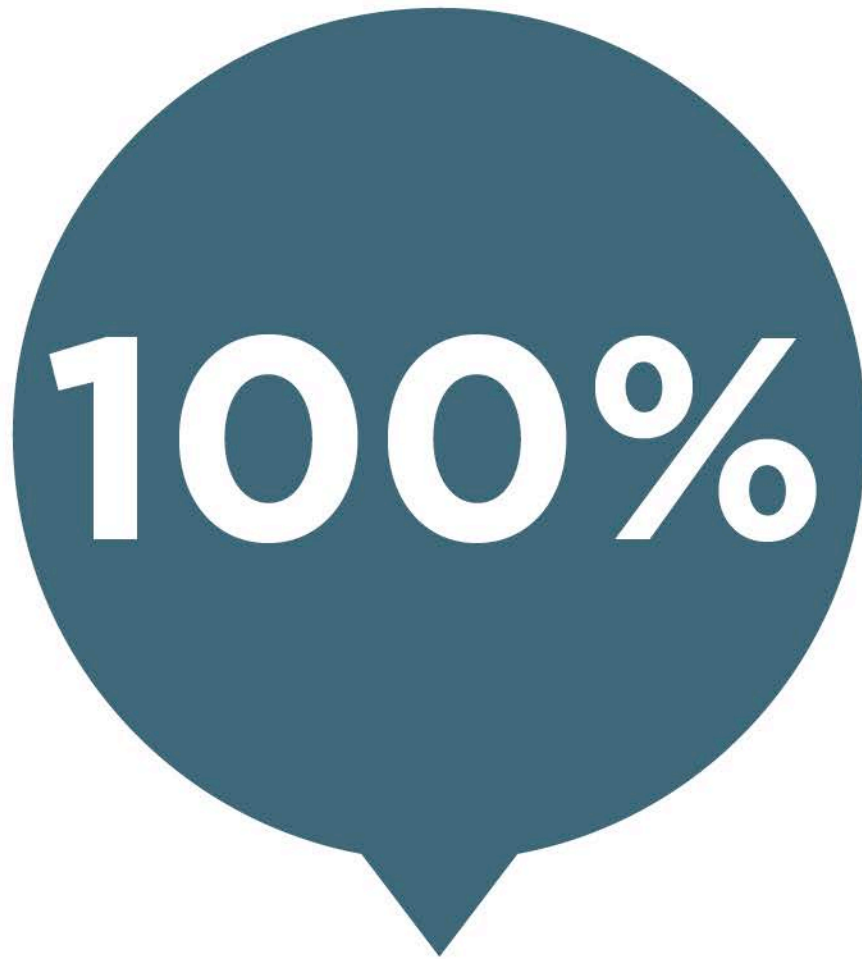
WHAT

WHY

WHEN

WHO

HOW



**reclaimed water**  
must be submetered

# HEALTHCARE



## ADAPTATION SPECIFIC CREDITS

Meter 5 additional subsystems, such as:

- Purified water systems
- Dietary department
- Laundry or laboratory
- Physiotherapy and treatment areas
- Surgical suite





# SELECT METERING EQUIPMENT

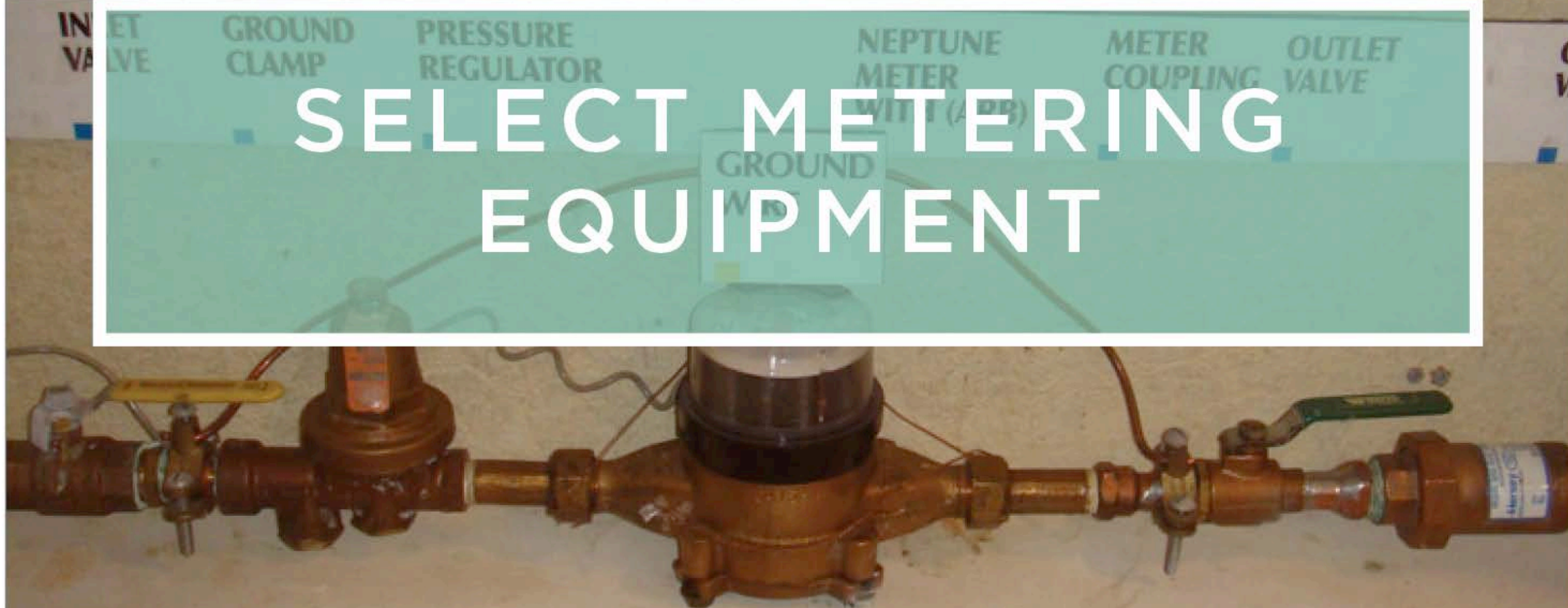


photo credit: CCI Center

WHAT

WHY

WHEN

WHO

HOW



# **WE** Credit

## Cooling Tower Water Use



## **WE Credit**

Cooling Tower Water Use

# 1-2

**POINTS**

BD+C

optimize cooling tower cycles



# CREDIT INTENT

balance water conversation  
and cooling tower needs

WHAT


WHY

WHEN

WHO

HOW





REMOVE WATER BY  
BLOWDOWN AND ADD  
MAKEUP WATER TO  
REPLACE LOSSES



EFFICIENCY IS MEASURED  
IN # OF CYCLES OF RE-  
CIRCULATED WATER  
BEFORE BLOWDOWN



Conduct one-time  
potable water analysis  
to optimize cooling  
tower cycles

WHAT

WHY

WHEN

WHO

HOW



# COOLING TOWER PARAMETER

Ca (as  $\text{CO}_3$ )  
Total alkalinity  
 $\text{SiO}_2$   
Chloride  
Conductivity

## COOLING TOWER CYCLES

Maximum possible cycles without additional treatment

1 point

Achieve minimum of 10 cycles with added filtration  
OR

Cycles for 1 point + use 20% alternative water source

2 points





USE ALTERNATIVE  
WATER TO REDUCE  
POTABLE WATER USE

If blending,  
test both potable and  
reclaimed water

WHAT

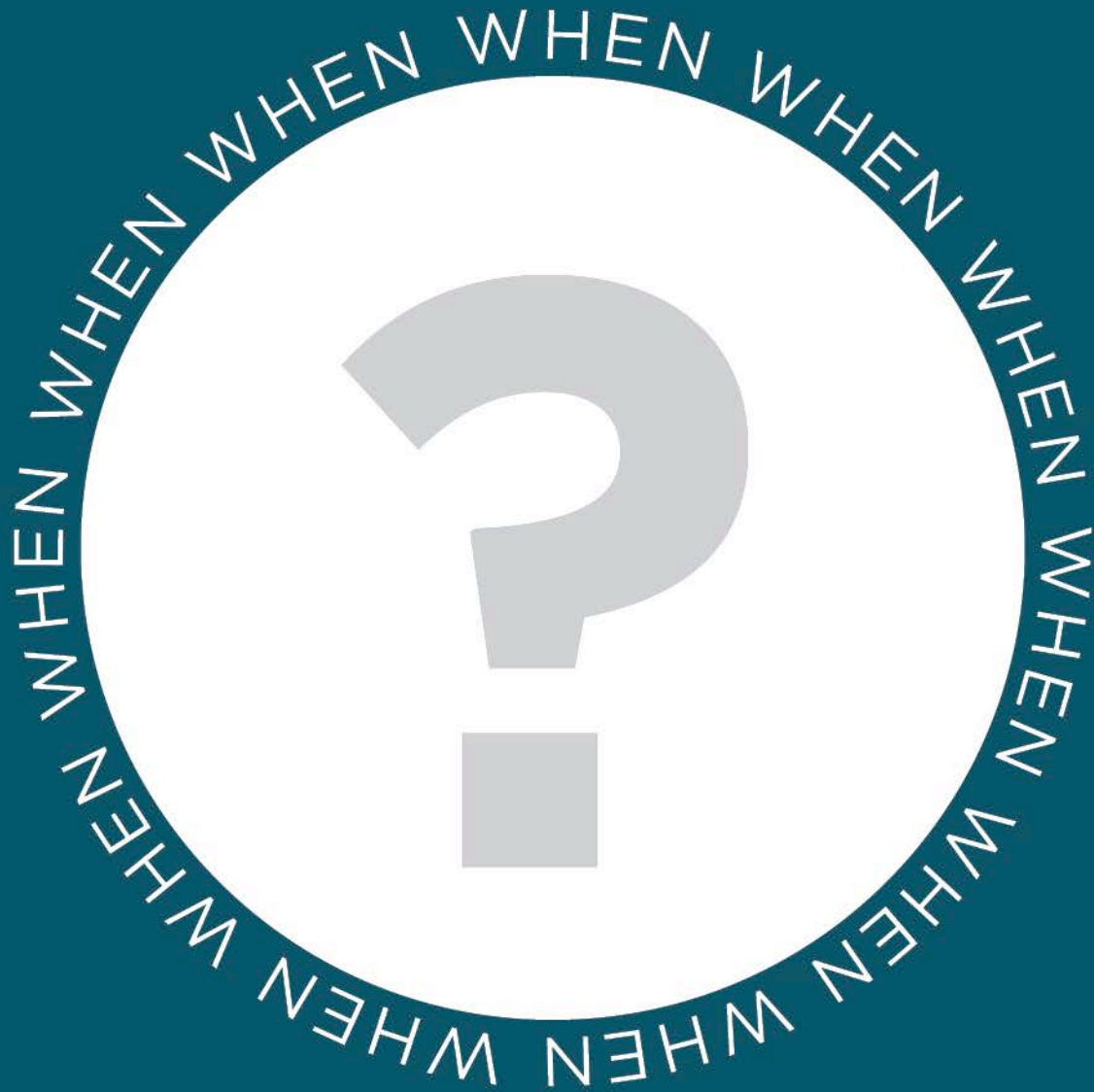
WHY

WHEN

WHO

HOW







# Conduct a potable water analysis for source of makeup water

WHAT

WHY

WHEN

WHO

HOW



# CYCLES OF CONCENTRATION

$$\text{number of cycles of concentration} = \frac{\text{acceptable maximum concentrations in condenser water}}{\text{parameter concentrations in makeup water}}$$

Adjust settings  
so maximum # of  
cycles is achieved  
(1 point)

WHAT

WHY

WHEN

WHO

HOW



# INCREASE # OF CYCLES

Use additional treatment

OR

Use nonpotable water  
(additional point)

WHAT

WHY

WHEN

WHO

HOW

Consider 100%  
nonpotable water  
from HVAC condensate  
or rainwater

WHAT

WHY

WHEN

WHO

HOW

## CONSIDER

---

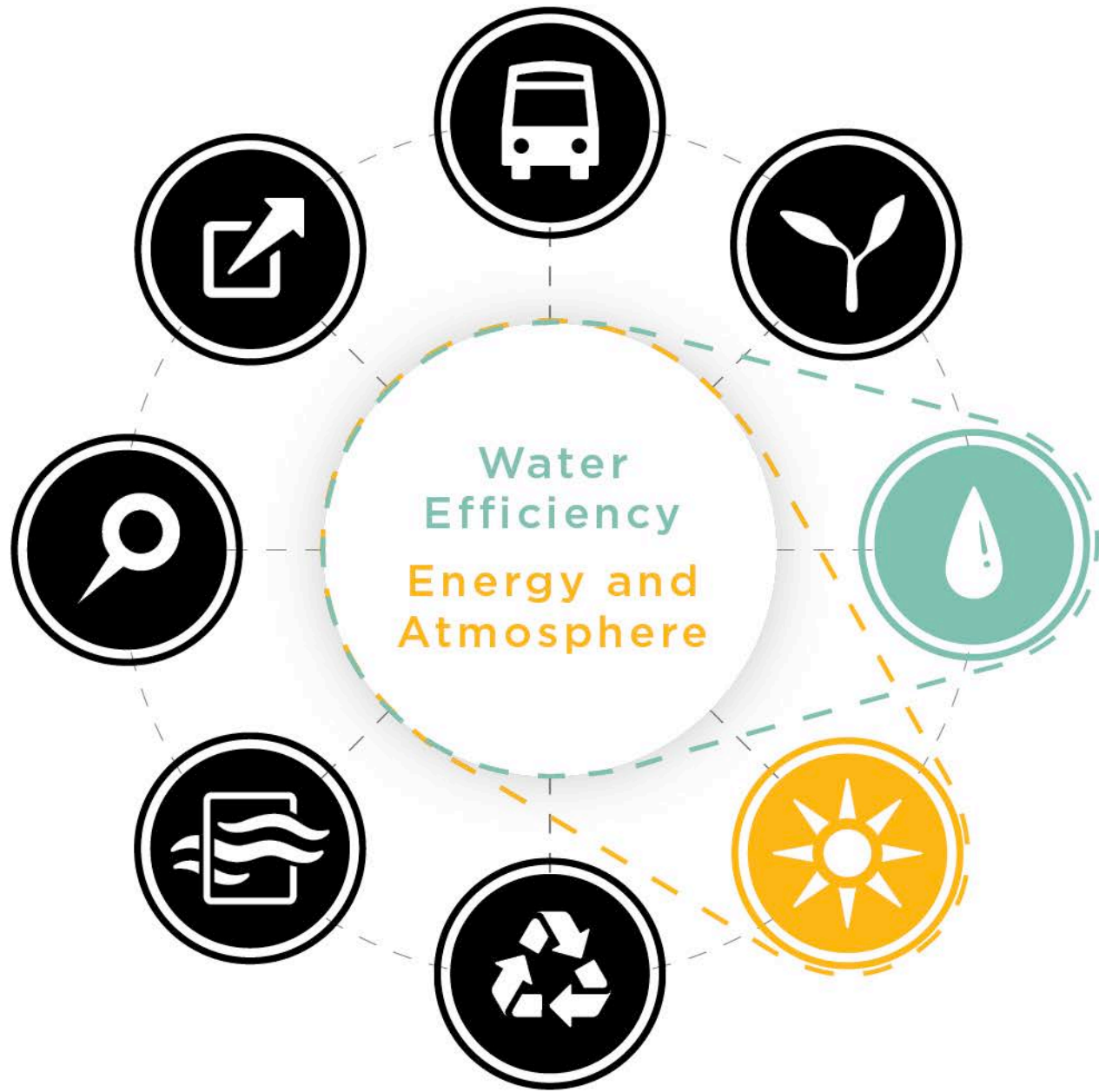
- Design of system
- Long term operation
- Integration of nonpotable water
- Limitations of local water quality











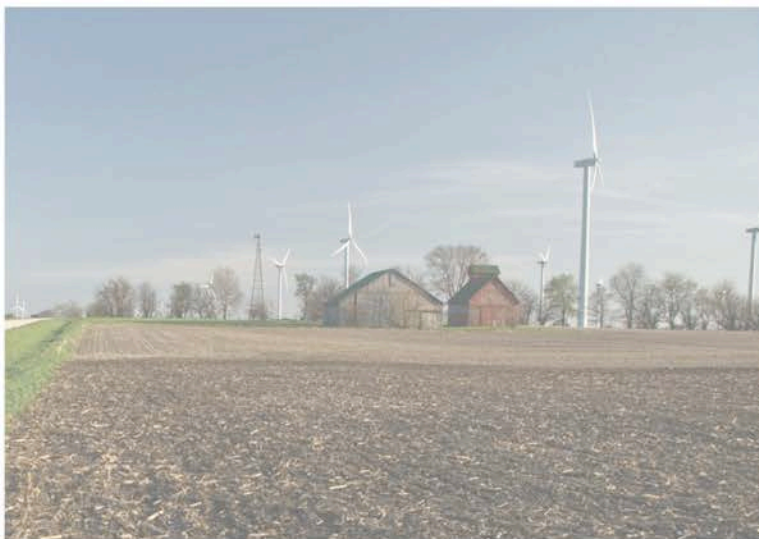




# ENERGY & ATMOSPHERE



# DESIGN AND CONSTRUCTION RATING SYSTEMS



presented by  
**USGBC**



# SPEAKERS



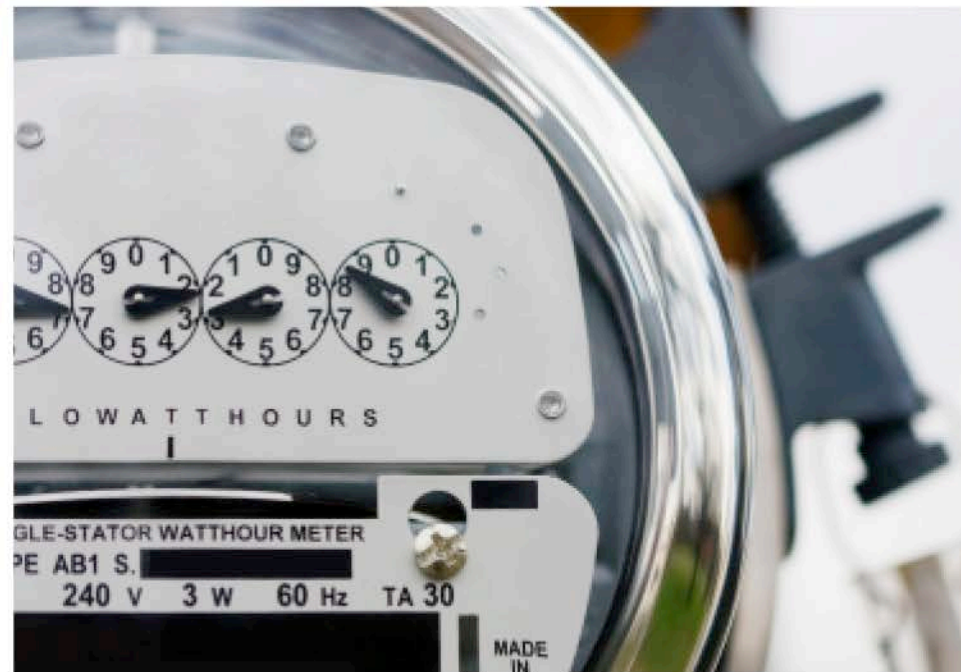
**Jeremy Poling**

LEED AP BD+C, O+M, PE  
Principal Energy Engineer  
Goby, LLC



**Manus McDevitt**

PE  
Principal  
Sustainable Engineering Group, LLC







---

# **EA** Prerequisite

Fundamental Commissioning  
and Verification

---

Cx

Commissioning

---

---

# CxA

# Commissioning Authority

---

Engage a  
commissioning  
authority (CxA)  
to develop  
commissioning plan

WHAT

WHY

WHEN

WHO

HOW









# Develop owner's project requirements

WHAT

WHY

WHEN

WHO

HOW

---

# OPR

owner's project  
requirements

---

# SYSTEMS TO BE COMMISSIONED

Mechanical

Electrical

Plumbing

Renewable energy

WHAT

WHY

WHEN

WHO

HOW



# OPTIONAL SYSTEMS TO BE COMMISSIONED

Life safety systems

Communications/data

Fire protection

Process equipment

WHAT

WHY

WHEN

WHO

HOW

# OPR ELEMENTS

Key project requirements

Occupant requirements

Budget considerations  
and limitations

Target goals

Performance criteria

Operations and  
maintenance requirements

# Develop basis of design

WHAT

WHY

WHEN

WHO

HOW

---

# BOD

basis of design

---

# BOD COMPONENTS

Systems and assemblies

Performance criteria/assumptions

Descriptions

Governing codes and standards

Owner directives

Design development guidelines

Revision history

# Engage commissioning authority

WHAT

WHY

WHEN

WHO

HOW



## CxA REQUIREMENTS

For all LEED projects	<ul style="list-style-type: none"><li>• experienced</li><li>• independent of design/construction team*</li><li>• reports findings directly to owner</li><li>• may be owner, employee, or consultant</li></ul>
For EA Prerequisite	<ul style="list-style-type: none"><li>• may be employee of design/construction firm</li></ul>
For EA Credit	<ul style="list-style-type: none"><li>• may not be employee of design/construction</li><li>• may not be contracted through construction team</li></ul>

\* For the prerequisite only. CxA may be on design team for projects under 20,000 SF (1860 sm)

# DEVELOP PRELIMINARY Cx PLAN

Overview

Team members

Process activities

WHAT

WHY

WHEN

WHO

HOW

# CxA reviews OPR, BOD, and mid-design documents

WHAT

WHY

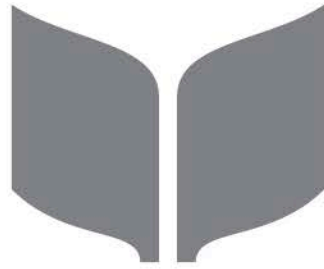
WHEN

WHO

HOW

## EXAMPLE ISSUES LOG ENTRY

COMMENT NUMBER	SHEET	COMMENT	DESIGN TEAM COMMENTS RESPONSE	FINAL REVIEW COMMENT/ STATUS
P-1	BOD	SH-1 and SH-1A identified in BOD were not included on any of the plumbing drawings	Will be included in later design as required	



## REFERENCED STANDARDS

ASHRAE Guidelines 0-2005

ASHRAE Guidelines 1.1-2007

NIBS Guideline 3-2012

[www.ashrae.org](http://www.ashrae.org)

Update OPR, BOD,  
and Cx plan  
as needed

WHAT

WHY

WHEN

WHO

HOW



# CxA holds kickoff meeting

WHAT

WHY

WHEN

WHO

HOW

Installation verification  
(construction) checklists

Functional performance testing

Issues Log

Ongoing team meetings

Contractor/sub-contractor  
management related to Cx

Schedule and communication  
of Cx activities

Develop construction  
checklist to ensure  
systems have been  
installed, started up,  
programmed, tested,  
and balanced

WHAT

WHY

WHEN

WHO

HOW

# CONDUCT PRE-FUNCTIONAL INSPECTIONS

Site-visits

Field observations

Review of start-up forms

Construction checklists

Complete test and balance (TAB reports)

WHAT

WHY

WHEN

WHO

HOW



**WRITE AND DEVELOP  
FUNCTIONAL TEST  
SCRIPTS  
PERFORM FUNCTIONAL  
TESTING**

# Prepare Cx report

WHAT

WHY

WHEN

WHO

HOW



Prepare facility  
requirements

**AND**

Operations and  
maintenance plan

WHAT

WHY

WHEN

WHO

HOW

# DATA CENTERS



## ADAPTATION SPECIFIC CREDITS

### Flexibility in CxA criteria

Include Power Utilization Effectiveness (PUE)



**EA Credit**

Enhanced Commissioning

# EA Prerequisite Fundamental Commissioning

In-depth CxA role

Verification requirements

Monitoring-based Cx

Building envelop Cx

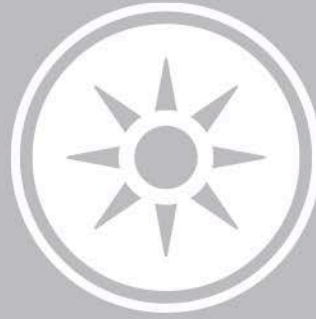
WHAT

WHY

WHEN

WHO

HOW



## **EA Credit** **Enhanced Commissioning**

### **OPTION**

# **1**

Enhanced systems  
commissioning

**3-4 POINTS**

**and/  
or**

### **OPTION**

# **2**

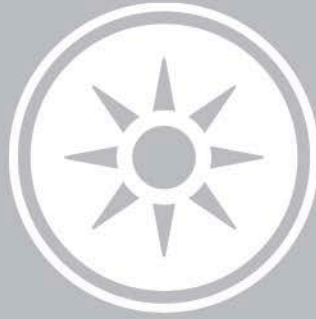
Envelope  
commissioning

**2 POINTS**

## CxA REQUIREMENTS

For all LEED projects	<ul style="list-style-type: none"><li>• experienced</li><li>• independent of design/construction team*</li><li>• reports findings directly to owner</li><li>• may be owner, employee, or consultant</li></ul>
For EA Prerequisite	<ul style="list-style-type: none"><li>• may be employee of design/construction firm</li></ul>
For EA Credit	<ul style="list-style-type: none"><li>• may not be employee of design/construction team</li><li>• may not be contracted through construction team</li></ul>





## **EA Credit** **Enhanced Commissioning**

**OPTION**

**1**

Enhanced systems  
commissioning

**3-4 POINTS**

**and/  
or**

**OPTION**

**2**

Envelope  
commissioning

**2 POINTS**



## **EA Credit**

### **Enhanced Commissioning**

#### **OPTION 1. Enhanced systems commissioning**

**PATH**

**1**

Enhanced  
commissioning

**3 POINTS**

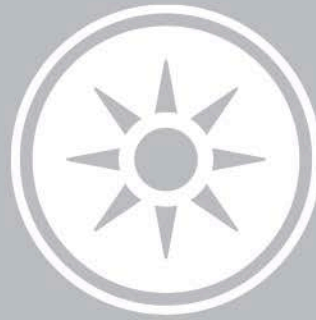
**or**

**PATH**

**2**

Enhanced and  
monitoring-based  
commissioning

**4 POINTS**



## EA Credit

### Enhanced Commissioning

#### OPTION 1. Enhanced systems commissioning

##### PATH

# 1

Enhanced commissioning:  
Additional tasks related to  
building systems  
and operations

**3 POINTS**

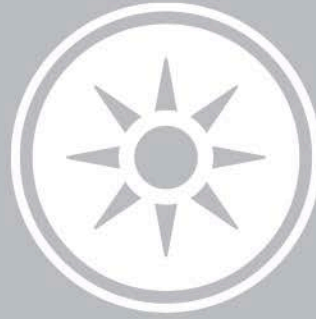
or

##### PATH

# 2

Enhanced and  
monitoring-based  
commissioning

**4 POINTS**



## EA Credit

### Enhanced Commissioning

#### OPTION 1. Enhanced systems commissioning

PATH

1

Enhanced commissioning:  
Additional tasks related to  
building systems  
and operations

3 POINTS

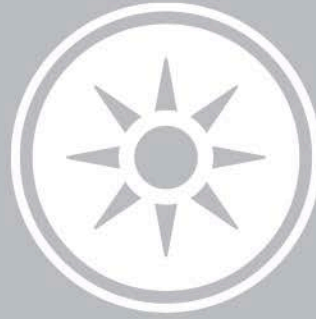
or

PATH

2

Enhanced and monitoring-  
based commissioning:  
Additional monitoring-based  
procedures

4 POINTS



## **EA Credit** **Enhanced Commissioning**

OPTION

**1**

Enhanced systems  
commissioning

**or**

OPTION

**2**

Envelope commissioning:  
Include thermal  
envelope in scope of  
commissioning

# Update OPR, BOD, and Cx plan

WHAT

WHY

WHEN

WHO

HOW



# OPTION 1.

## Enhanced Systems Commissioning

Develop systems manual  
scope and format

WHAT

WHY

WHEN

WHO

HOW

# Create training requirements

WHAT

WHY

WHEN

WHO

HOW

CxA reviews contract  
submittals to verify  
they meet OPR, BOD,  
and design documents

WHAT

WHY

WHEN

WHO

HOW

Execute training  
requirements

Include monitoring  
equipment and  
software (Path 2)

WHAT

WHY

WHEN

WHO

HOW

# FINAL DELIVERABLE TO OWNER

Up-to-date systems manual

Documentation of operator training

Completed functional  
performance test reports

Up to date issues log

Cx Report

WHAT

WHY

WHEN

WHO

HOW



**months**

after substantial completion,  
CxA reviews building operations

WHAT

WHY

WHEN

WHO

HOW



# CxA issues ongoing commissioning plan

WHAT

WHY

WHEN

WHO

HOW

# OPTION 1, PATH 2: Enhanced and monitoring- based commissioning

Permanent energy  
monitoring systems

Real-time energy analytics

Ongoing commissioning

WHAT

WHY

WHEN

WHO

HOW

---

# MBCx

monitoring based  
commissioning

---

# OPTION 2.

## Envelope commissioning

Complete all  
prerequisite Cx activities  
for the envelope

WHAT

WHY

WHEN

WHO

HOW



# INCORPORATE BECx INTO Cx PLAN AND PROCESS

WHAT

WHY

WHEN

WHO

HOW

The background features a large, faint, grey circular logo. The top arc of the logo contains the text "IN ENERGY & ENVIRONME" in white, uppercase letters. The center of the logo depicts a stylized green leaf or plant. The bottom arc of the logo contains the text "LEADERSHIP IN DESIGN" in white, uppercase letters.

# PLANNING THE Cx PROCESS TABLE IN REFERENCE GUIDE

WHAT

WHY

WHEN

WHO

HOW



# TIPS FOR SUCCESSFUL Cx

1. Engage CxA early
2. Find CxA with relevant experience
3. Coordinate with necessary project team members



# EA Credit

## Enhanced Commissioning

OPTION

1

Enhanced  
commissioning

4 POINTS

or

OPTION

2

Monitoring-based  
commissioning

5 POINTS

# HEALTHCARE



## ADAPTATION SPECIFIC CREDITS

Additional testing requirements  
for life safety equipment

# DATA CENTERS



## ADAPTATION SPECIFIC CREDITS

Address requirements of any  
mission critical functional testing

# CORE & SHELL



## ADAPTATION SPECIFIC CREDITS

Commission only systems in design  
team's scope of work



---

## **EA** Prerequisite and Credit

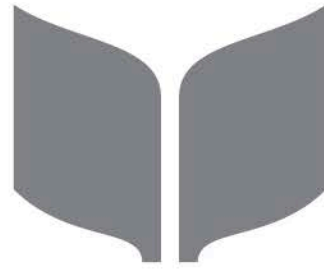
### **PREREQUISITE**

Minimum Energy  
Performance

### **CREDIT**

Optimize Energy  
Performance





# REFERENCED STANDARD

ANSI/ASHRAE/IESNA  
Standard 90.1-2010

[www.ashrae.org](http://www.ashrae.org)



# **EA Prerequisite**

## **Minimum Energy Performance**

### **OPTION**

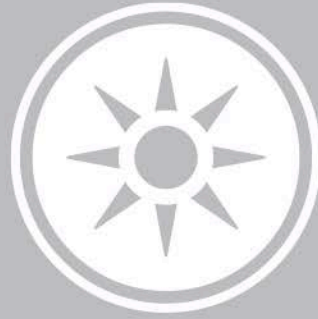
# **1**

**Whole-building energy simulation**

5% improvement for New Construction

3% improvement for Major Renovations

2% improvement for Core & Shell



# **EA Prerequisite**

## **Minimum Energy Performance**

**OPTION**

**2**

**Prescriptive compliance: ASHRAE  
50% Advanced Energy Design Guide**

Meet HVAC and service water heating requirements of  
ASHRAE 50% Advanced Energy Design Guide (AEDG)



# **EA Prerequisite**

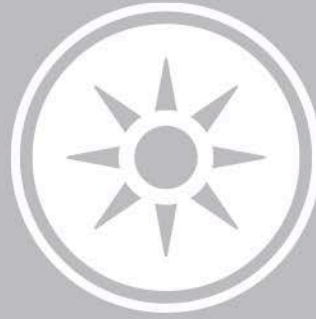
## **Minimum Energy Performance**

**OPTION**

**3**

**Prescriptive compliance: Advanced Buildings™  
Core Performance™ Guide (CPG)**

Comply with prescriptive criteria of Sections 1 & 2  
and select strategies from Section 3



## EA Credit

### Optimize Energy Performance

#### OPTION

# 1

Whole-building  
energy simulation

**1-18 POINTS**

**1-16 POINTS (SCHOOLS)**

**1-20 POINTS (HEALTHCARE)**

or

#### OPTION

# 2

Prescriptive compliance:  
ASHRAE Advanced  
Energy Design Guide

**1-6 POINTS**

# Establish energy performance target

WHAT

WHY

WHEN

WHO

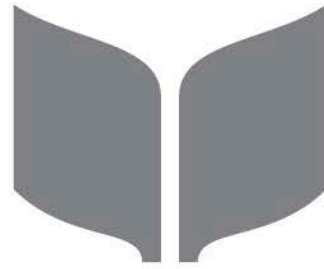
HOW











# REFERENCED STANDARD

ANSI/ASHRAE/IESNA  
Standard 90.1-2010

[www.ashrae.org](http://www.ashrae.org)



A wide-angle photograph of a desert landscape under a cloudy sky. The foreground is filled with low-lying, scrubby vegetation and patches of bare, rocky ground. In the distance, rolling hills or mountains are visible under a sky with soft, grey clouds. A large, semi-transparent yellow rectangle is centered over the image, containing the main title and subtitle in white text.

# EA PREREQUISITE MINIMUM ENERGY PERFORMANCE

Determine appropriate climate zone

WHAT

WHY

WHEN

WHO

HOW

Review mandatory  
components early in  
design process

WHAT

WHY

WHEN

WHO

HOW



# Establish energy use target

WHAT

WHY

WHEN

WHO

HOW



# EA Prerequisite

## Minimum Energy Performance

OPTION

1

Whole-building  
energy simulation

or

OPTION

2

Prescriptive  
compliance:  
ASHRAE 50%  
Advanced Energy  
Design Guide

or

OPTION

3

Prescriptive  
compliance:  
Advanced  
Buildings™ Core  
Performance™  
Guide

WHAT

WHY

WHEN

WHO

HOW



## EA Credit

### Optimize Energy Performance

#### OPTION

# 1

Whole-building  
energy simulation

18 POINTS POSSIBLE

or

#### OPTION

# 2

Prescriptive compliance:  
ASHRAE Advanced  
Energy Design Guide

6 POINTS POSSIBLE

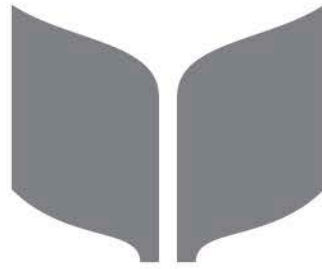
WHAT

WHY

WHEN

WHO

HOW



# REFERENCED STANDARDS

## EA PREREQUISITE REFERENCED STANDARDS

### OPTION 2.

ASHRAE 50% Advanced Energy Design Guides

### OPTION 3.

The Advanced Buildings Core Performance Guide

Consider passive and  
then active strategies  
for energy load  
reductions

WHAT


WHY

WHEN

WHO

HOW





REDUCE  
ENERGY NEED



USE ENERGY  
MORE  
EFFICIENTLY



INCORPORATE  
RENEWABLES  
(CREDIT ONLY)

WHAT

WHY

WHEN

WHO

HOW



## OPTION 1.

Whole-building energy  
simulation + EA Credit

Optimize Energy Performance  
+ Integrative Process Credit

Identify requirements for  
concept-level energy modeling

WHAT

WHY

WHEN

WHO

HOW

# OPTION 1.

## Whole-building energy simulation

Engage qualified energy  
modeler to create  
preliminary model

WHAT

WHY

WHEN

WHO

HOW

# OPTION 1.

## Whole-building energy simulation

Analyze various  
efficiency measures

WHAT

WHY

WHEN

WHO

HOW

Update model based  
on design and build  
baseline model to  
reflect minimum  
requirements

WHAT

WHY

WHEN

WHO

HOW

---

# non-regulated load

*(noun)*

any building load, end-use, or control which does not have an ASHRAE 90.1-2010 Appendix G baseline modeling requirement

---

Compare proposed  
and baseline model to  
determine savings

WHAT

WHY

WHEN

WHO

HOW



# ENERGY SAVINGS

5%

**new  
construction**

3%

**major  
renovations**

2%

**core  
and shell**

WHAT

WHY

WHEN

WHO

HOW

# PRESCRIPTIVE OPTIONS

Assess ASHRAE 90.1-2010  
prescriptive requirements

WHAT

WHY

WHEN

WHO

HOW

# OPTION 2.

## ASHRAE 50% Advanced Energy Design Guide

Select building type and  
review requirements

WHAT

WHY

WHEN

WHO

HOW

Equipment efficiency

Economizers

Ventilation

Ducts and dampers

# ASHRAE 50% ADVANCED ENERGY DESIGN GUIDE FOR SMALL TO MEDIUM OFFICE BUILDINGS

Building envelope, opaque: roofs, walls, floors, slabs, doors, and continuous air barriers	1 point
Building envelope, glazing: vertical fenestration	1 point
Interior lighting, including daylighting and interior finishes	1 point
Exterior lighting	1 point
Plug loads, including equipment and controls	1 point

# OPTION 3.

## Advanced Buildings™

### Core Performance™ Guide

#### (Prerequisite only)

Achieve requirements of  
Sections 1 & 2, and parts  
of Section 3 of CPG

WHAT

WHY

WHEN

WHO

HOW



ID+C

Different prescriptive  
options

Energy simulation  
tailored to tenant level

# HEALTHCARE, WAREHOUSES, DATA CENTERS, RETAIL



---

ADAPTATION SPECIFIC CREDITS



---

## **EA** Prerequisite and Credit

### **PREREQUISITE**

Minimum Energy  
Performance

### **CREDIT**

Optimize Energy  
Performance



---

## **EA** Prerequisite

Building-level Energy Metering  
(BD+C only)

Capture data on total building-level energy consumption



## **EA Credit**

Advanced Energy Metering  
(1 Point)

Track system-level energy use









# DETERMINE WHICH ENERGY END USES REQUIRE METERS

photo credit: Ana Kahanui

WHAT

WHY

WHEN

WHO

HOW



# DETERMINE WHICH SUBMETERS APPROPRIATE FOR PROJECT

photo credit: Eli Duke

WHAT

WHY

WHEN

WHO

HOW





# REFERENCED STANDARDS

## EXAMPLE REFERENCE STANDARDS

Electricity: American National Standards Institute

– ANSI C12.20, Class 0.2 ( $\pm 0.2$ ): [ansi.org](http://ansi.org)

Natural Gas: American National Standards Institute

– ANSI B109: [ansi.org](http://ansi.org)

# DATA CENTERS



---

ADAPTATION SPECIFIC CREDITS

IT energy metered separately



---

## **EA** Prerequisite and Credit

### **PREREQUISITE**

Fundamental Refrigerant  
Management

### **CREDIT**

Enhanced Refrigerant  
Management



# EA PREREQUISITE

## Fundamental Refrigerant Management

Do not use chlorofluorocarbon (CFC)-based refrigerants

**or**

Complete CFC phase-out conversion

WHAT

WHY

WHEN

WHO

HOW



## EA Credit

### Enhanced Refrigerant Management

OPTION

1

No refrigerants or  
use low impact  
refrigerants only

or

OPTION

2

Calculate refrigerant  
impact to ensure within  
ODP and GWP limits

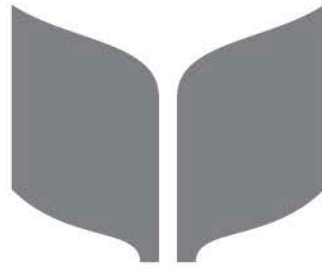
WHAT

WHY

WHEN

WHO

HOW



# REFERENCED STANDARD

## MONTREAL PROTOCOL

New construction



no new CFC-based  
refrigeration

Existing HVAC



CFC okay prior  
to 1995/2012



# EA PREREQUISITE

## Fundamental Refrigerant Management

Specify equipment with  
no CFC refrigerants

WHAT

WHY

WHEN

WHO

HOW



# REPLACE OR RETROFIT EXISTING EQUIPMENT THAT USES CFC REFRIGERANTS

(exempt: small equipment  
with < 0.5 lbs (225 g) refrigerant)

WHAT

WHY

WHEN

WHO

HOW





## EA Credit

### Enhanced Refrigerant Management

#### OPTION

# 1

No refrigerants  
or low-impact  
refrigerants

**1 POINT**

or

#### OPTION

# 2

Calculation  
of refrigerant  
impact

**1 POINT**

# REFRIGERANT ODP/GWP (EXAMPLES)

REFRIGERANT	ODPr	GWPr	COMMON BUILDING APPLICATIONS
CHLOROFLUOROCARBONS			
CFC-11	1.0	4,680	Centrifugal chillers
CFC-12	1.0	10,720	Refrigerators, chillers
HYDROCHLOROFLUOROCARBONS			
HCFC-123	0.02	76	CFC-11 replacement
HYDROFLUOROCARBONS			
HFC-23	~0	12,240	Ultra-low-temperature refrigeration
NATURAL REFRIGERANTS			
Carbon dioxide (CO2)	0	1.0	
Ammonia (NH3)	0	0	

---

# refrigerant charge (Rc)

*(noun)*

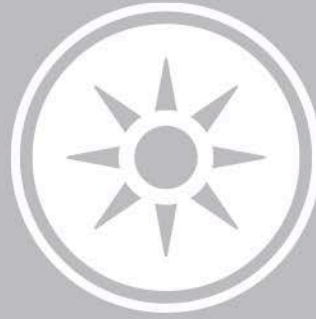
ratio of the total refrigerant  
used to the cooling capacity  
measured in lbs/ton (kg/kW)

# RETAIL



## ADAPTATION SPECIFIC CREDITS

Additional requirements for  
commercial refrigeration



## **EA Credit**

### **Demand Response**

**CASE**

**1**

Demand response  
program available

**2 POINTS**

**or**

**CASE**

**2**

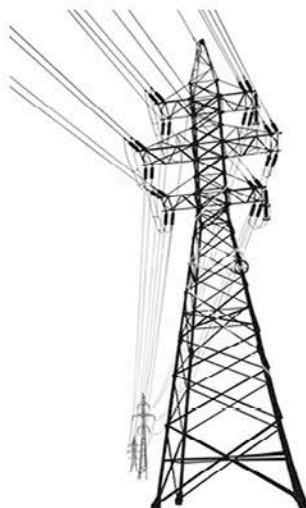
Demand response  
program not available

**1 POINT**

# DEMAND RESPONSE



POWER GRID NEEDS **80** MW



POWER  
GRID ONLY  
HAS **70** MW



POWER GRID PAYS  
CONSUMERS TO REDUCE  
**10** MW TO BALANCE  
SUPPLY & DEMAND











## EA Credit

### Demand Response

CASE

1

Demand response  
program available

2 POINTS

or

CASE

2

Demand response  
program not available

1 POINT

# Incorporate automated demand response capability

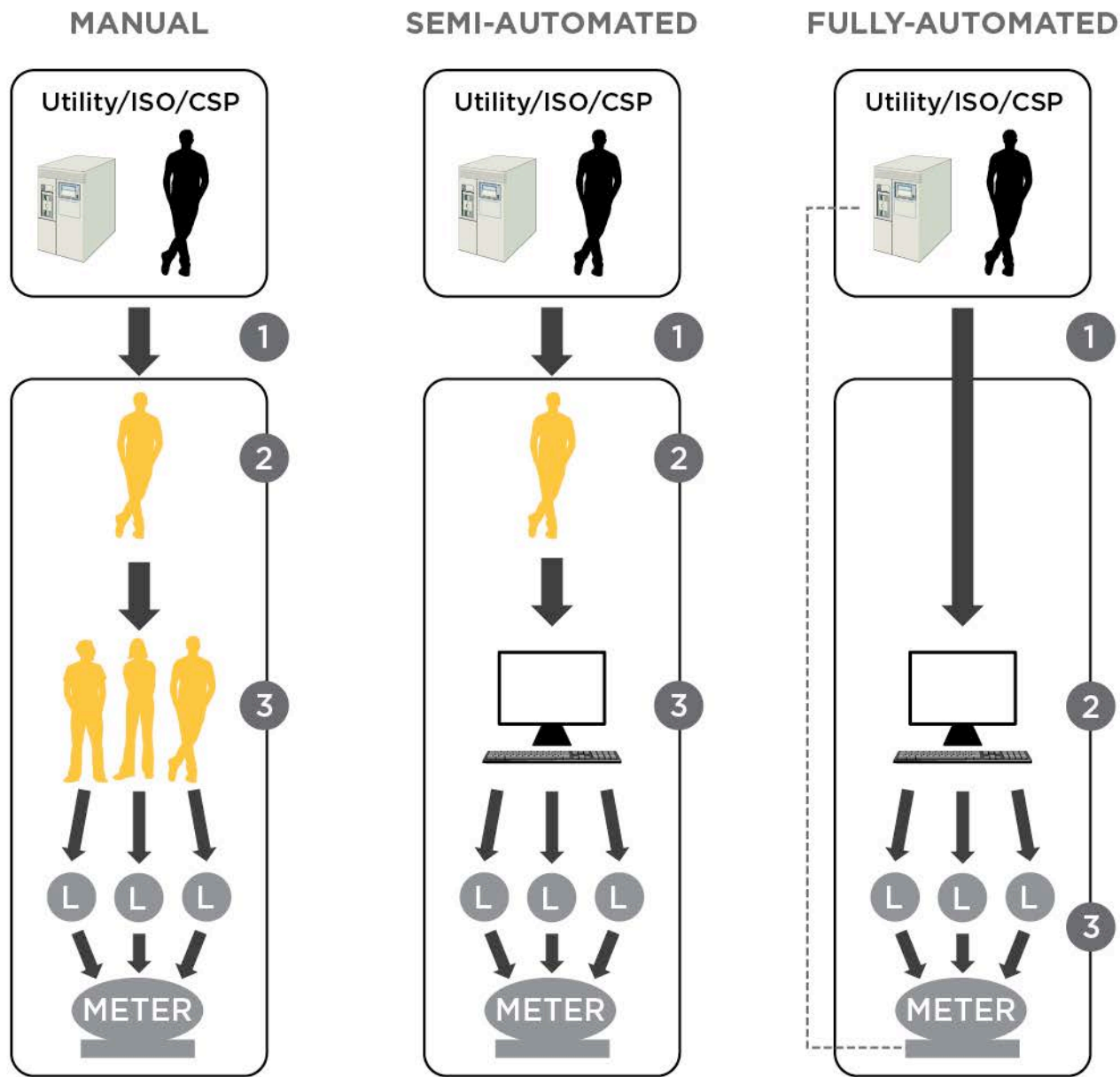
WHAT

WHY

WHEN

WHO

HOW



ISO = Independent System Operator    CSP = Curtainment Service Provider    L = Load

Source: LBNL



Use estimates from  
energy model or  
use space peak  
load calculations

WHAT

WHY

WHEN

WHO

HOW



10%

**minimum reduction**  
in peak electricity demand

WHAT

WHY

WHEN

WHO

HOW

# PREPARE PEAK DEMAND RESPONSE PLAN

Clear direction for implementation

Activities

Responsible parties

Anticipated reduction for  
each measure

WHAT

WHY

WHEN

WHO

HOW

Design for full  
automation capacity  
(but program can be  
semi-automated)

WHAT

WHY

WHEN

WHO

HOW



**minimum**  
contract length

WHAT

WHY

WHEN

WHO

HOW

# CASE 2.

## Demand response program not available

Contact provider to express  
interest in future programs

WHAT

WHY

WHEN

WHO

HOW



A photograph of a modern office interior. Large windows on the left let in bright sunlight, casting shadows on a grey carpeted floor. Several potted plants are visible, including a large one in the foreground and smaller ones further back. A white wall and a ceiling with a black track lighting fixture are also visible.

REDUCE  
ENERGY NEED

A close-up photograph of a speedometer or gauge. The needle is pointing towards the 60 mark. The background is a mix of light blue and red. Large numbers 60, 80, and 100 are visible on the scale.

USE ENERGY  
MORE  
EFFICIENTLY

A photograph of several white wind turbines in a field. The turbines are tall with three blades each. The background shows a hilly landscape under a cloudy sky.

INCORPORATE  
RENEWABLES



---

## **EA Credit**

### **Renewable Energy Production**

Use renewable energy systems to offset project's energy costs

BD+C and ID+C - Up to 3 points









A photograph of an industrial facility, likely a water treatment plant, featuring large silver pipes and tanks. In the foreground, a large horizontal pipe runs across the frame. In the background, there are more vertical pipes and tanks, some with green safety railings. The facility is set against a backdrop of green hills under a clear blue sky.

# EXPLORE OPTIONS FOR RENEWABLE ENERGY SYSTEMS

WHAT

WHY

WHEN

WHO

HOW



Estimate annual  
energy cost based  
on energy model or  
the Commercial Building  
Energy Consumption  
Survey (CBECS)

WHAT

WHY

WHEN

WHO

HOW

Design and specify  
system criteria, then  
estimate annual  
energy cost

WHAT

WHY

WHEN

WHO

HOW



## PERCENTAGE OF RENEWABLE ENERGY

% renewable  
energy cost



equivalent cost usable  
energy produced by the  
renewable energy system

---

total estimated building  
annual energy cost

# ID+C AND CORE & SHELL PROJECTS

ANNUAL ENERGY USE	POINTS
1%	1
3%	2
5%	3



---

## **EA Credit**

Green Power and Carbon Offsets

Purchase green power, carbon offsets or  
renewable energy certificates (RECs)

# PERCENTAGE OF TOTAL ENERGY USE



**50%**

**1 point**



**100%**

**2 points**

WHAT

WHY

WHEN

WHO

HOW



## PATHS TO OFFSET ENERGY USE

TYPE	MEASUREMENT	VERIFICATION
REC's	MWh	certified by appropriate Green-e program
carbon offsets	metric tons of CO <sub>2</sub> equivalent	
green power	MWh	







Investigate available  
green power options  
for offsetting all  
energy systems

WHAT

WHY

WHEN

WHO

HOW

## SCOPE 1

Direct greenhouse gas emissions from sources owned/controlled by the entity

## SCOPE 2

Indirect GHG emissions associated with generation of purchased electricity



# APPLICATION OF OPTIONS

SOURCE	OPTIONS
non-electricity	carbon offsets
electricity	REC's, green power, or carbon offsets

WHAT

WHY

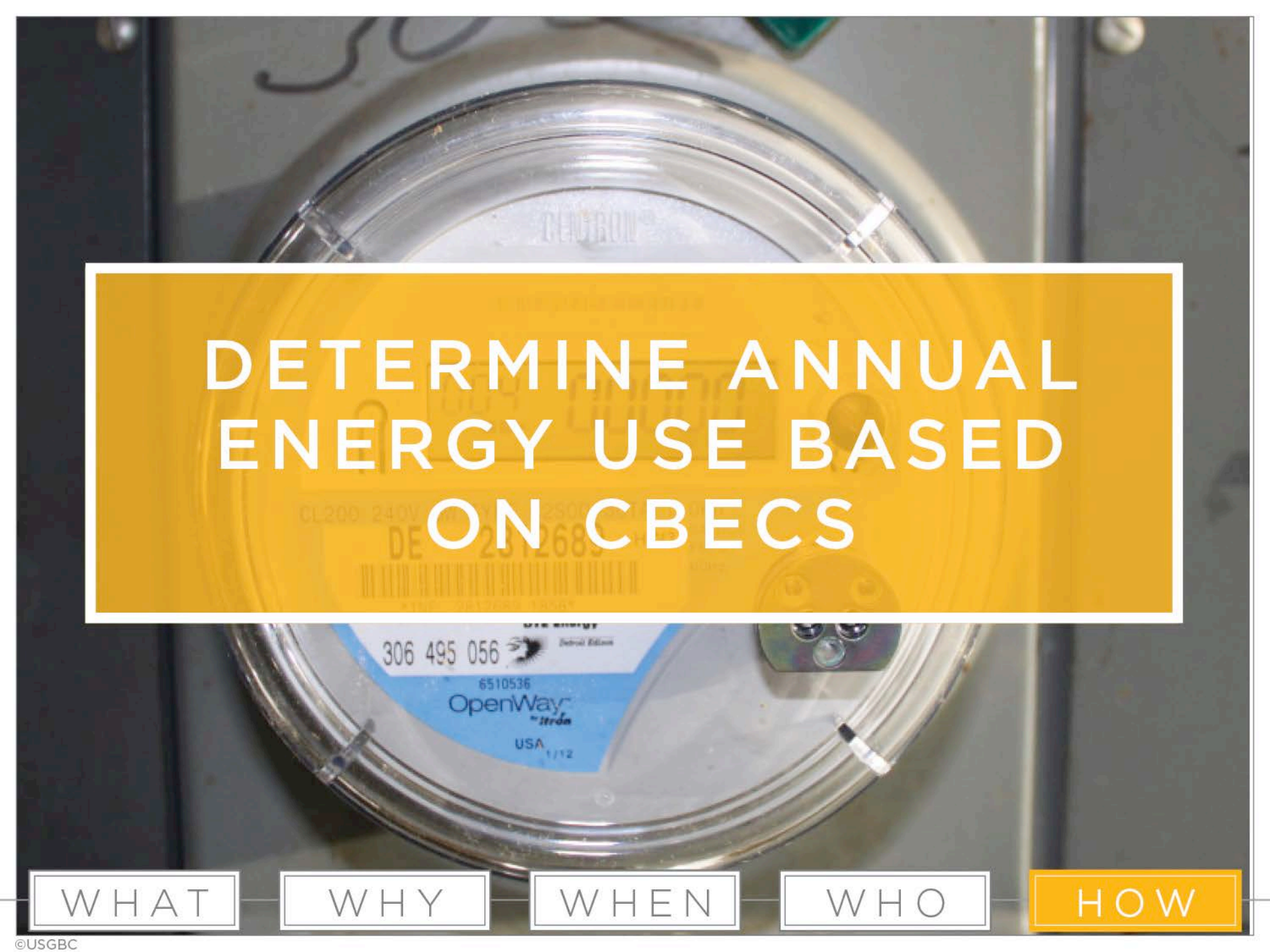
WHEN

WHO

HOW



**consecutive years**  
minimum contract length



# DETERMINE ANNUAL ENERGY USE BASED ON CBECS

WHAT

WHY

WHEN

WHO

HOW

**EA CREDIT**  
**Green Power and**  
**Carbon Offset**

based on ENERGY CONSUMED

**EA CREDIT**  
**Renewal Energy Production**  
based on COST





# NET ZERO PROJECTS ELIGIBLE FOR 2 POINTS WITHOUT ADDITIONAL PURCHASING

photo credit: CNT

WHAT

WHY

WHEN

WHO

HOW

The Green-e logo is a circular emblem. The top half is green with four white diagonal lines radiating from the center. The bottom half is white with a green outline. A registered trademark symbol (®) is located to the right of the emblem.

# PURCHASE FROM A GREEN-E PROVIDER

# Green-e

WHAT

WHY

WHEN

WHO

HOW



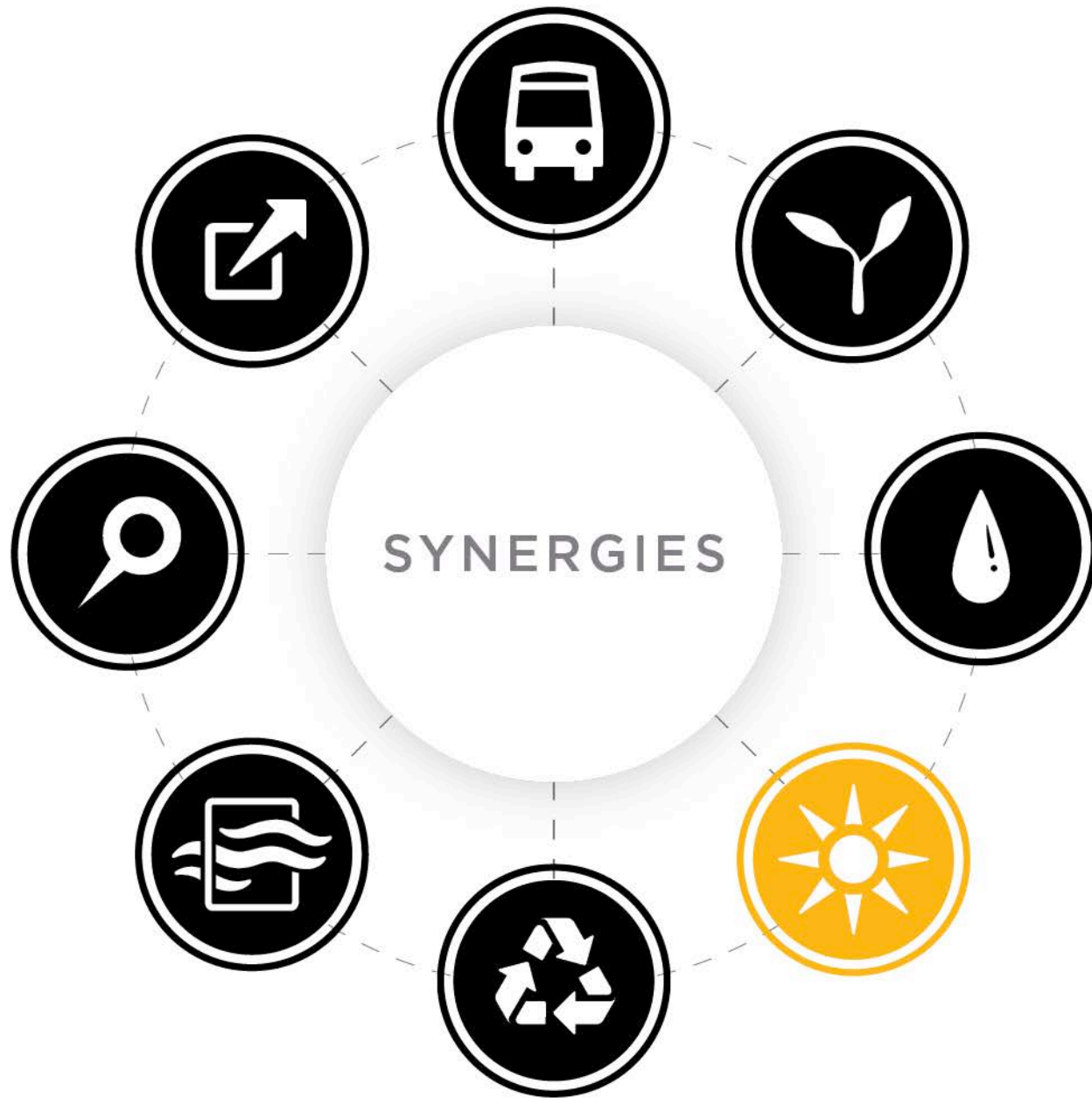


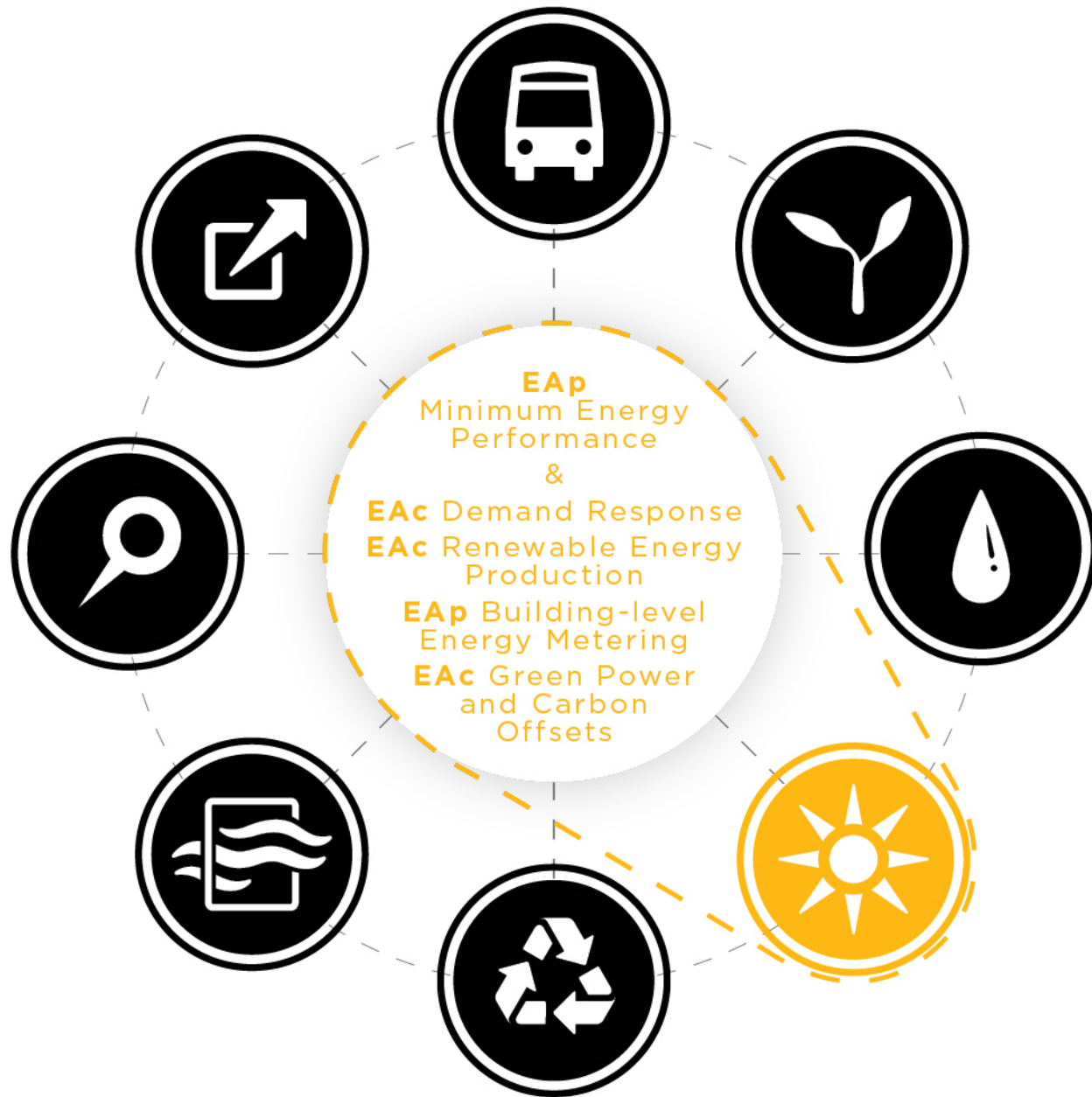
# GLOBAL LEED

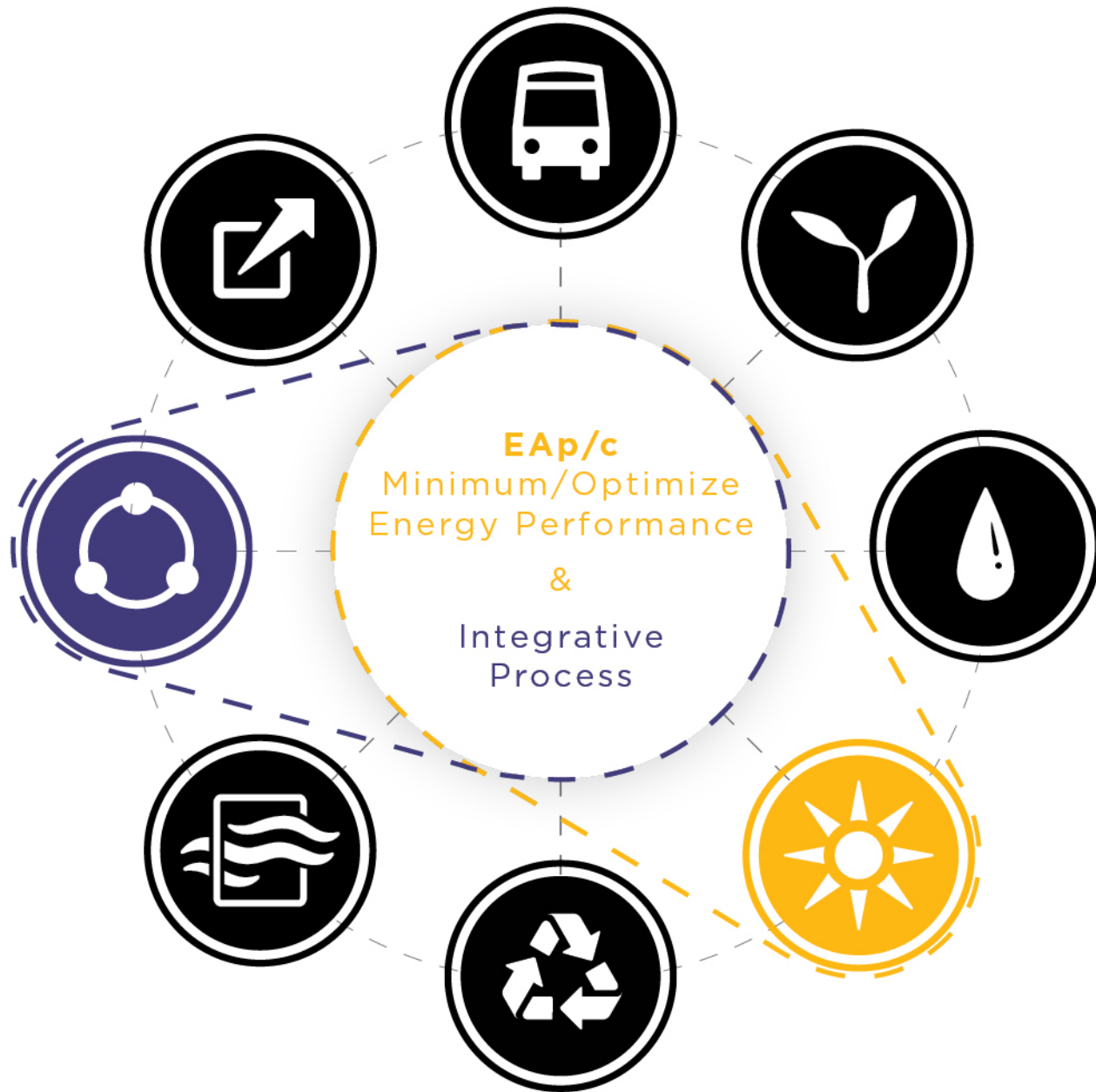
Green power, RECs and carbon offsets must be Green-e certified

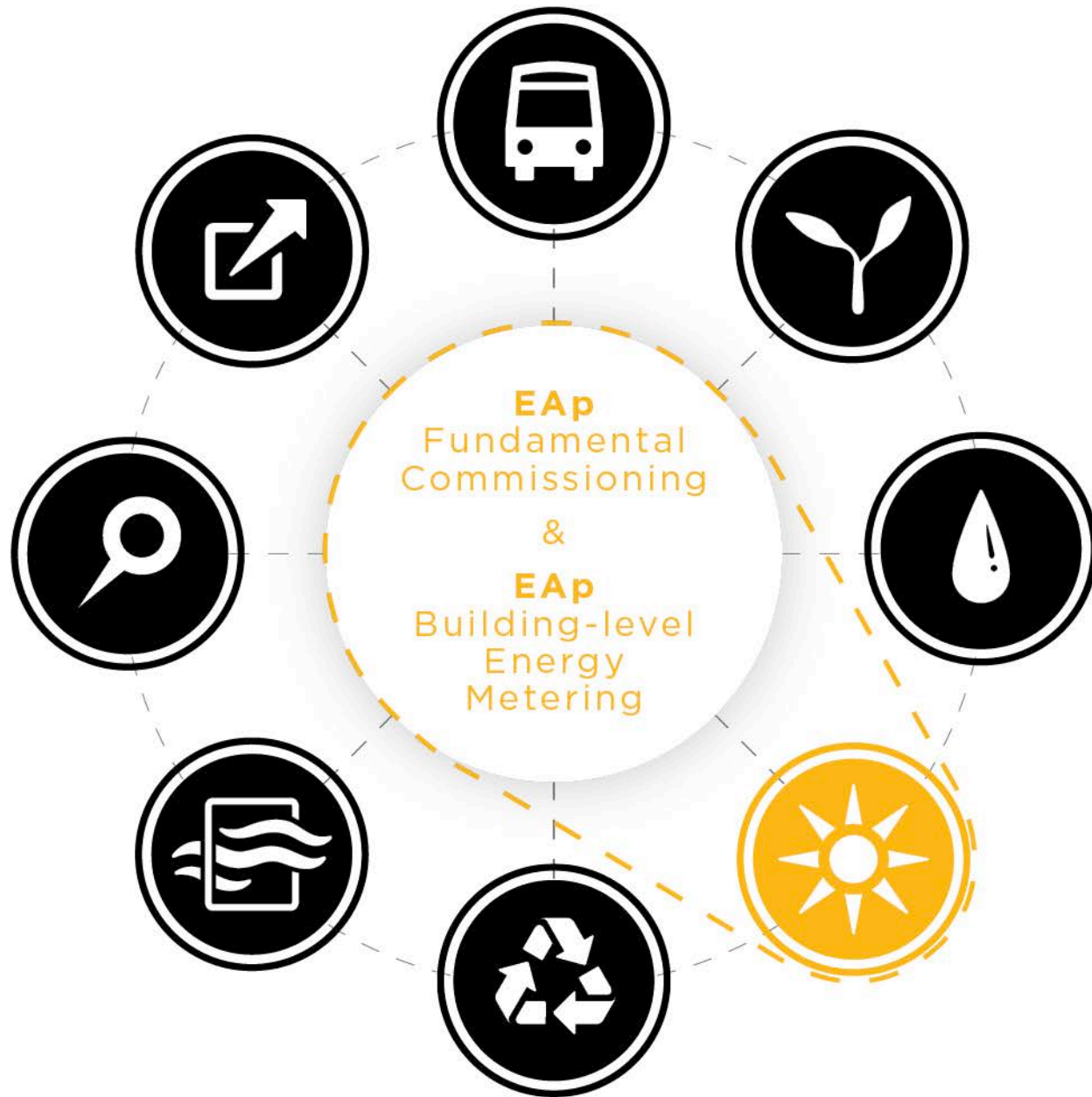
**or**

Demonstrate equivalency



















# LEED v4 RATING SYSTEM REVIEW

LOCATION & TRANSPORTATION

SUSTAINABLE SITES

WATER EFFICIENCY

ENERGY & ATMOSPHERE

MATERIALS & RESOURCES

INDOOR ENVIRONMENTAL QUALITY