Green Building Overview, Rating Systems and the (Proposed) ASHRAE Standard 189.1

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Engineering Outreach SERVICE
The University of Georgia

Introduction and greetings from the University of Georgia



Overall Outline

- What is “green” and why do it?
- Sustainable design examples
- USGBC LEED and other green rating systems
- How HVAC systems affect being green
- ASHRAE’s recent efforts
  - Standard 189.1 (proposed)
  - Energy design goals ($\Rightarrow$ Net zero buildings)

What is a “Green Design” or Sustainable Design?

- ASHRAE *GreenGuide* provides one definition for sustainable building design:

“Sustainability is the providing of the needs of the present without detracting from the ability to fulfill the needs of the future”

"Every problem is just an opportunity in disguise"

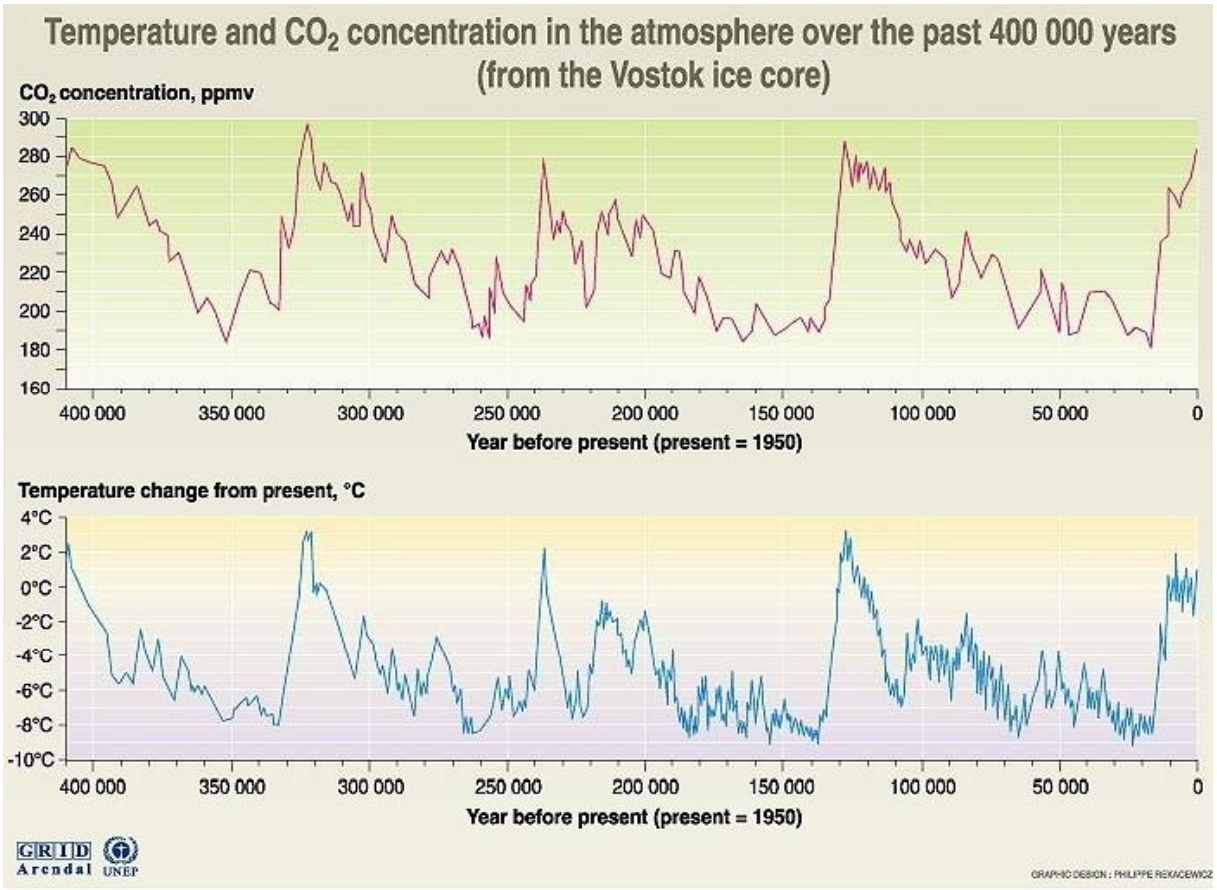
- Individuals
- Companies, organizations
- Nations



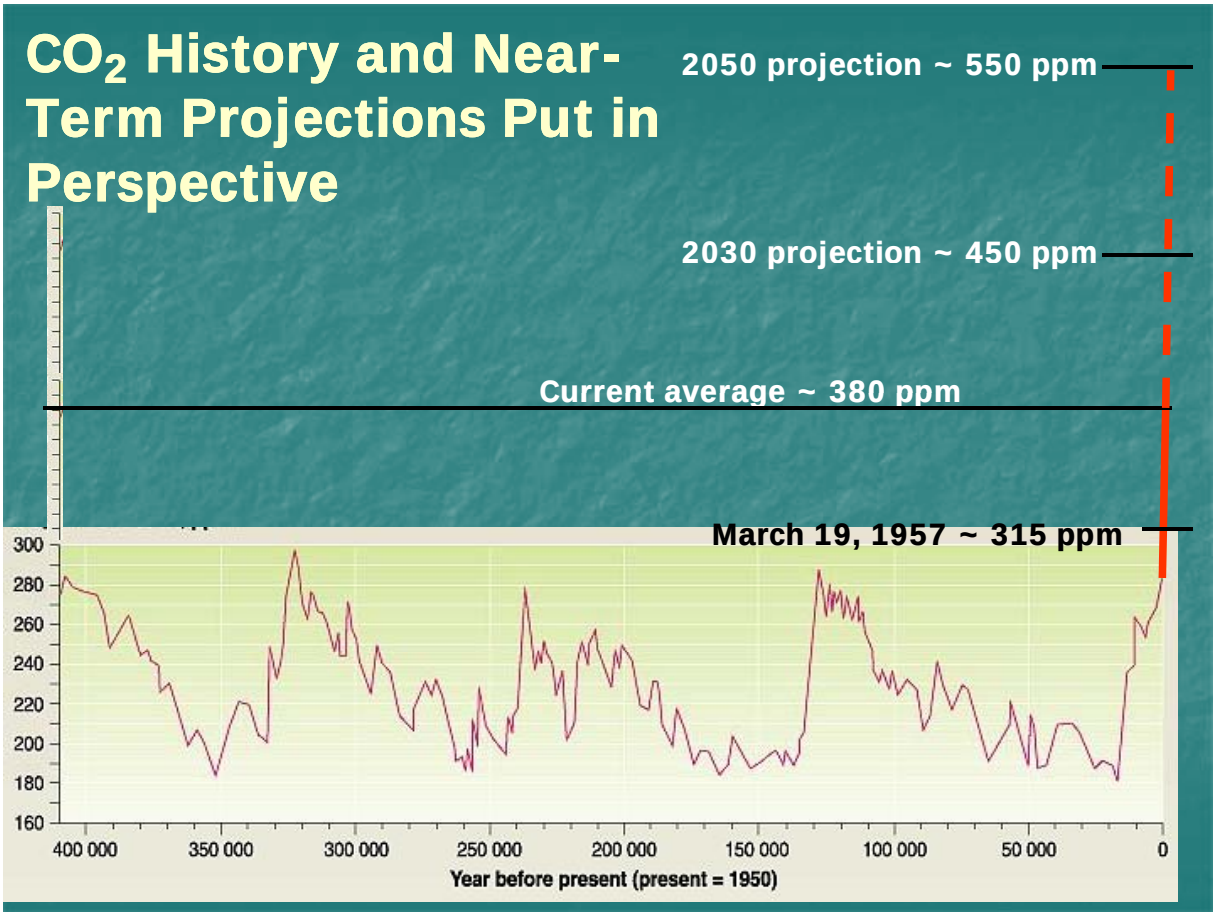
Environmental Impact of Buildings in U.S.*

- 65.2% of total U.S. electricity consumption
- > 36% of total U.S. primary energy use
- 30% of total U.S. greenhouse gas emissions
- 136 million tons of construction and demolition waste in the U.S. (approx. 2.8 lbs/person/day)
- 12% of potable water in the U.S.
- 40% (3 billion tons annually) of raw materials use globally

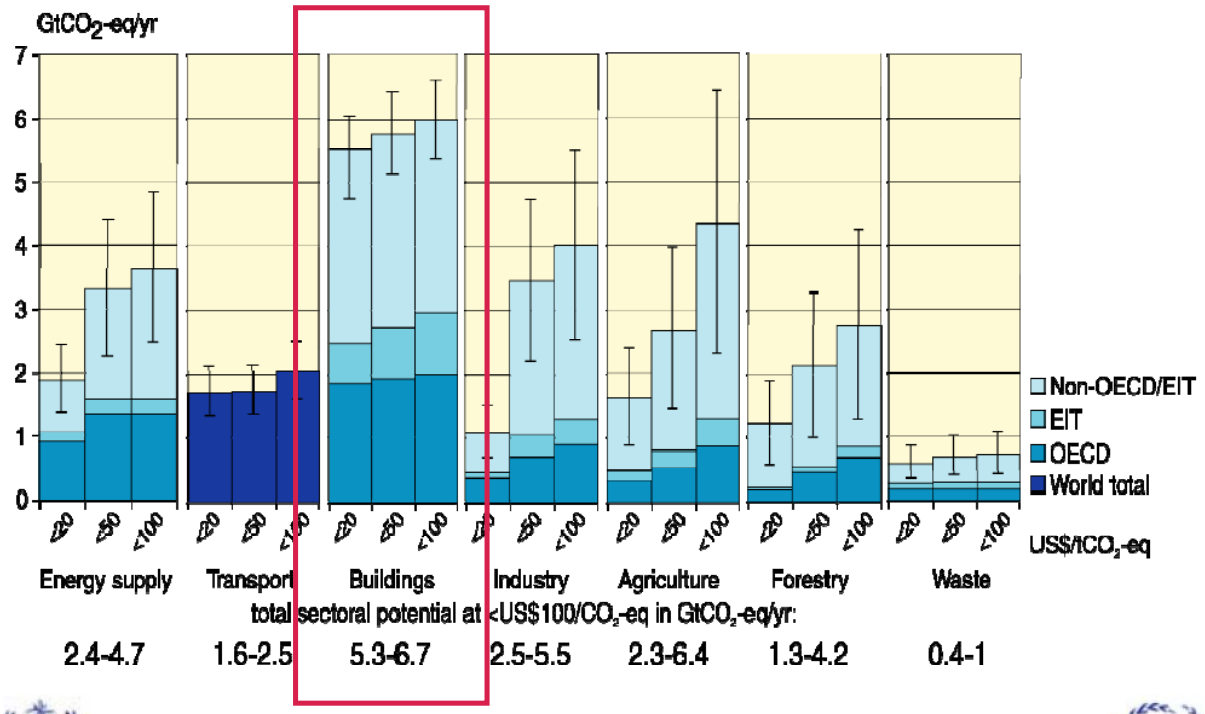
* Commercial and residential



Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.



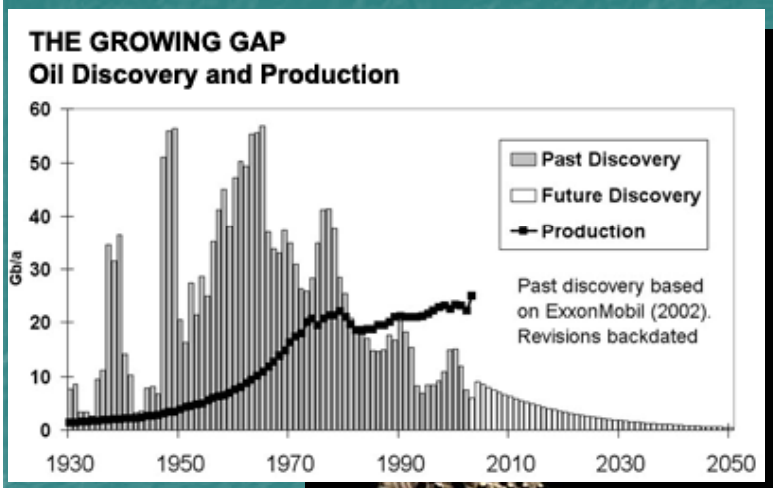
Economic mitigation potential by sector in 2030



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

WMO UNEP

Peak Oil and Energy Costs



Green Buildings Overview,
Standard 189 - 10

Are Green Buildings "Mainstream"?

- Is 'Green' only for those who 'have to' (mandated) or those with corporate mission?
- 41% of U.S. based REITs actively pursuing energy efficiency and green building
- McGraw-Hill 2006 Smart-Market Report: **3.5% higher occupancy rates, 3% higher rents, 7.5% increase in building value** for "green".
- 15 of world's largest REITs developed UN *Principles for Responsible Investment*

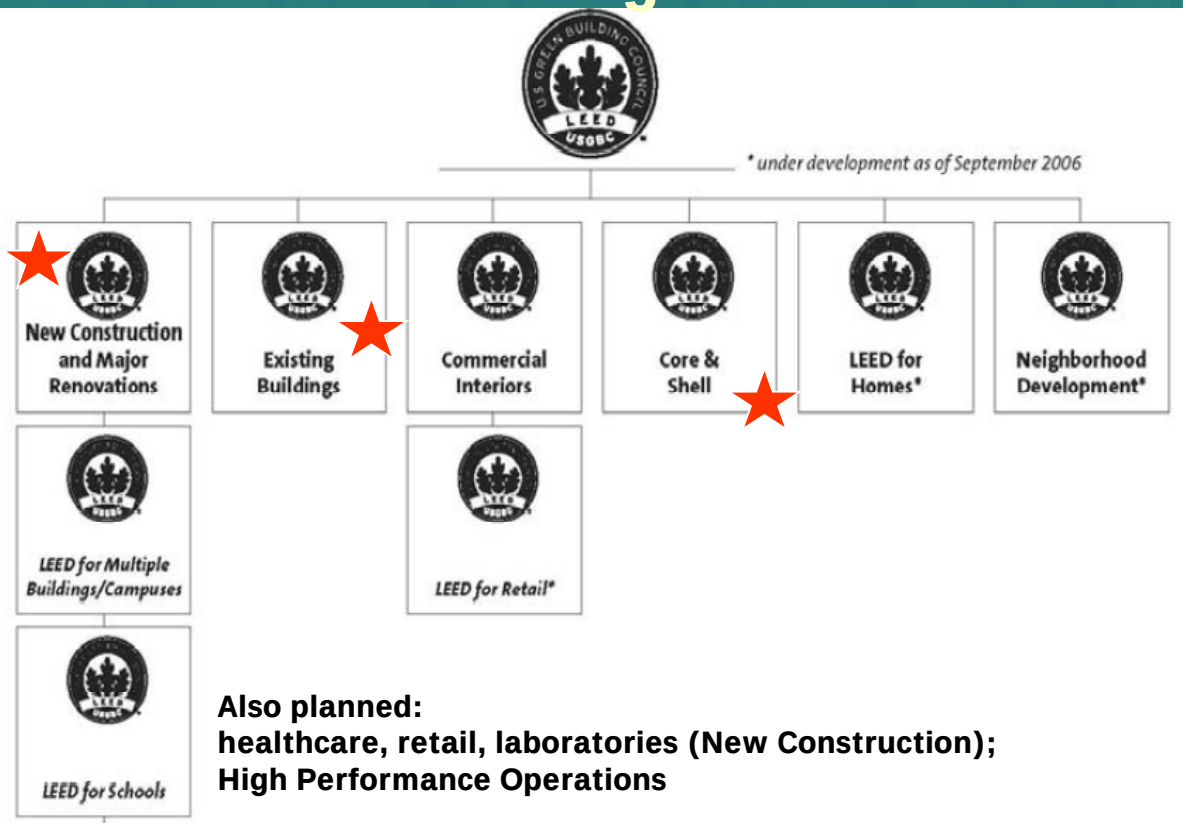
"Real Estate Biz Getting Greener" ***Solar Today***, July 2007

Green Building Rating Systems (LEED and Other Programs)

USGBC and LEED: Topics

- **L**eadership in **E**nergy and **E**nvironmental **D**esign
- Overview of LEED programs mostly relevant to ASHRAE and its members
- Resources for LEED

LEED Programs



Also planned:
healthcare, retail, laboratories (New Construction);
High Performance Operations

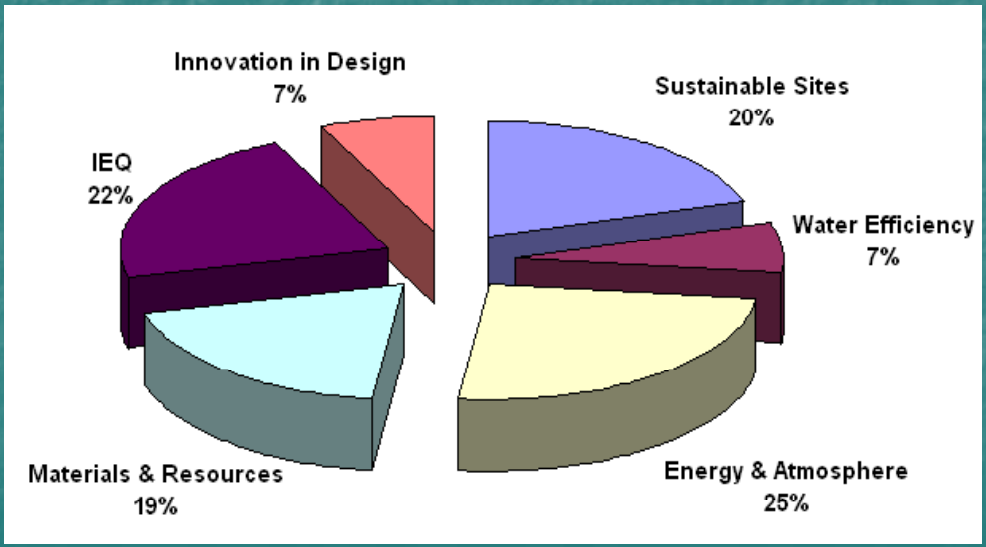
Five Categories - WISER

- Water Efficiency
- Indoor Environmental Quality
- Sustainable Sites
- Energy & Atmosphere
- Resources & Materials



LEED(R)-NC Point Distribution

LEED credit categories (LEED 2.2)



5 Sustainable Design Categories



	•Sustainable Site Planning	8 credits / 14 points
★	•Water Conservation and Efficiency	3 credits / 5 points
★	•Energy and Atmosphere	6 credits / 17 points
	•Materials and Resources	7 credits / 13 points
★	•Indoor Environmental Quality	8 credits / 15 points

LEED™ Rating System

- **Certified Level 26-32 points**
- **Silver Level 33-38 points**
- **Gold Level 38-51 points**
- **Platinum Level 52+ points**

total core points	64
innovation points	4
design process points	1
TOTAL POSSIBLE	**69**
prerequisites required	**7**

Energy and Atmosphere



Prerequisites

- Building Systems Functional Commissioning
- Minimum Energy Performance
- CFC Reduction in Equipment

Credits

1. Optimize Energy Performance
2. Renewable Energy
3. Additional Commissioning
4. Elimination of HCFC's & Halons
5. Measurement and Verification
6. Green Power

Energy Performance Determination

- Minimum level (prerequisite)
  - Comply with ASHRAE Standard 90.1-2004
- For credits: Three options

I) Whole building simulation (90.1-2004 App. G)

New Buildings	Existing Building Renovations	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

EA Cr 3: Additional Commissioning

- Contract for enhanced Cx (as described in the *Reference Guide*). To include:
  - Review of Owner's Project Req'ts, Basis of Design, submittals
  - Develop systems (operations) manual
  - Verify training completion
  - Review building operation within 10 months of 'substantial completion'

EA Cr 5: Measurement & Verification

- Develop and implement (for minimum of 1 year post-construction) a plan that complies with IPMVP
  - Option D (Whole Building Calibrated Simulation)
  - Option B (ECM isolation), as applied to monitoring and accountability of significant energy using systems, easily isolated

Materials and Resources: Credit 2 - Construction Waste

Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal
Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal

- Computed by either weight or volume (consistent for all waste streams and types); **sorting and documentation!**
- Primarily architectural related, but opportunity for HVAC related to contribute
  - Sheet metal and other metal parts, wire
  - Protective wrap
- Issue: Willing waste haulers and recyclers

Indoor Environmental Quality

Prerequisites

•Minimum Indoor Air Quality Performance (Standard 62.1-2004)

•Tobacco Smoke Control

Credits

1. Outdoor Air Delivery Monitoring

2. Increase Ventilation

3. Construction IAQ Management Plan

4. Low Emitting Materials

5. Indoor Chemical and Pollutant Source Control

6. Controllability of Systems

7. Thermal Comfort

8. Daylight and Views

IEQ: Outdoor Air Monitoring (EQ Cr. 1)

- Monitor CO_2 concentrations 3 to 6 feet off floor in densely (>25 people/1000 ft²) and naturally ventilated spaces
- For other areas, monitor outdoor air flow to ensure 62.1-2004 level compliance
- Generate alarm (BAS, operator or occupants) signaling when out of setpoint or min. outdoor air requirement



Managing IEQ During Construction

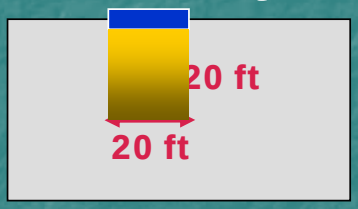
- Material Storage and Protection
- Ventilation During Construction
- Dust Control
- Material Selection
- Testing & Commissioning
- “Off-gassing” Prior to Occupancy

Construction IAQ Management: CEQ Cr 3.2 - Before Occupancy

- **Option 1:** Flush out per specified criteria
  - 4,300 m^3 of outdoor air per m^2 while maintaining T > 15 C and RH < 60%
  - Can start occupancy earlier, but must maintain specified O.A. flows
- **Option 2:** Air testing (added flush out if needed)
  - Formaldehyde, PM10, total VOC, 4-PCH and CO

IEQ: Thermal Controllability

- ***"Provide individual comfort controls for 50% (minimum) of the building occupants ..."***
  - Operable windows count if:



And

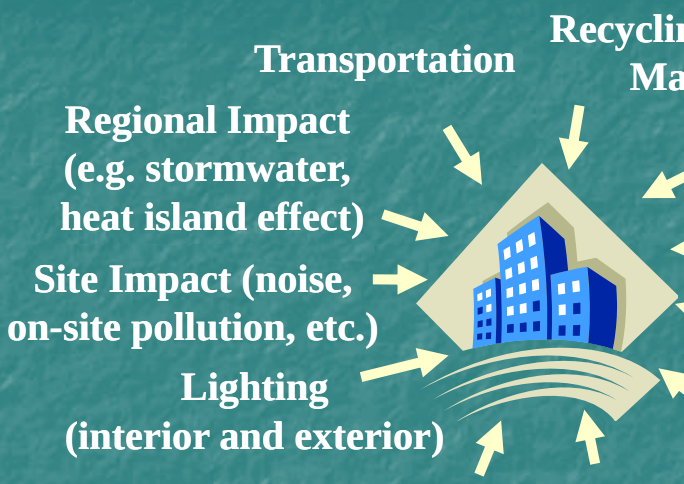
- ***"Provide comfort system controls for all shared multi-occupant spaces to enable adjustments to suit group needs and preferences"***

IEQ: Thermal Comfort

- **Cr 7.1: Design**
  Meet ASHRAE Standard 55-2004 and demonstrate compliance
- **Cr. 7.2: Verification**
  Survey occupants 6 to 18 months after occupancy begins;
  Agree to corrective action plan if >20% dissatisfied, plus measurement of performance in problems areas of building

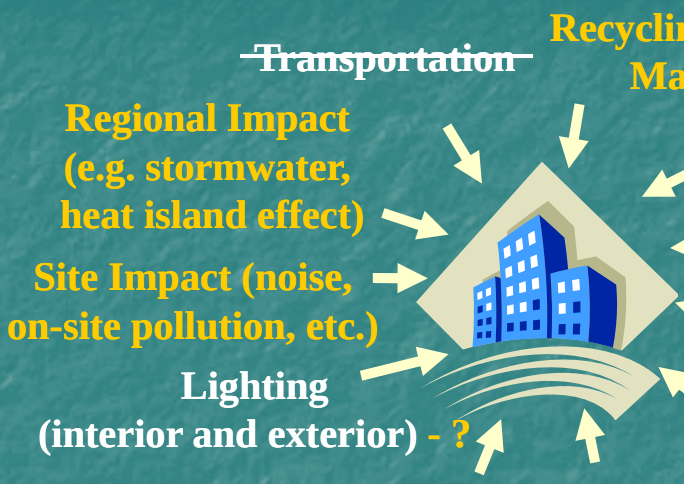
How HVAC Affects a Building's "Greenness"?

Issues Involved in Green Buildings



How many of these might ASHRAE members be involved with?

Issues Involved

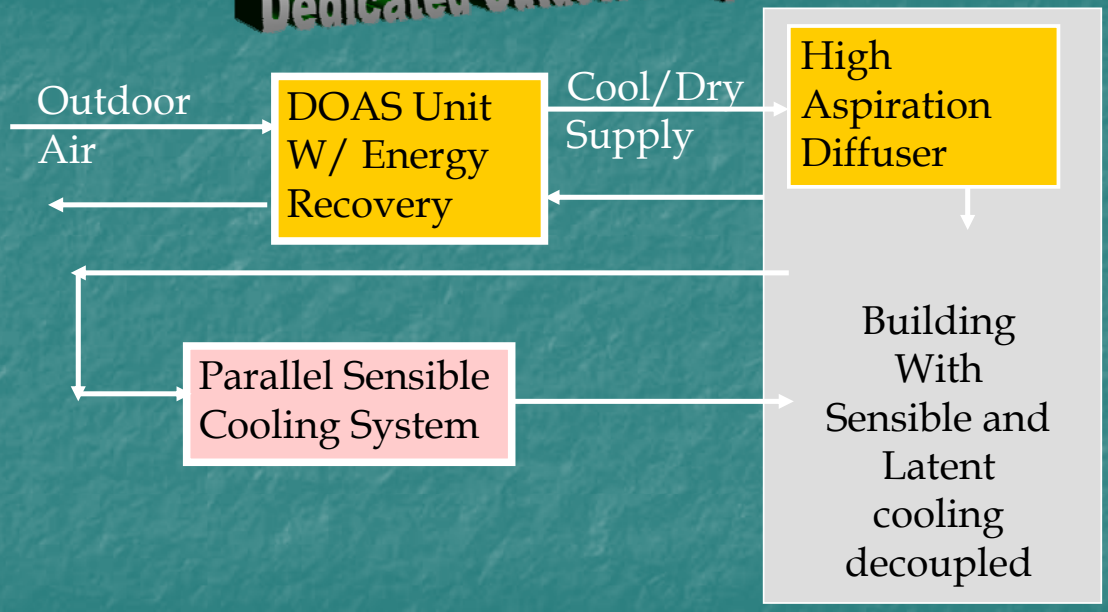


Surprise, possibly a lot of them!

Example Technology Areas for Focus and Current Trends

- **Ventilation methods:**
  - Dedicated Outdoor Air Systems (DOAS)
  - Displacement, Underfloor ventilation
  - Demand-controlled
- Peak load reduction
- Water conservation and reuse
- Solar hot water
- Integrated design process
- Part-load design focus

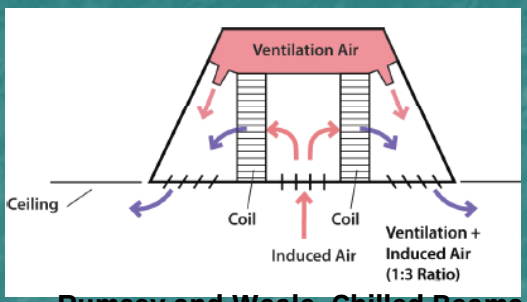
Green Tip #11: Dedicated Outdoor Air Systems



Source: Stanley A. Mumma, Ph.D., P.E. Fellow ASHRAE

Parallel Sensible System Options

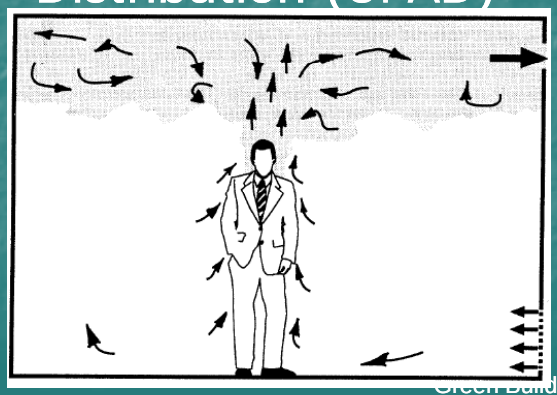
- Options
  - Fan coil units
  - Other DX system
  - Chilled beams
    - Passive – Natural convection cooling 'fin tube'
    - Active – Outlet for ventilation air as well
    - Multi-mode – Also lighting, fire protection, etc.
  - Radiant floor



Rumsey and Weale, Chilled Beams in Labs, ASHRAE Journal, Jan 2007

Green Tip #10: Displacement Ventilation

- Works well in school classroom, lecture hall, auditorium, large open area
- Not exactly the same as Underfloor Air Distribution (UFAD)



Underfloor Air Distribution

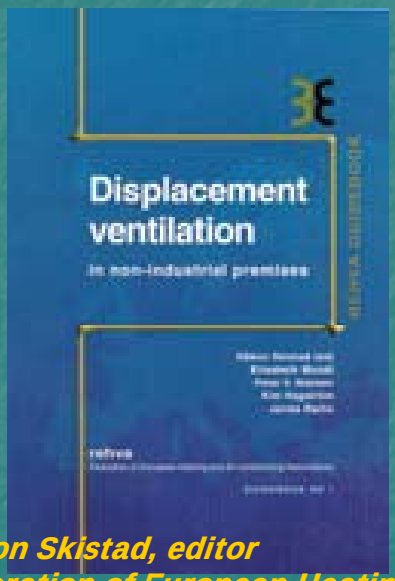
- Raised Floor as Supply Air Plenum
- Deliver 65º F (18 C) Supply Air
- Every Workstation has Control
- Air Volumes and Pressures Reduced
  - Convection is Working With Air Flow
  - Displacement Ventilation Concept
  - Improved Acoustics
- Improved IAQ
- Reduced HVAC Energy

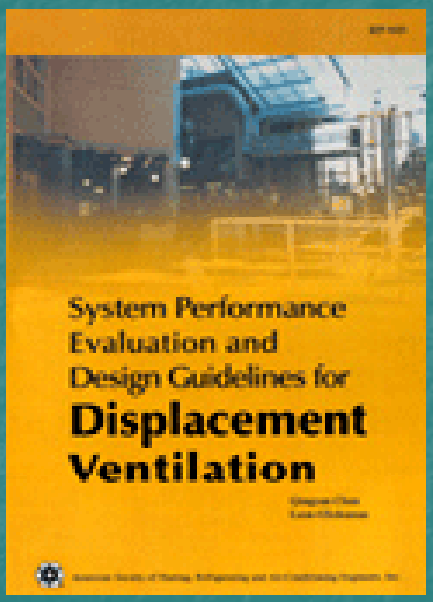




Displacement Ventilation

- Other resources





Håkon Skistad, editor
Federation of European Heating and Air-conditioning Associations Guidebook 1

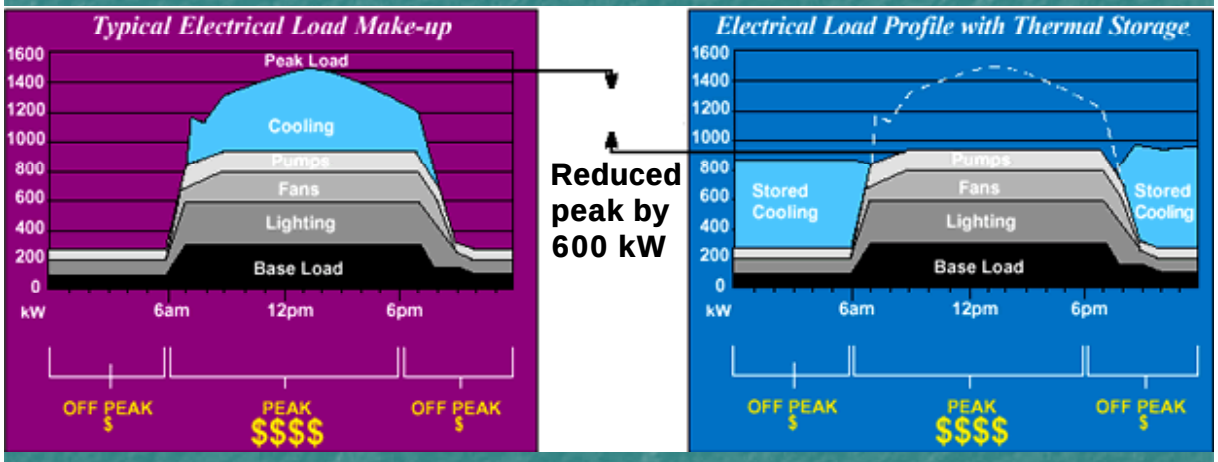
Example Technology Areas for Focus and Current Trends

- Ventilation methods:
  - Dedicated Outdoor Air Systems (DOAS)
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  - Demand-controlled
- **Peak load reduction**
- Water conservation and reuse
- Solar hot water
- Integrated design process
- Part-load design focus

Peak Load Reduction

- Reducing peak power demand is beneficial to the environment (and can significantly reduce energy costs)
- First step: Reduce overall load
- Thermal energy storage

ASHRAE GreenGuide Green Tip #22: Cooling Thermal Energy Storage



Green Tip #22: Cooling Thermal Energy Storage

Pro:

- ↓ chiller size
- More optimal chiller operation (high load factor)
- ↓ environmental impact
- Electric grid

Con:

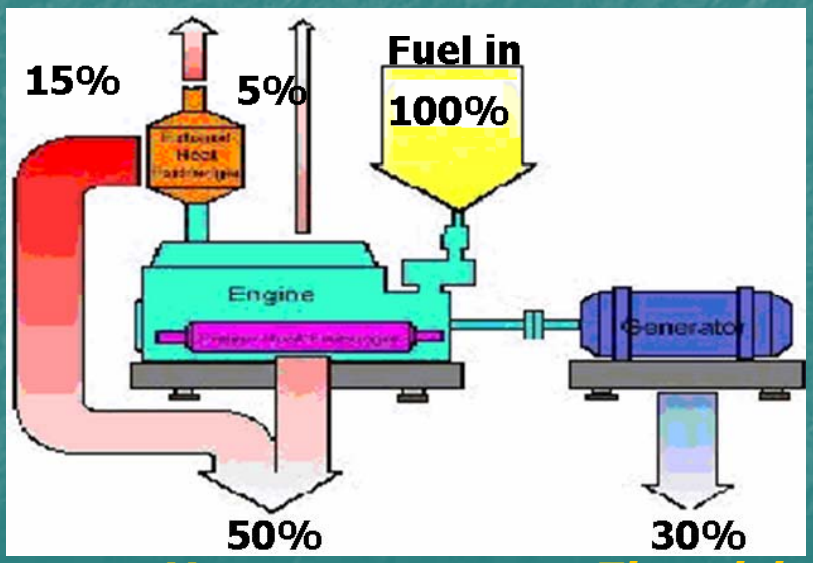
- Net first cost?
- Engineering design
- Space
- Operations and controls

Is total energy use more or less?

Cooling (Combined) Heat and Power (CHP)

- On-site electricity generation
- Waste heat used for building heating or cooling using absorption system
- Fuel utilization efficiency up to 80% (compare to ~40% for typical thermal electric generation plant)

Green Tip #16: CHP Systems



Heat *Electricity*

Example Technology Areas for Focus and Current Trends

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Example of Reuse

- Coverdell Veterinary Research building, UGA campus



Completed summer 2005, Cx summer, fall 2005 along with initial occupancy, dedicated by George Bush (Sr.) spring 2006

Coverdell Water Conservation

"Inputs"

- Roof rainwater collection
- AHU condensate collection
- Building perimeter sump water collection

"Outputs"

- Toilet flushing
- Cooling tower makeup

Condensate Water Collected
≈ 750,000 gallons per year
[2,850 m³ per year]
(not including rain, sumps)

Incremental additional cost
≈ $300,000 USD

Issues

Not so good

- Condensation on outside of downspout pipes

Good

- Integrated well with 'normal' city water supply
- Also, see IPC App. C (C102.4) requires coloring of water



Alternate Simpler Way to Reuse Condensate

- Direct drain from AHU to cooling tower sump





Example Technology Areas for Focus and Current Trends

- Ventilation methods:
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- **Solar hot water**
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Solar Hot Water: A Lost Art?

- A proven technology from decades ago, but in U.S. has been largely forgotten...

Potential Applications

- Hotels
- Dorms
- Pools
- Housing complex

among others



Univ. of South Carolina, West Quad Dorm

45% less energy than traditional dorm

Green Buildings Overview, Standard 189 - 53

One Way ...

66 beer bottles = one cheap rooftop solar water heater

By David Biello

Take 66 beer bottles. Fill them with water and connect so that it flows slowly from bottle to bottle. Place apparatus on roof (or better yet, build it in place) and voila, you have the ultimate in DIY solar thermal hot water systems. Not only do you get the pleasure of consuming 66 bottles of beer on the way, you also get the joy of providing hot water for your mother to shower in comfort.

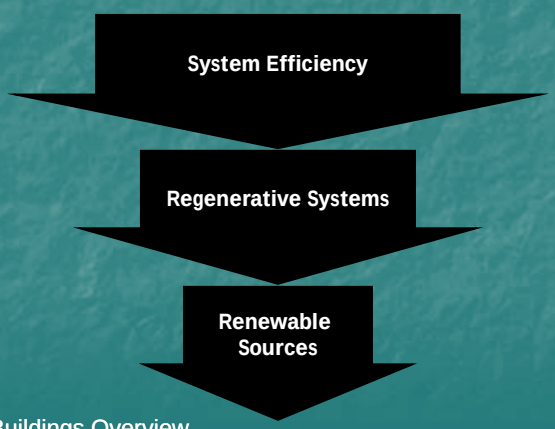


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- Solar hot water
- **Integrated design process**
- Part-load design focus

Integrated Design (IBD)

- 'Business as usual' does not result in optimized building design
- Designing whole building as an integrated set of systems



What is Integrated Building Design?

- *ASHRAE Technical Committee 7.01 – Integrated Building Design*

  "Interaction among all building disciplines, from earliest concept development throughout the building life cycle, in order to achieve integration of design efforts and operation of the total building."

Conventional Design Process

- A sequential process of response
  - Owner defines site
  - Architect works alone with Owner to develop program
  - Architect defines
    - Massing
    - Orientation
    - Layout
    - Building envelope
  - Engineers turned loose
    - Make it work
    - Stay within budget → **Design**, **Capital Cost**

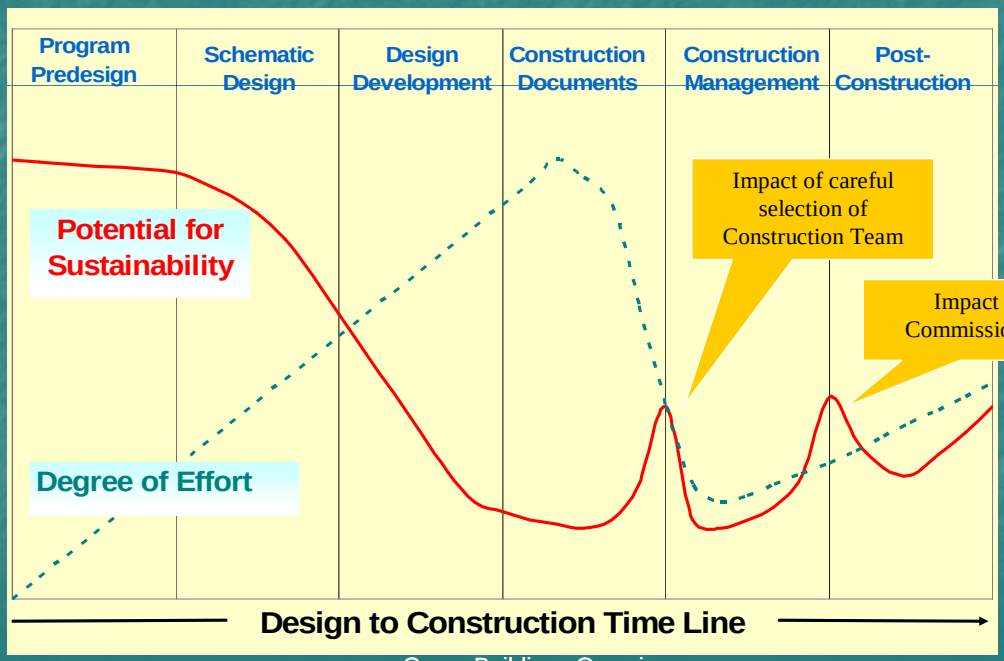
Defining IBD

- Integrated Design
  - The TEAM works collaboratively to develop all aspects of the design
  - Solutions are based on optimization of the whole



  - TEAM members work together

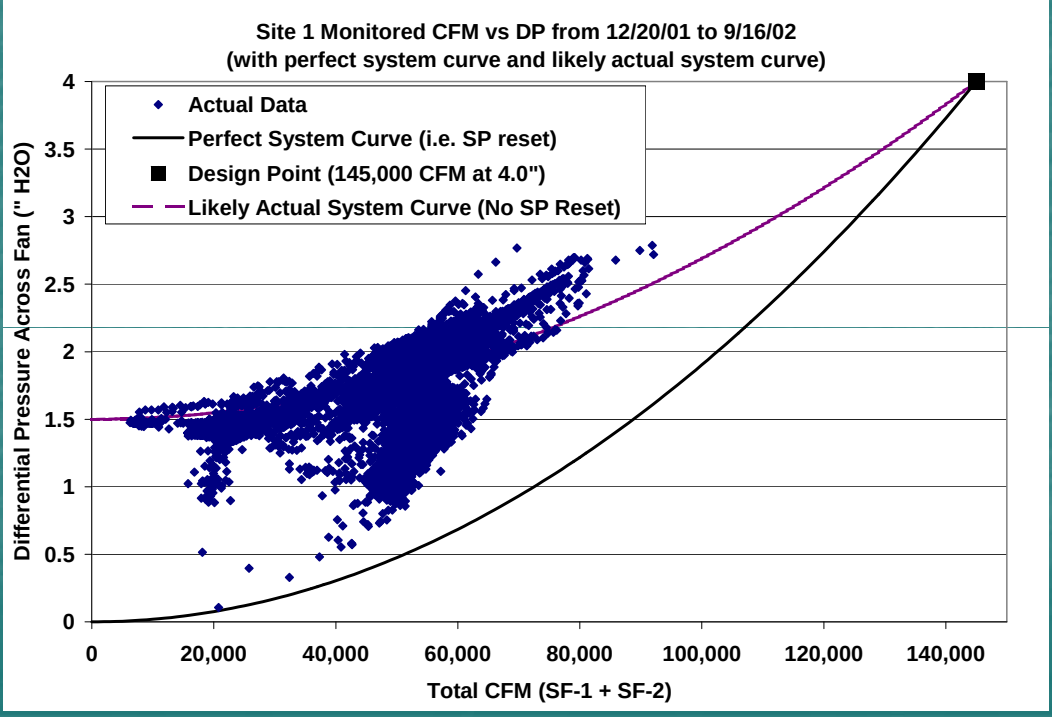
Potential Impact on Sustainability



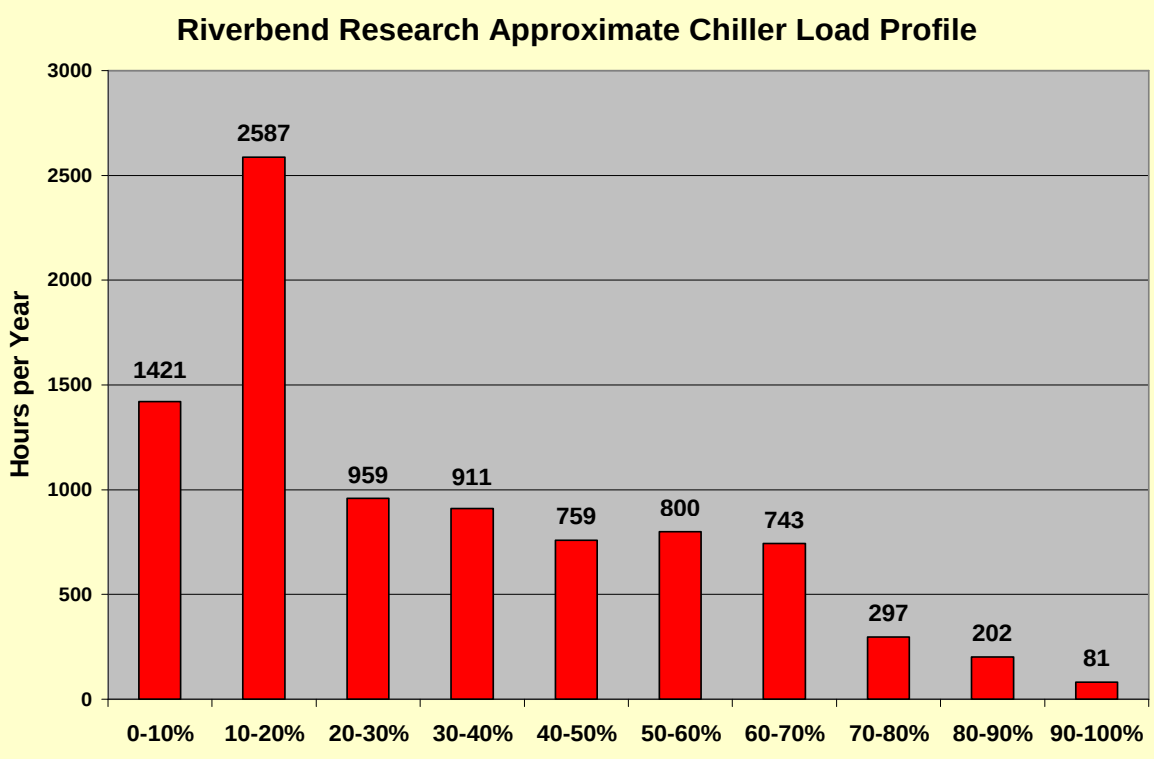
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- **Part-load design focus**

Risk and part load (CEC VAV Design Guide)



Optimize for Actual Chiller Load Profile



ASHRAE's Response

Who Said This?

"Overshadowing everything else is the question of conservation of natural resources. For how much longer are we going to waste ... resources to save first-cost only of buildings?"

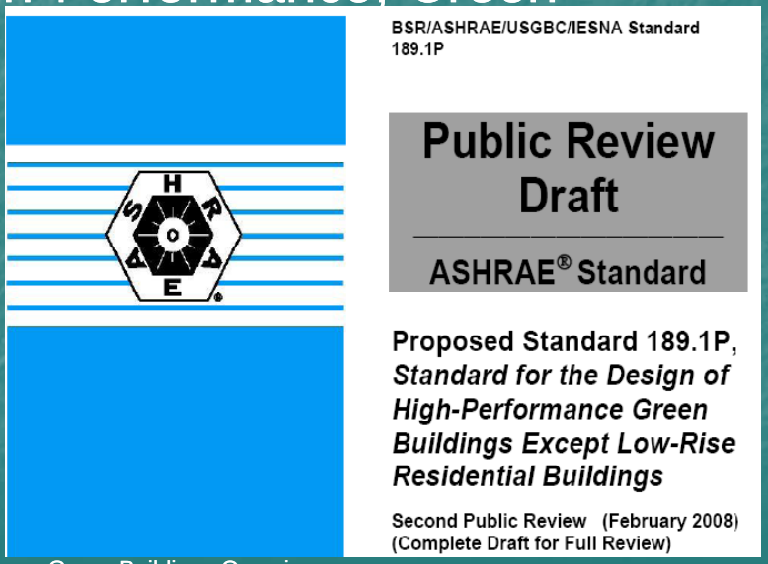
S.R. Lewis, President ASHVE, 1914

ASHRAE's Response

- Technical Committees (2.8, others)
- New proposed Standard 189 *"High Performance Green Buildings"*
- New proposed Standard 191 on water use
- ASHRAE Policy for Energy Use Intensity
- ASHRAE Climate Change Policy statement
- Advanced Energy Design Guides
- The GreenGuide

ASHRAE Standard 189.1

- Overview of proposed ASHRAE Standard 189.1 for "High-Performance, Green Buildings"
  - What is it?
  - Why have it?
  - Status
  - Highlights



ASHRAE's More Active Role in Sustainable Design

- Sustainability Policy

Strategic Plan

Strategic Plan Directives

- ASHRAE will lead the advancement of sustainable building design and operations.
- ASHRAE will be a world-class provider of education and certification programs.
- ASHRAE will position itself as premier provider of HVAC&R expertise.
- ASHRAE will be a global leader in the HVAC&R community.

Standard 189.1: Intent

- What Standard 189.1 is:
  - a standard
  - applies to all buildings except low-rise residential buildings (same as ASHRAE Std 90.1)
  - intended for adoption into model building codes
- What Standard 189.1 is not:
  - not a design guide
  - not a rating system

Even if not adopted by local authorities, this Standard is an indication of future trends

Standard 189.1: Intent

- Intended to be used in conjunction with ASHRAE Standards 90.1-2007, 62.1-2007 and 55-2004







Why is this Needed?

- Localities are beginning to adopt “green building” as a requirement
  - LEED certification (to some level)
  - Others are more vague
- Intended to fill a gap in evolving building codes
- ASHRAE partnership with USGBC, IESNA, and will be submitted for ANSI approval

Organization and What it Covers

- Similar to LEED and other ASHRAE standards

ASHRAE/USGBC/IESNA Standard 189.1,
Standard for High-Performance Green Buildings
Except Low-Rise Residential Buildings

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- **Mandatory**
- **Prescriptive**
- **Performance**

Section 2 - Purpose

"The purpose of this standard is to provide minimum requirements for the ***siting, design, and construction (including plans for operation)*** of high performance, green buildings to:

(a) ***balance*** environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity, and

(b) support the goal of development that ***meets the needs of the present without compromising*** the ability of future generations to meet their own needs."

Section 2 - Scope

- Provides minimum criteria that:

  (a) Apply to **new buildings and major renovation projects** (new portions or new systems).

  (b) Addresses site sustainability, water and energy efficiency, IEQ the building's impact on the atmosphere, materials and resources.

- **Does not apply to:**

  (a) single-family residential, multi-family <3 stories, manufactured houses (mobile or modular homes);

  (b) buildings that do not use electricity, fossil fuel or water.

Progress and Status

- 1st Draft created: June 2006 – April 2007
- 45-Day public review period May-July '07
  - 964 total comments received
- 189.1 committee met in Aug and Oct to work through the comments

- **2nd public review schedule**
  - Feb. 22 – April 7, 2008: 2nd public review
  - May 2008 – committee begins to review comments
  - Fall 2008 Final Changes for review

Goals for Standard 189.1

- **Establish mandatory criteria in all topical areas**:
  - one 'problem' with existing rating systems is that they contain few mandatory provisions
  - avoids claims about a 'green building', but still making **no** improvements in some areas
- **Provide simple compliance options:**
  - another critique of existing rating systems is the need for extensive calculations (e.g. energy)
- **Complement green building rating programs:**
  - Std 189.1 is **not** intended to compete with green building rating programs

Sponsors and Project Committee

- Consensus process
- Sponsor and co-sponsors:
  - ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)
  - USGBC (U.S. Green Building Council)
  - IESNA (Illuminating Engineering Society of North America
- Project committee:
  22 voting members;
  variety of disciplines,
  industries & organizations



Challenges

- Using normative (code) language
- Determining the stringency for a "minimum" standard
- Identifying standards or regulations to cite *(could not reference guidelines)*
- Prescribing universal strategies *(requirements for all, not a menu)*
- Coordination with other initiatives
- Creating something that is enforceable

Potential Users of Std. 189.1

- Organizations with green building rating systems (LEED, Green Building Initiative)
- **Developers:** individual projects
- **Corporations:** corporate owned
- **Universities:** campus buildings
- **States / provinces / municipalities:**
  - their own buildings
  - basis for incentives
  - private construction, through reference in local codes

Standard 189.1 Basic Structure

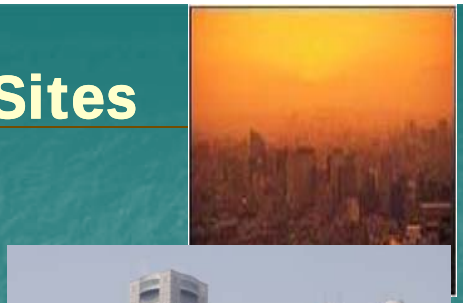
- x.1: Scope
- x.2: Compliance
- x.3: Mandatory
  (required for all projects)
- x.4: Prescriptive **option**
  (simple option, minimal choices, very few calculations)
- x.5: Performance **option**
  (more sophisticated, flexibility, but more effort)

Highlights of Standard 189.1

Chapter 5 - Sites:

- **Discourages unmitigated sprawl**
- **Prohibited development activity**
  - Flood plains, wetlands, fish and wildlife habitat
- **Other areas that are addressed:**
  - Amount of impervious surface area *[max of 60% of total site to be impervious]*
  - Urban heat island *[shaded or higher solar reflective index materials]*
  - Light "pollution" limitations

Sustainable Sites



Mandatory Provisions

- **Heat island effect**
  - Site hardscape:
    to be shaded, be SRI 29, or porous pavers
  - Wall:
    to be shaded up to 20 feet above grade
  - Roofs:
    Solar Reflective Index, or green or cool roof



Sustainable Sites

Mandatory Provisions

- **Reduction of light pollution**
  - Outdoor lighting trespass:
    limits on horizontal and vertical lux



Sustainable Sites

Prescriptive / Performance Options

- **Site development**
  - All sites: Min. 40% of area to be effective pervious surface (vegetation, green roof, porous pavers)
  - Greenfield sites: Min. 20% of area native or adapted plants



Green Buildings Overview,
Standard 189 - 85

Chapter 6 – Water Use Efficiency

Mandatory Provisions

- **Site water use**: bio-diverse plantings, hydrozoning, & smart irrigation controllers



Green Buildings Overview,
Standard 189 - 86

Chapter 6 – Water Use Efficiency



Mandatory Provisions

- **Building water use**: plumbing fixtures & fittings, appliances, HVAC systems & equipment, generally 20% lower than U.S. EPAct criteria (when possible)
- **Metering**: meters, meter data collection, data storage & retrieval



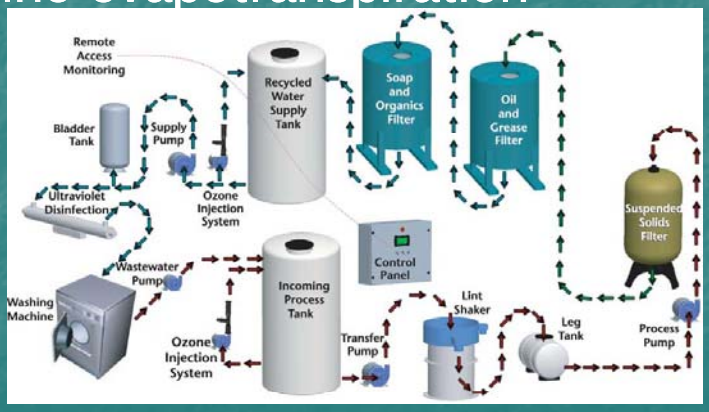
Chapter 6 – Water Use Efficiency

- Exterior
  - Minimize need through plant selection
  - Smart (evapotranspiration) controllers
- Interior – *Energy Star* and other standards
- No "once through" cooling for HVAC
- 5 cycles for cooling tower water (or specified minimum water concentration)
- Metering installed for monitoring during operation

Chapter 6 – Water Use Efficiency

Performance Option

- **Site water use reduction**: proposed potable water for irrigation < 35% of baseline evapotranspiration
- **Building use**:



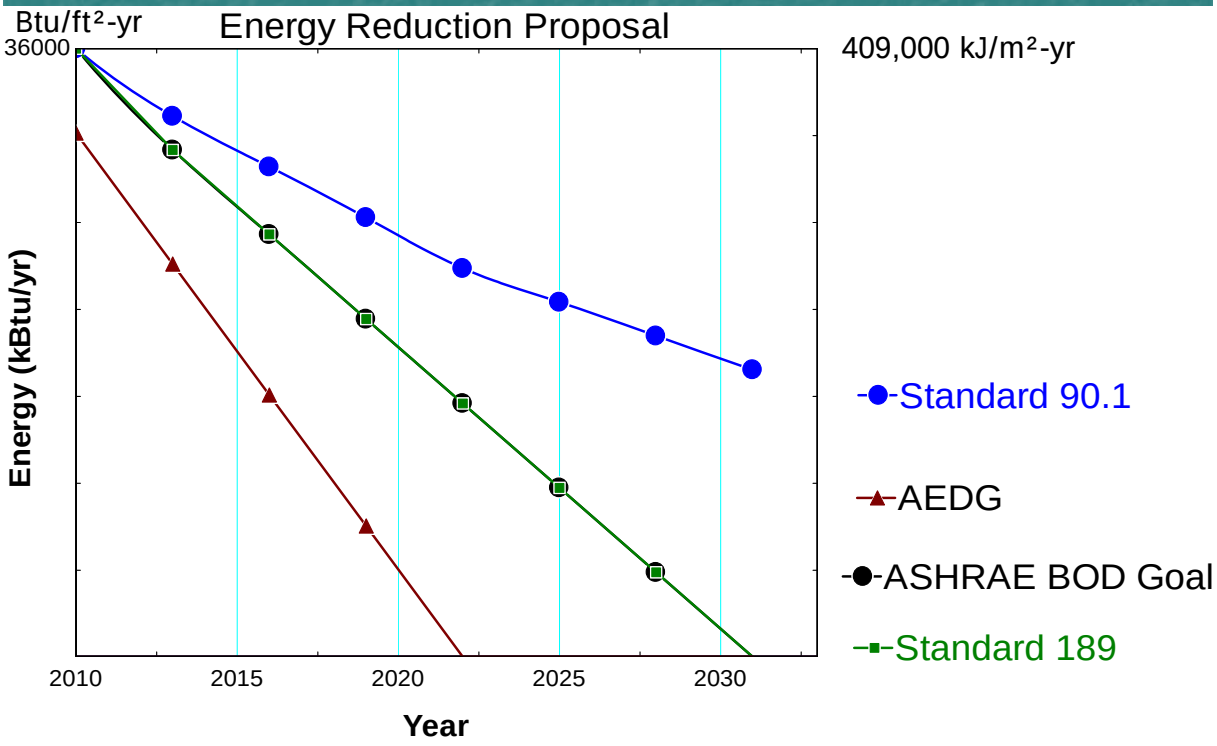
Proposed use < [mandatory+ prescriptive]

Highlights for Energy (Chapter 7)

Energy - General:

- Goal is 30% less than Standard 90.1-2007 ***INCLUDING PROCESS LOADS***
- Appendix G from Standard 90.1 is incorporated as a Normative Appendix
- Metering for verification
- Peak load reduction
- Other areas increase stringency beyond Standard 90.1

ASHRAE Energy Goals



Highlights for Energy (Chapter 7)

- **Mandatory Requirements:**
  - "Energy Star" rated equipment and appliances
  - **On-site renewable power**
    peak electrical generation
    1% of service load
  - Exception allowed is *100%*
    solar hot water heating, **OR**
    by combined 10% improvement
    in energy and CO_{2e}





the *service overcurrent protection device rating*. The rating of the *on-site renewable energy power system* shall be the nameplate rating in kVA (dc).

Highlights for Energy (Chapter 7)

Energy – Mandatory continued:

- Submetering for monitoring & verification

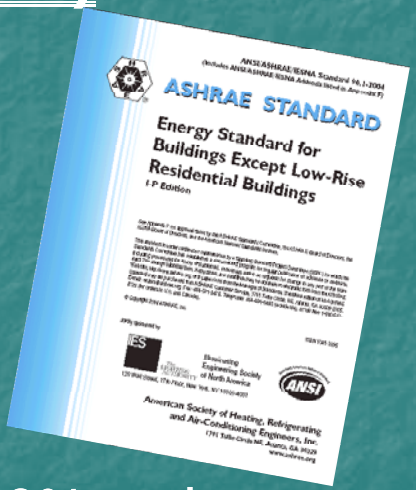
Table 7.3.3-2 Component Energy Metering Thresholds

Component	Sub-Metering Threshold
Chillers/heat pumps	> 70 kW (240,000 Btu/h) cooling capacity
Packaged AC units	> 70 kW (240,000 Btu/h) cooling
Fans	> 15 kW (20 hp)
Pumps	> 15 kW (20 hp)
Cooling towers	> 15 kW (20 hp)
Boilers and other heating equipment	> 300 kW (1,000,000 Btu/h) input
General lighting circuits	> 100 kVA
Miscellaneous electric loads	> 100 kVA

Highlights for Energy (Chapter 7)

Prescriptive Option (General)

- Maximum size limits for individual dwelling units



- Comply with ASHRAE/IESNA Standard 90.1-2007 plus...30% savings

Highlights for Energy (Chapter 7)

Prescriptive Option (Continued)

- Prescriptive Option:
  - Lower lighting power density (90%), expand occupancy sensor control
  - Increased requirement for economizers and variable speed controls

Climate Zones	Cooling Capacity for Which an Economizer is Required
1A, 1B, 2A	No Economizer Requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥ 9.7 kW (33,000 Btu/h)[a]

  - SHGC , East & West window area combination limits for climate zones 1-4 (west only in 5-6)

Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- Generally increased insulation required for roof elements, walls (adds continuous req't)

Example:
Climate zone 3 **Std 90.1 Std 189.1**
Insulation above deck R-2.6 ➔ R-4.4

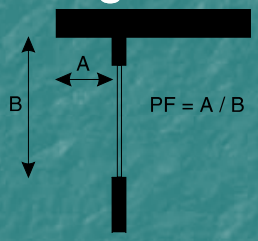
- More stringent SHGC

Example for 10-40% window area:
Climate zone 5
Std. 90.1: 0.39 (0.49 north)
Std. 189.1: 0.35 all orientations

Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- Overhang: PF > 0.5



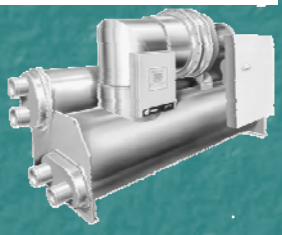


- Orientation: solar gain through east/west < north/south
- Continuous air barrier

Highlights for Energy (Chapter 7)

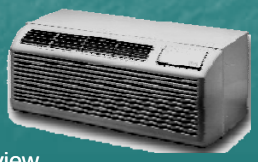
Prescriptive Option (Mechanical)

- Higher equipment efficiencies





- More pipe/duct insulation
- Fan power allowance 10% less
- Unoccupied hotel/motel rooms to have auto-shutoff



Highlights for Energy (Chapter 7)

Prescriptive Option (Lighting)

- Interior lighting power to be 10% less than ASHRAE Standard 90.1
- Occupancy sensor controls
- Auto-controls for lighting in daylight zones



Highlights for Energy (Chapter 7)

Prescriptive Option (continued):

- Expand requirements for ventilation energy recovery; based on climate zone and flow

Zone	% Outside Air at full design L/s							
	≥10% and < 20%	≥20 and <30%	≥30% and < 40%	≥40% and < 50%	≥50% and < 60%	≥60% and < 70%	≥70% and < 80%	≥80%
	Design Supply Fan L/s							
2B,3B,3C,4B,4C,5B	NR	NR	NR	>7800	>4500	>2600	>2100	>1900
3A,4A	>5200	>3300	>2600	>2100	>1900	>1700	>900	>500
1A,2A, 5A, 6A, 6B	>2400	>2100	>1900	>1700	>1200	>700	>0	>0
7,8	>900	>0	>0	>0	>0	>0	>0	>0

Highlights for Energy (Chapter 7)

Performance Based Option:

- Demonstrated equivalent performance in **both** ***energy*** and ***CO_2 equivalent*** compared to if using the Prescriptive path



Proposed ≤ Mandatory + Prescriptive Path

Using Appendix D "Performance Option for Energy Efficiency"

Green Buildings Overview,
Standard 189 - 101

Energy: Environmental

Energy generation emissions factors:

Table 7.5.3: CO_2e Emission Factors

Building Project Energy Source	CO_2e kg/kWh (lb/kWh)
Grid delivered electricity and other fuels not specified in this table	0.758 (1.670)
LPG or propane	0.274 (0.602)
Fuel oil (residual)	0.312 (0.686)
Fuel oil (distillate)	0.279 (0.614)
Coal (except lignite)	0.373 (0.822)
Coal (lignite)	0.583 (1.287)
Gasoline	0.309 (0.681)
Natural gas	0.232 (0.510)

NREL National Renewable Energy Laboratory
Innovation for Our Energy Future

Source Energy and Emission Factors for Energy Use in Buildings

M. Deru and P. Torcellini

Technical Report
NREL/TP-550-38617
Revised June 2007

ew,

Indoor Environmental Quality (Ch 8)



Indoor Environmental Quality:

- Mandatory:
  - ***1.3 times Standard 62.1-2004 outdoor airflow for offices and classrooms (climate zone exceptions)***
  - CO_2 monitoring for systems serving densely occupied spaces (lower threshold for *densely occupied*) ***Table for action levels***
  - Outdoor airflow monitoring - non-densely occupied spaces



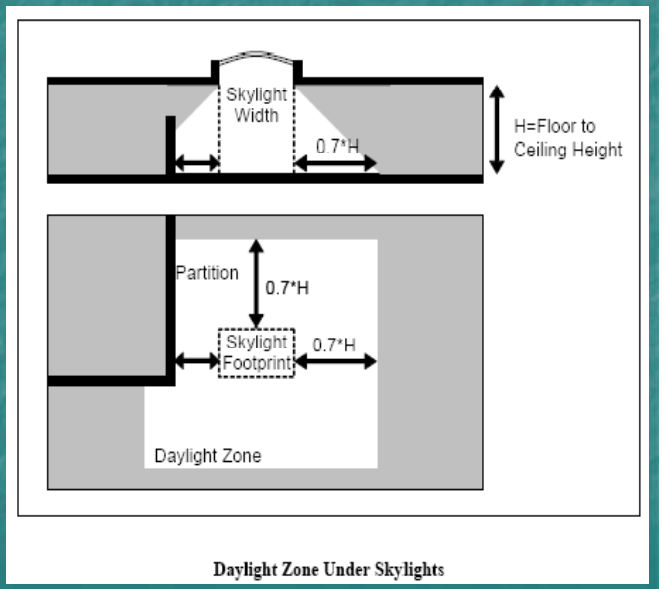
CO_2 Action Levels

Ventilation per Person cfm	Actual Δ Concentration (ppm) MET=1.0	MET=1.2	MET=1.5	Action Level Δ Concentration (ppm) MET=1.0	MET=1.2	MET=1.5
5	1,680	2,000	2,520	1,800	2,200	2,600
6	1,400	1,667	2,100	1,500	1,800	2,200
7	1,200	1,429	1,800	1,300	1,600	1,900
8	1,050	1,250	1,575	1,200	1,400	1,700
9	933	1,111	1,400	1,100	1,300	1,500
10	840	1,000	1,260	1,000	1,100	1,400
11	764	909	1,145	900	1,100	1,300
12	700	833	1,050	800	1,000	1,200
13	646	769	969	800	900	1,100
14	600	714	900	700	900	1,000
15	560	667	840	700	800	1,000
16	525	625	788	700	800	900
17	494	588	741	600	700	900
18	467	556	700	600	700	800
19	442	526	663	600	700	800
20	420	500	630	600	700	800
21	400	476	600	500	600	700
22	382	455	573	500	600	700
23	365	435	548	500	600	700
24	350	417	525	500	600	700
25	336	400	504	500	600	600
26 or more	323	388	485	500	600	600

Indoor Environmental Quality (Ch 8)

- Mandatory:
  - Daylighting by toplighting for large open spaces

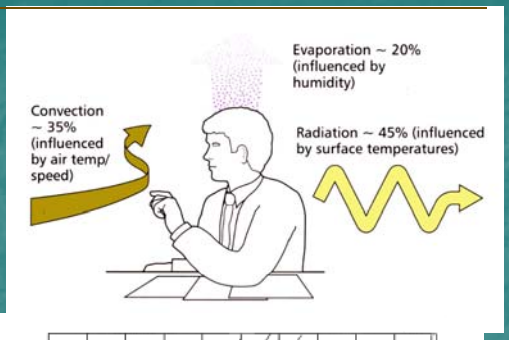


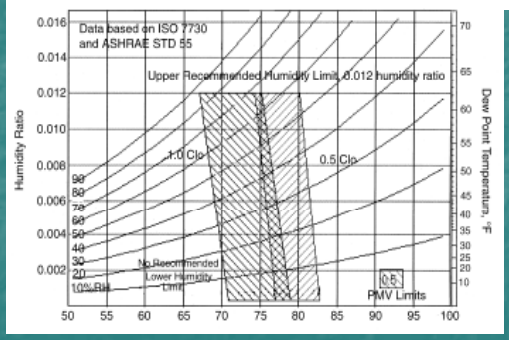


Daylight Zone Under Skylights

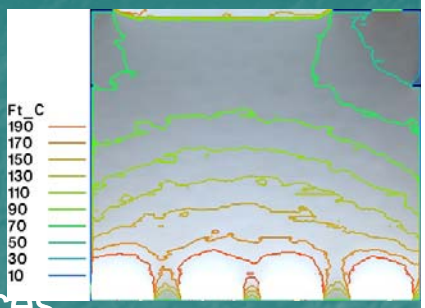
Indoor Environmental Quality (Ch 8)

- Mandatory:
- Thermal Comfort
  - Comply with ASHRAE Std 55
- Mat systems at building entrances





Indoor Environmental Quality (Ch 8)



Performance Option:

- Daylighting simulation
  - All regularly occupied spaces
  - Minimum illuminance target: 300 lux (30 fc) on work surfaces, 4.5 m (15 ft) from façade, noon equinox
  - Direct sunlight on workplane < 20% of occupied hours on equinox day
- Modeling to show compliance with CDHS California Section 1350 (low emitting materials)

Materials (Chapter 9)

- Mandatory:
  - CFC refrigerant restrictions
  - ***Divert 50 % of non-hazardous construction waste, demolition debris***
- Prescriptive Option:
  - Minimum 10% recycled content (cost)
  - Regionally Extracted, Processed, & Manufactured Materials
  - Biobased products
- Performance Option:
  - ***Life Cycle Assessment*** per ISO 14044

Highlights of Standard 189.1

Construction, Occupancy, O&M

- Commissioning for projects > 500 m^2
  - HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy
- Addition of monitoring equipment for measurement and verification
  - water, energy and IAQ
  - M&V plans in place

Construction and Operation

Mandatory Provisions

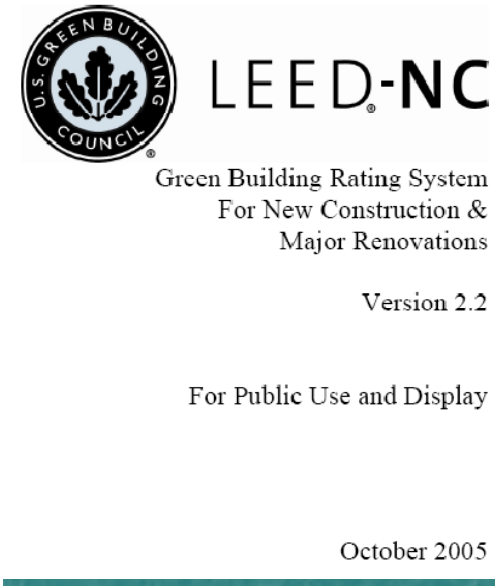
- Construction
  - Minimize idling of construction vehicles
  - Moisture control measures during construction

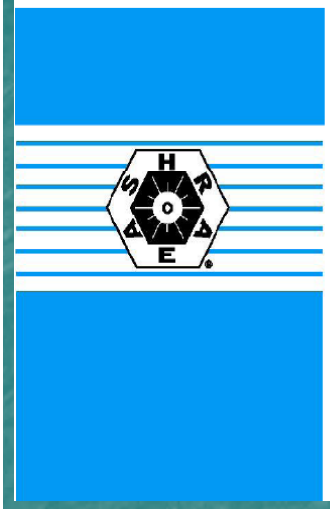


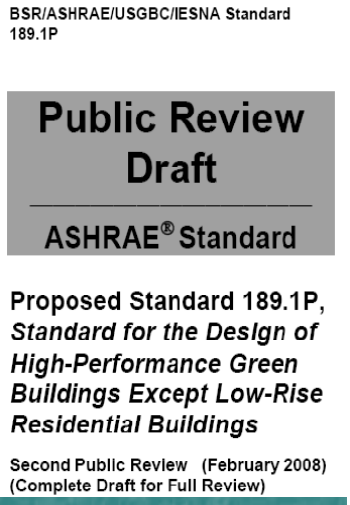
Prescriptive Option - **NONE**

Performance Option - **NONE**

Compare Standard 189.1 to LEED







- Voluntary vs. mandatory
- 189.1 is:
  - More comprehensive
  - Pushes the envelope

FURTHER INFORMATION

- Information on ASHRAE standards: **www.ashrae.org** *then follow "Standards", includes listserv for Standard 189.1*
- Information on USGBC programs: **www.usgbc.org**
- Information on IESNA programs: **www.iesna.org**

Thank you!

- Comments, questions, concerns, advice ...

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