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
- Design technologies focus
- 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”

Is it just as easy as putting up a sign?

Or, do you have to be a "tree hugger"?

- **Every problem is just an opportunity in disguise**

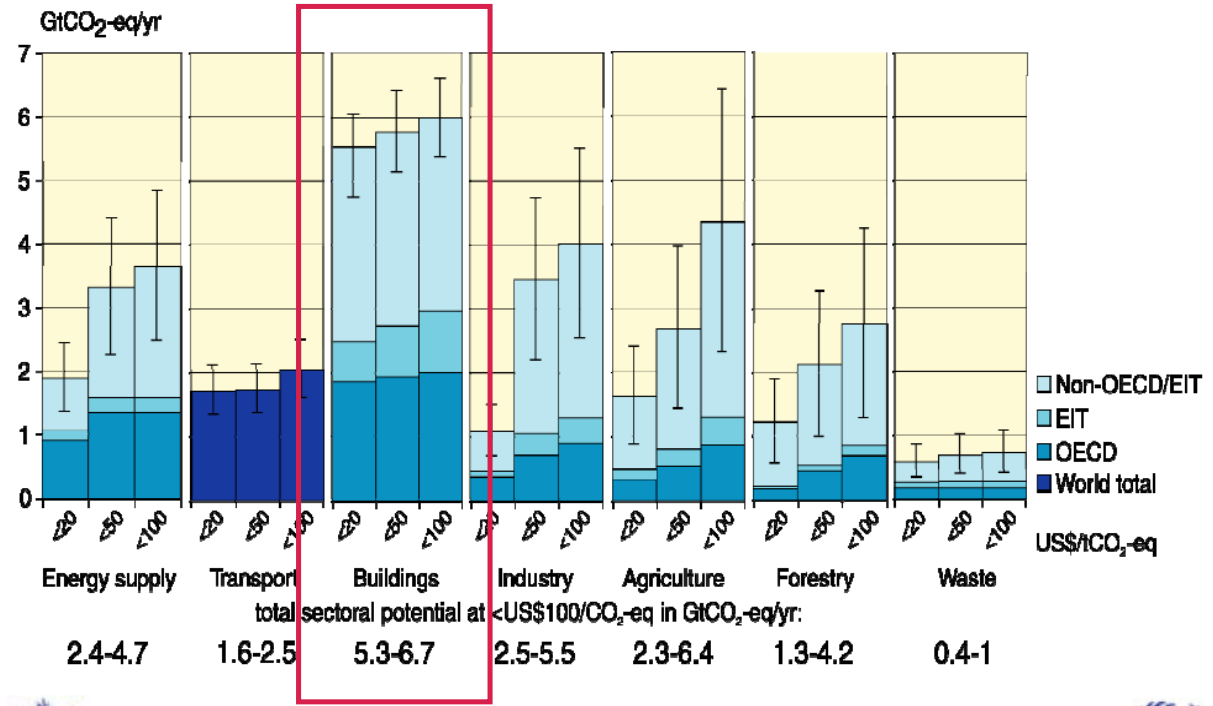
Environmental Impact of Buildings in U.S.*

- 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

Green Buildings Overview,
Standard 189 - 7

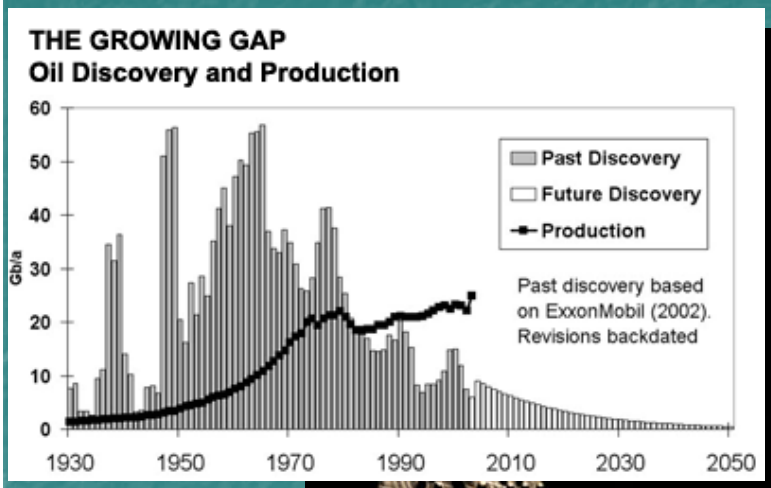
Economic mitigation potential by sector in 2030

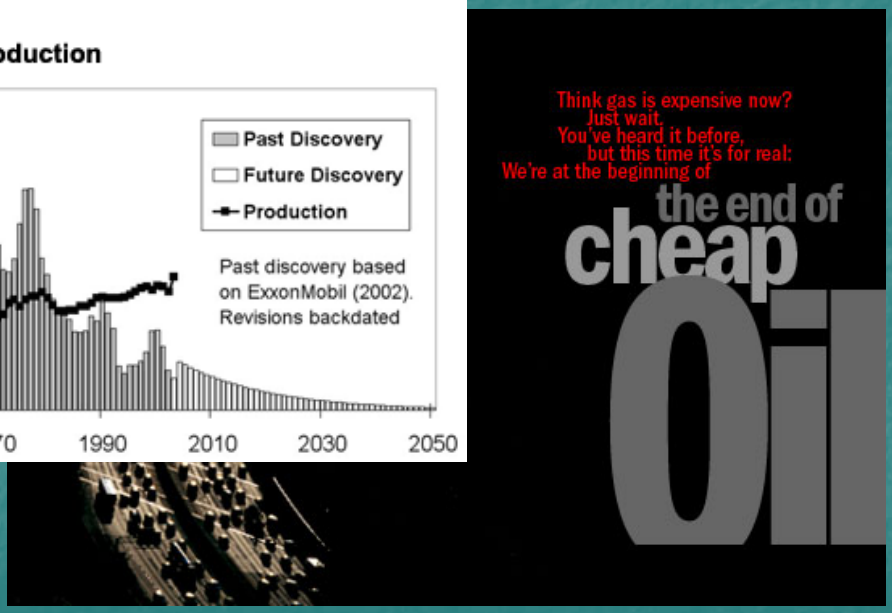


INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

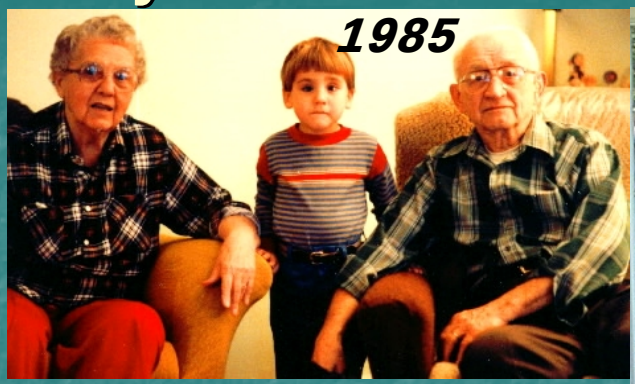
WMO UNEP

Peak Oil and Energy Costs





Why be Green – A Personal Reason



2007

Sustainable Design Examples Worldwide

- *Europe ...*

Swiss Re - London

Sustainable Design Examples Worldwide

- *Asia ...*

Hong Kong Science Park

Note: Building Integrated PV

Sources:
www.metaefficient.com
www.treehugger.com

Sustainable Design Examples Worldwide

- *U.S. …* ***Hearst Tower, New York LEED Gold Rating*** ***2006***

Original, 1920's

Green Buildings Overview, Standard 189 - 13

Are Green Buildings "Mainstream"?

- Is 'Green' only for those who 'have to' (mandated) or those with corporate mission?
- 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*

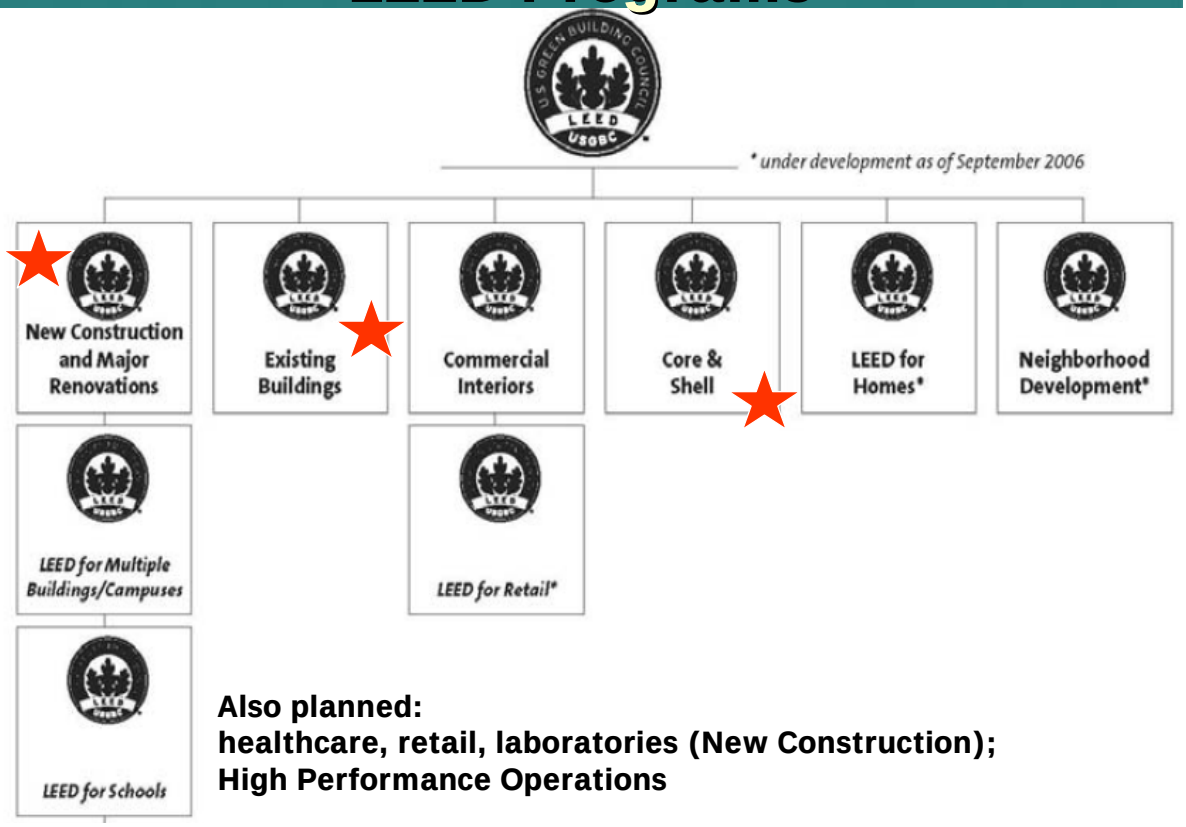
"Real Estate Biz Getting Greener" ***Solar Today***, July 2007

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



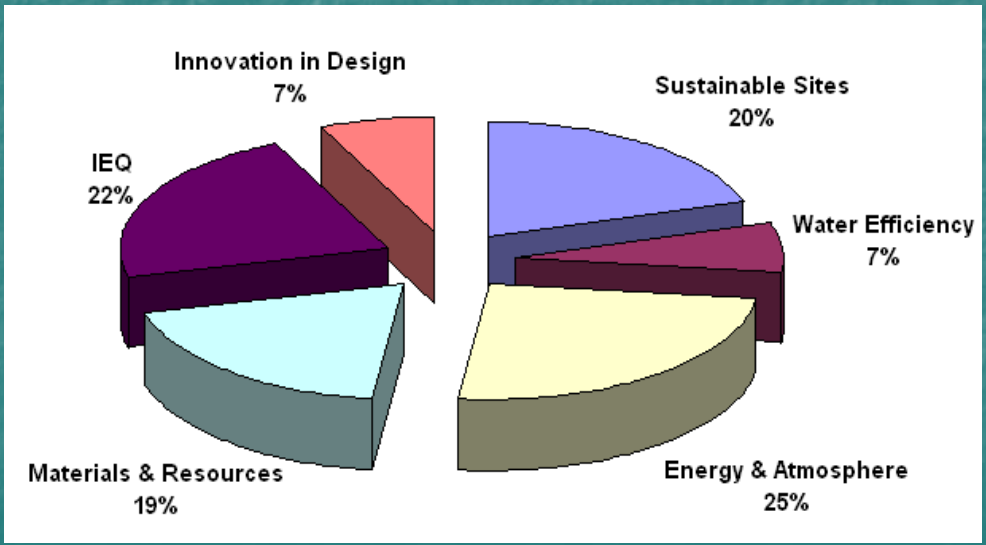
Also planned:
healthcare, retail, laboratories (New Construction);
High Performance Operations

Five Categories - WISER

- **W**ater Efficiency
- **I**ndoor Environmental Quality
- **S**ustainable Sites
- **E**nergy & Atmosphere
- **R**esources & 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

Energy Performance (Cont'd)

- Three options (cont'd)

  (II) Prescriptive measures in ASHRAE's *Adv. Energy Design Guide for Small Office Buildings* **= 4 points**

  (III) Comply with basic criteria [14] (with 3 exceptions) and prescriptive measures [7] in ***Advanced Buildings Benchmark,*** *Version 1.1 , Jan. 2005* from New Buildings Institute www.poweryourdesign.com **= 1 point**

Energy: "Barriers to Implementation"

- Barriers to using high efficiency HVAC equipment are mostly **not** technical

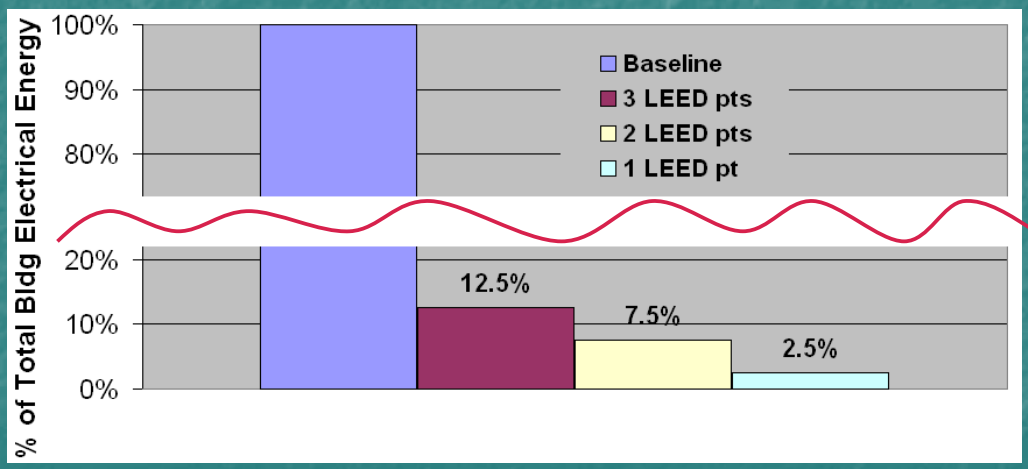

Overcoming
Barriers to Efficiency
By Thomas M. Lawrence, Member ASHRAE, Jeffrey D. Mullen, Douglas S. Noonan, and Jay Enck

ASHRAE Journal, S40:44, Sept. 2005

  - Building ownership
  - Capital constraints, cost amortization
  - Planning horizon
  - Full cost to society not accounted for

EA Credit 2: Renewable Energy

- Must be generated <u>on-site</u>



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

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
  - 14,000 ft^3 of outdoor air per sq. ft. while maintaining T > 60 F and RH < 60%
- **Option 2:** Air testing (added flush out if needed)

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;
  Agree to corrective action plan if >20% dissatisfied

Where are all the LEED projects?

- May 2007: LEED-NC 4,800 total, 600 certified [1]
  Aug 2007: 8,858 total LEED projects [2]
  1,040 certified (12%)

WHY? Project time lag can not explain all of these

- ***Many projects start out with best intentions, but never end up certifying!***

- Common characteristics of successful LEED project
  1. Team buy-in and shift in approach
  2. Team leadership

[1] *J. Yudelson, Env. Design & Construction, July 2007*

[2] *Sustainable Facility, Oct 2007*

To LEED or Not to LEED?

Generalizations:

- LEED primarily intended for the top 25% of the building market
- Green Globes looking for the other 75%
- ASHRAE Standard 189.1 – We'll see ...

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?"

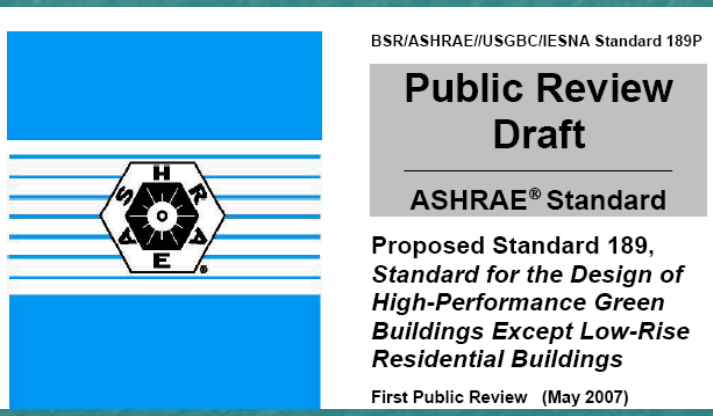
S.R. Lewis, President ASHVE, 1914

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



STANDARD 189.1: Intent

- What Standard 189.1 is:
  - a standard *(title uses the word "green" to convey intent, there is no claim to sustainability)*
    - Intended for adoption into 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

Why is this Needed?

- Localities are beginning to adopt "green building" as a requirement
  - Some use 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,
Standard for High-Performance Green Buildings
Except Low-Rise Residential Buildings

SECTION

Foreword

1 Purpose

2 Scope

3 Definitions, Abbreviations, and Acronyms

4 Administration and Enforcement

5 Sustainable Sites

6 Water Use Efficiency

7 Energy Efficiency

8 The Building's Impact on the Atmosphere, Materials and Resources

9 Indoor Environmental Quality (IEQ)

10 Construction and Operation

11 Normative References

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

Status

- 45-Day public review period May-July
- 964 total comments received
- 189.1 committee met Aug 16-17 and Oct 22-23 to discuss the comments
  Still a work in process
- 2nd public review draft is coming
  - ~March 1 – April 15, 2008: 2nd public review
  - ~May – committee begins to review comments
  - Fall 2008 ASHRAE Standard and ANSI approval

Highlights of Standard 189.1

Energy:

- 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

Highlights of Standard 189.1

Energy (continued):

- Mandatory Requirements:
  - **"Energy Star"** rated equipment and appliances
  - **Communicating submetering** of key systems (criteria based on size)
  - **On-site renewable power systems** with peak electrical generation 1% of service load
  - Exception allowed is 100% solar hot water heating, or generate 2.5% of peak power

Highlights of Standard 189.1

Energy (continued):

- Prescriptive Option:
  - Lower lighting power density, 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]

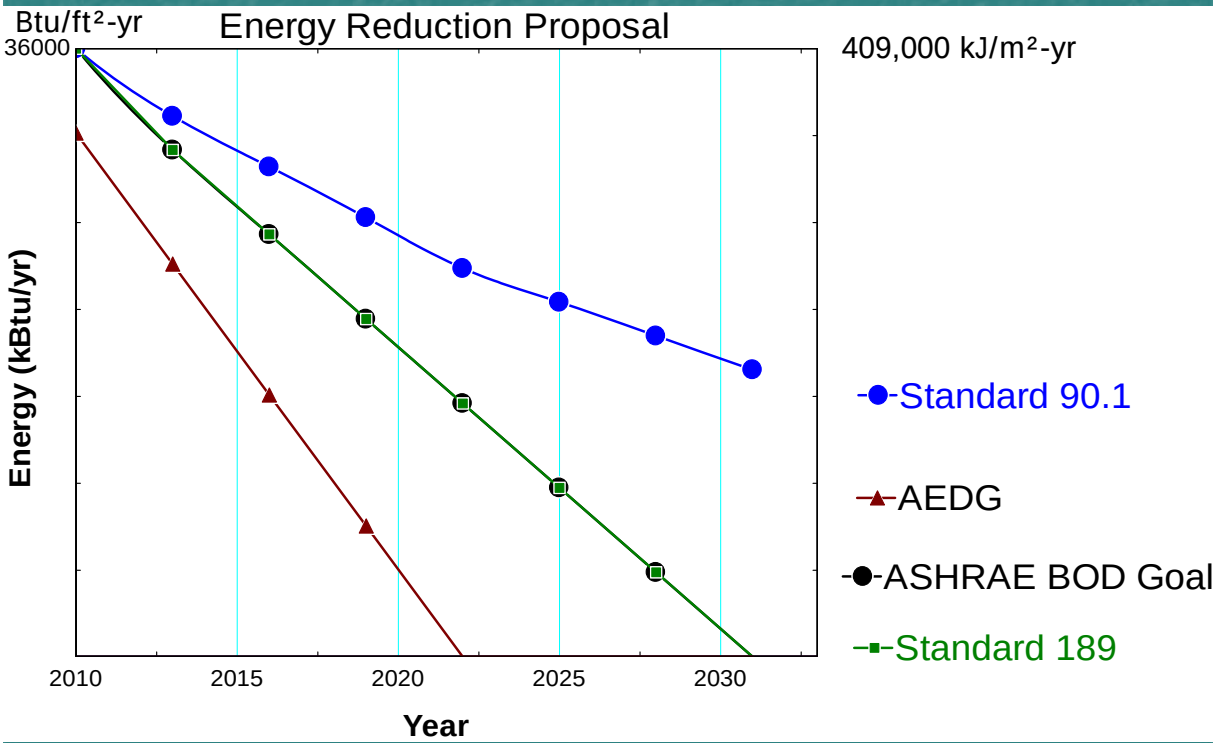
  - SHGC , East & West window area combination limits for climate zones 1-4 (west only in 5-6)

Highlights of Standard 189.1

Energy (continued):

- Performance Based Option:
  - Demonstrated savings in **both** ***energy*** and ***CO_2 equivalent*** for compliance

ASHRAE Energy Goals



Highlights of Standard 189.1

Materials:

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

Highlights of Standard 189.1

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 only densely occupied spaces (lower threshold for *densely occupied*) ***Table for action levels***
  - Outdoor airflow monitoring if system includes non-densely occupied spaces

Highlights of Standard 189.1

Indoor Environmental Quality:

- **Prescriptive Option:**
  - Side daylighting for offices and classrooms, with shading requirements
  - Low emitting materials
- **Performance Option:**
  - Daylighting simulation
  - Modeling to show compliance with CDHS Section 1350

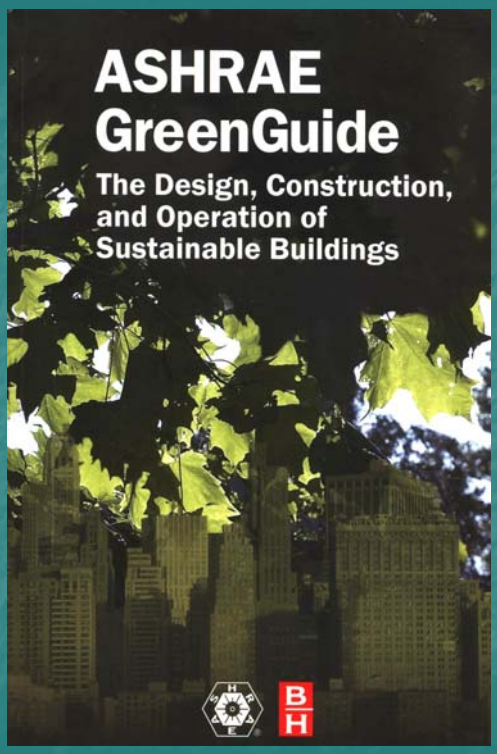
Highlights of Standard 189.1

Construction, Occupancy, O&M

- Commissioning for projects > 5,000 ft²
  - 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

ASHRAE GreenGuide

- Second edition released Oct 2006
- New chapters on:
  - LEED process
  - Building IEQ and interaction with local environment
- New Green Tips
- Reorganized



Thank you!

- Comments, questions, concerns, advice ...

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Example Technology Areas for Focus and Current Trends

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

Example Technology Areas for Focus and Current Trends

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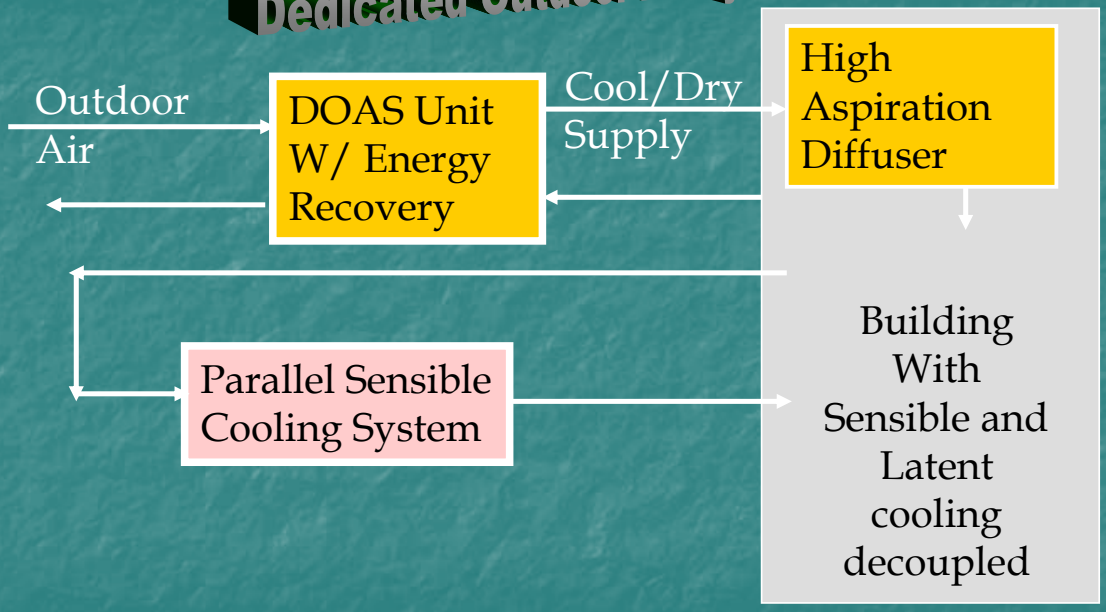
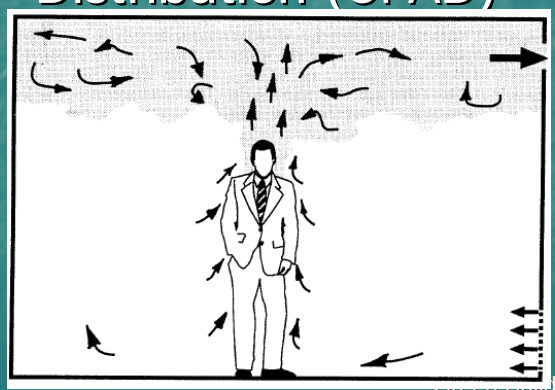
Green Tip #11:
Dedicated Outdoor Air Systems



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

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)



School Case Study Example ...

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

Green Tip #12:

Demand Controlled Ventilation

Demand-Controlled Ventilation and Sustainability

Pro

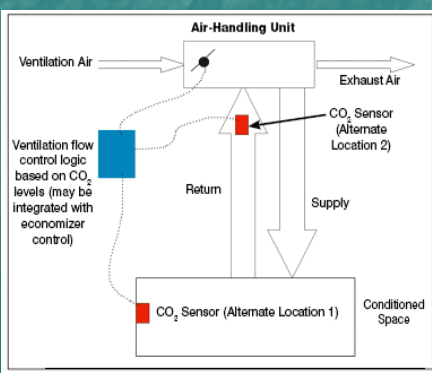
By Tom Lawrence, Ph.D., P.E., Member ASHRAE

ASHRAE Journal, December 2004

- Reduces building's energy use through not conditioning 'unnecessary' outdoor air
- Maintains adequate ventilation by monitoring

Con

- Additional first cost
- Sensors need calibration



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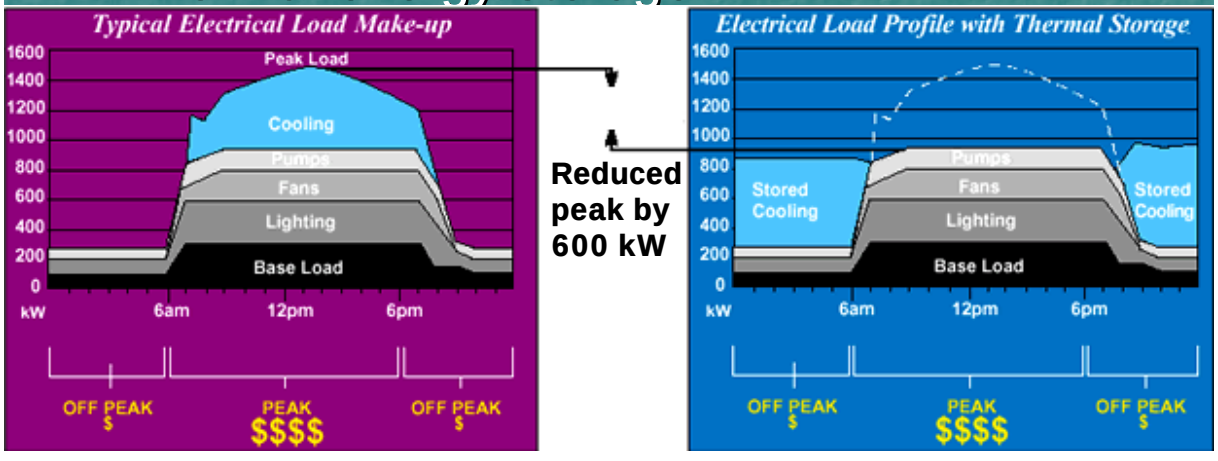
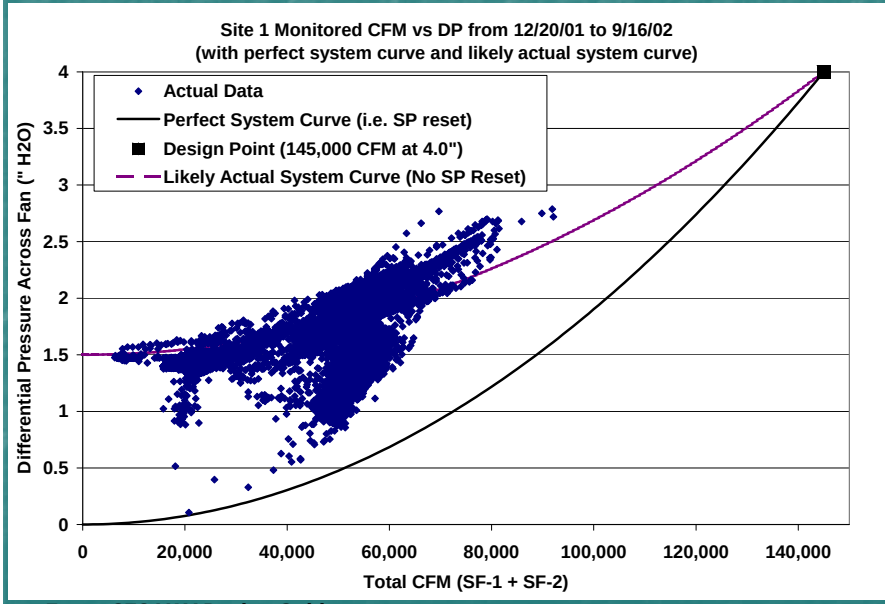
Peak Load Reduction

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



Part-load Focus



From: CEC VAV Design Guide

- Fan Systems
- Chillers

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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
(not including rain, sumps)

Incremental additional cost
≈ $300,000

Example Technology Areas for Focus and Current Trends

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Green Roofs or Cool Roofs

Technology Comparison
Green Roof versus 'Cool' Roof

Property	Green Roof	Cool Roof
Decrease roof temperature	✓	✓
Improve roof surface life	✓	✓
Impact on cooling load	↓	↓
Impact on heating load	↓	↑
Building structural concern	Yes	No
Improved stormwater management	Yes	No
Urban heat island effect	↓	↓
Cost	+ +	Minor +