ASHRAE Standard 189.1, “Standard for the Design of High Performance Green Buildings Except Low-Rise Residential Buildings”

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Reminders

- Cell phones – please silence
- Commercialism – ASHRAE observance!
- Please fill out the surveys
- My views and not ASHRAE's

Presentation Overview

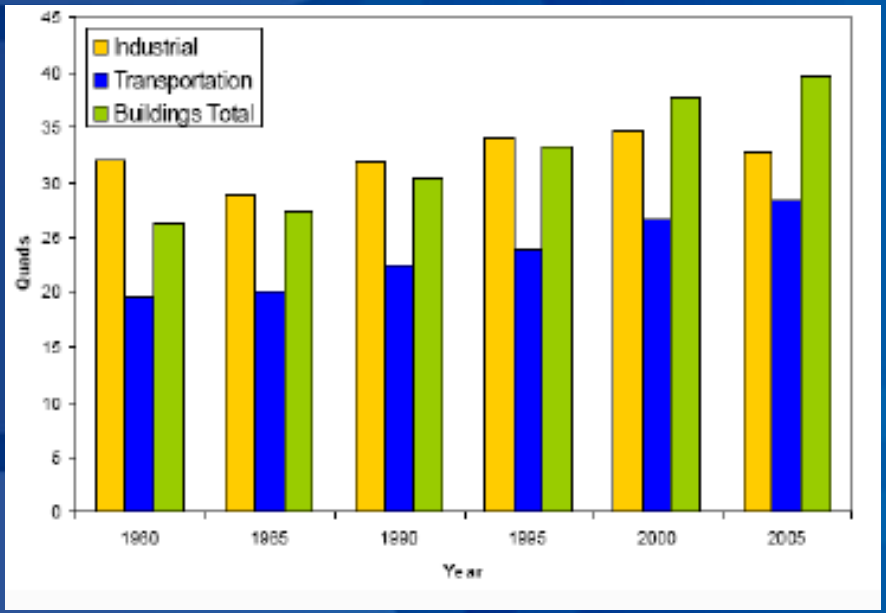
- Why have it?
- What is it?
- Suggestions

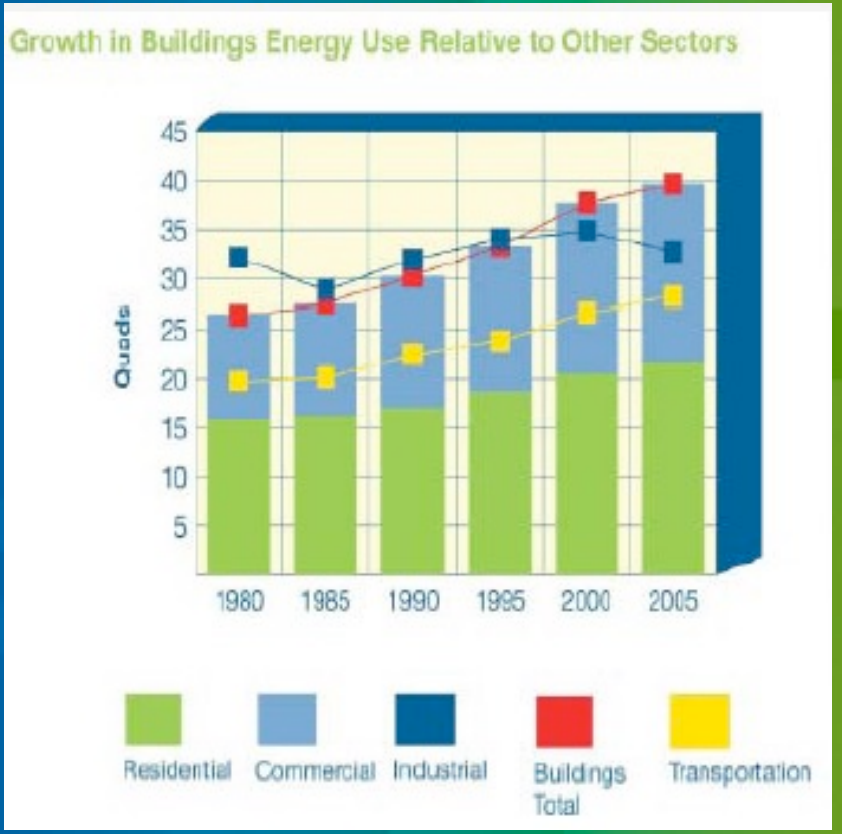
Total Energy Consumption

Buildings Represent

- 17% of fresh water consumption
- 25% of wood consumption
- 33% of CO_2 emissions
- 30% of waste generation
- 55% of natural gas use
- 72% of electrical energy use

Building Energy Use Growth





Projected World Energy Supply

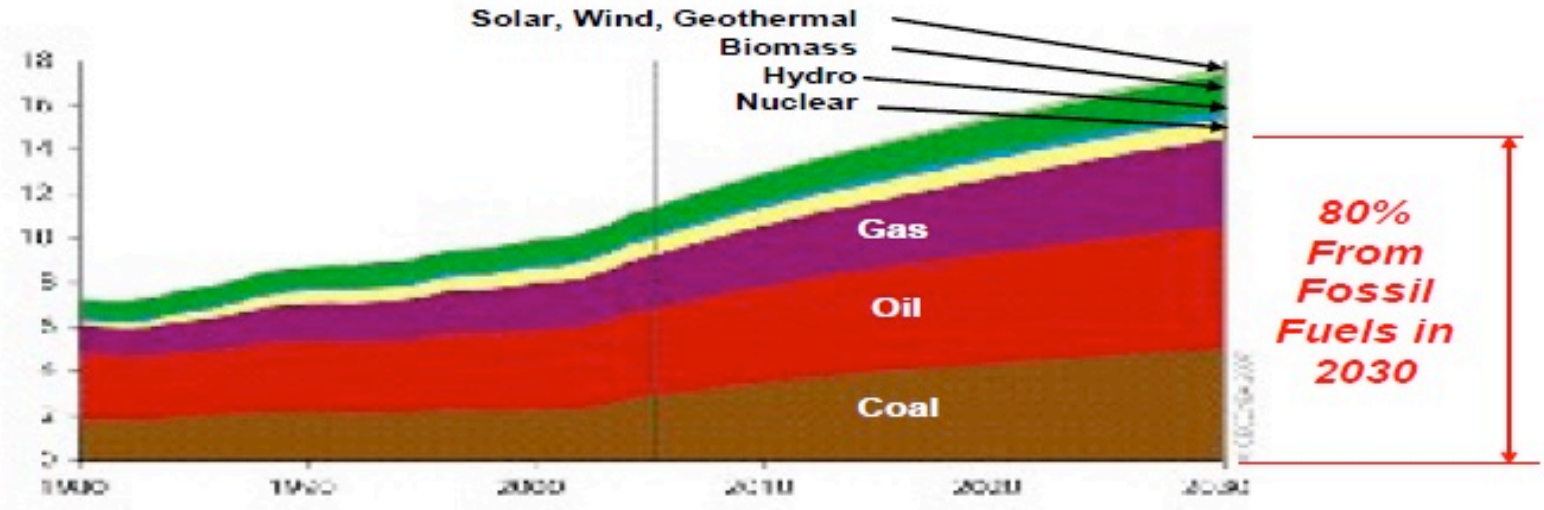
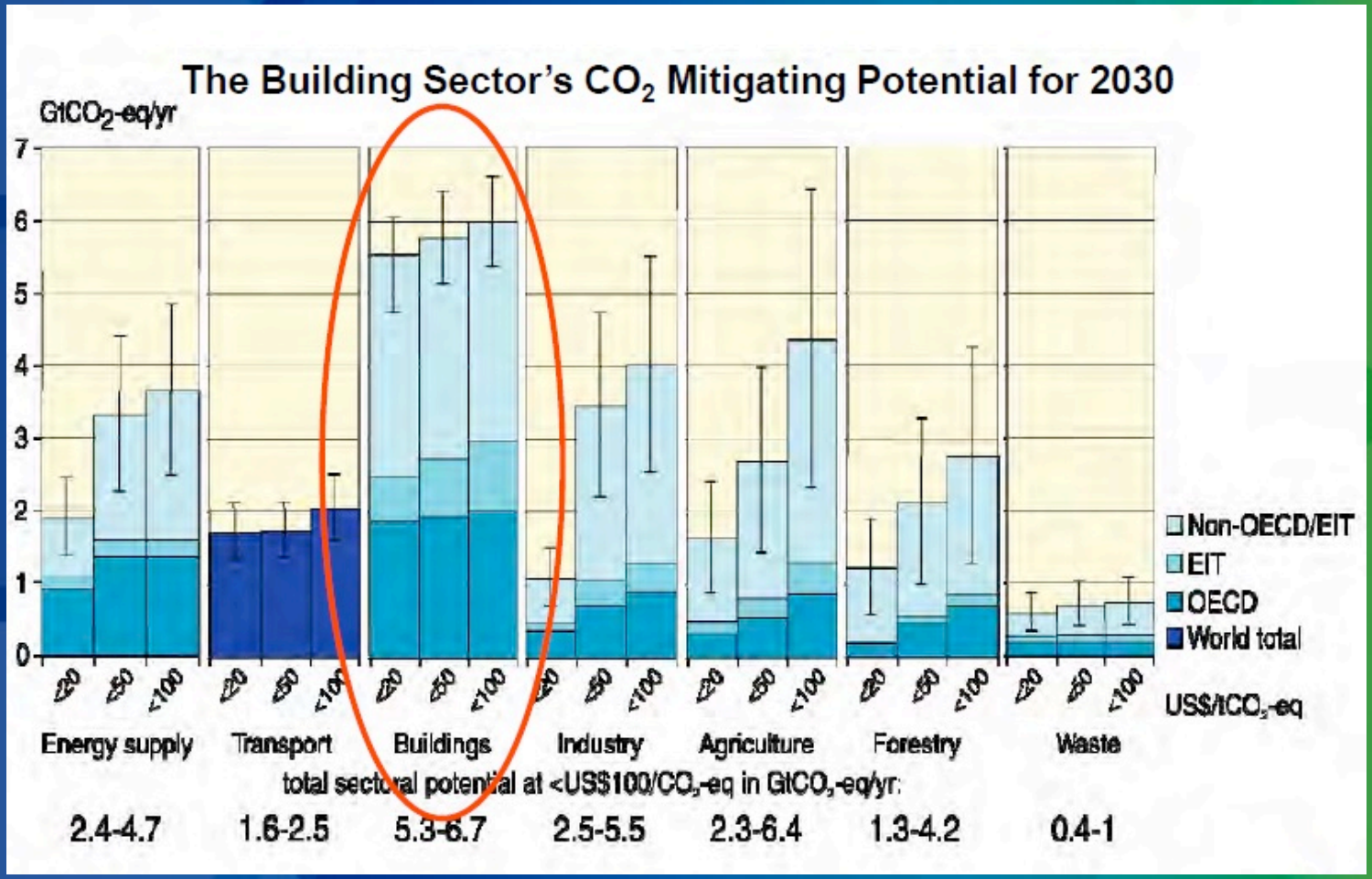
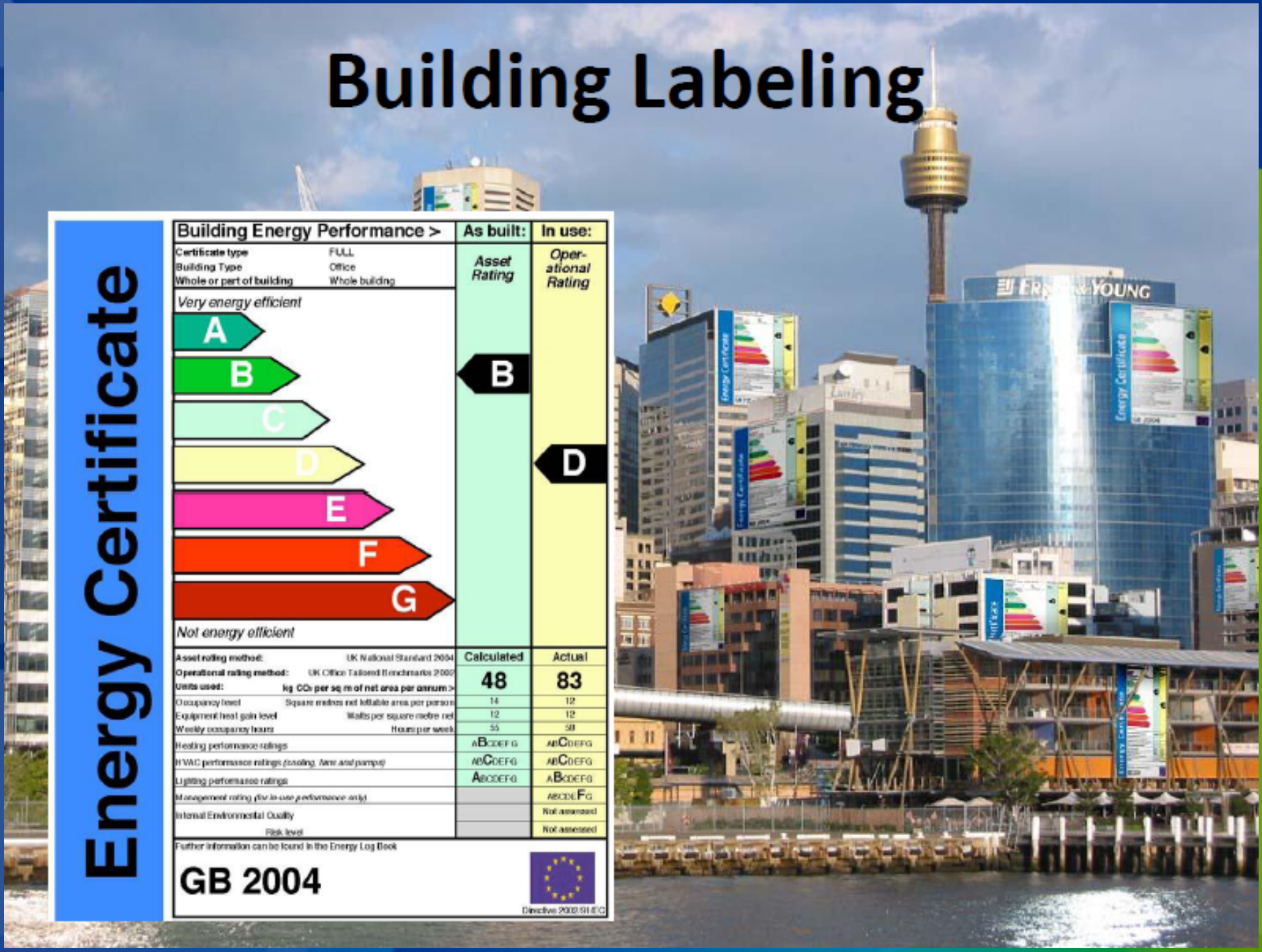


Figure 4:
Projected Global Energy Supply: 1980 – 2030
Billions of Tons of Oil Equivalents
Source: International Energy Agency "World Energy Outlook, 2006" (Reference Scenario)

IPCC Data


The Building Sector's CO_2 Mitigating Potential for 2030
$GtCO_2$-eq/yr
7
6
5
4
3
2
1
0
<20
<50
<100
Energy supply
Transport
Buildings
Industry
Agriculture
Forestry
Waste
Non-OECD/EIT
EIT
OECD
World total
US$/tCO$_2$-eq
total sectoral potential at <US$100/CO$_2$-eq in GtCO$_2$-eq/yr:
2.4-4.7
1.6-2.5
5.3-6.7
2.5-5.5
2.3-6.4
1.3-4.2
0.4-1

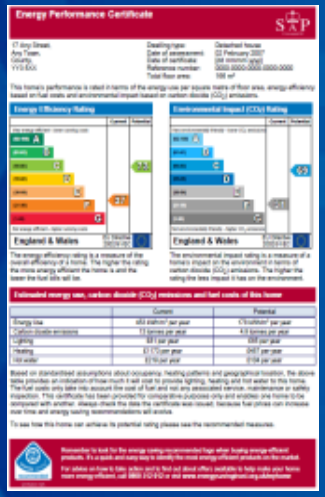
Building Labeling



Relationship to Other Programs

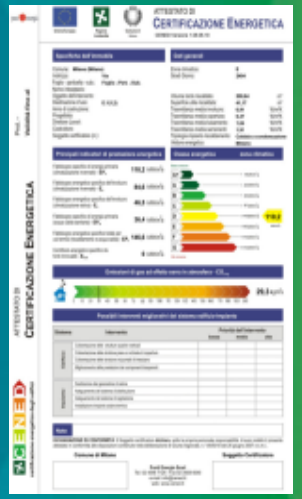
- **Europe**
  - **Standard EN 15217 Energy performance of buildings—methods for expressing energy performance and for energy certification of buildings (2007)**
  - **Explicit effort to learn from EU experience**


Austria



England & Wales

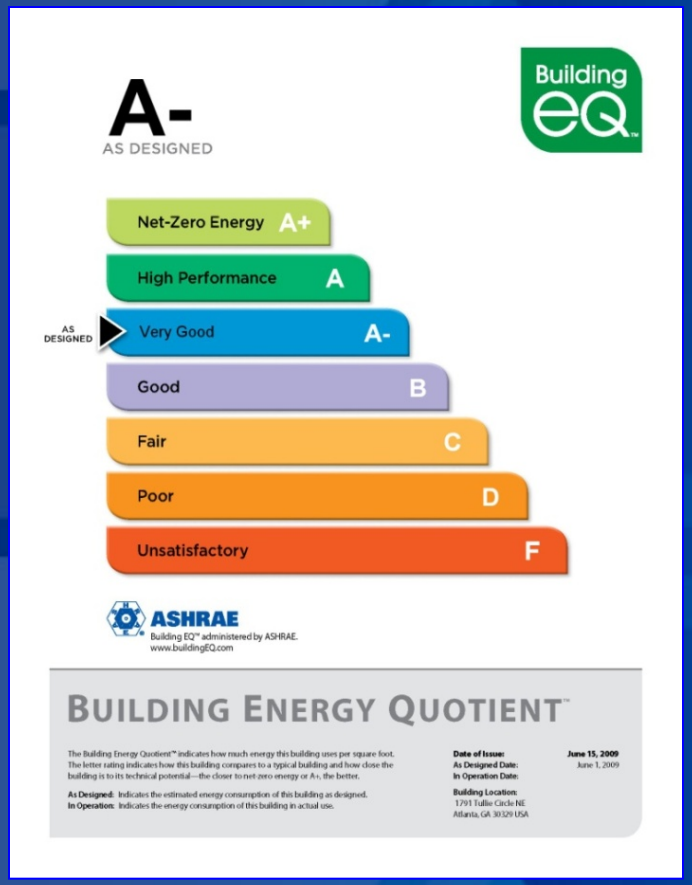
Greece



Italy

ASHRAE's Building Energy Labeling Program

Building Energy Quotient™



Standard 189.1

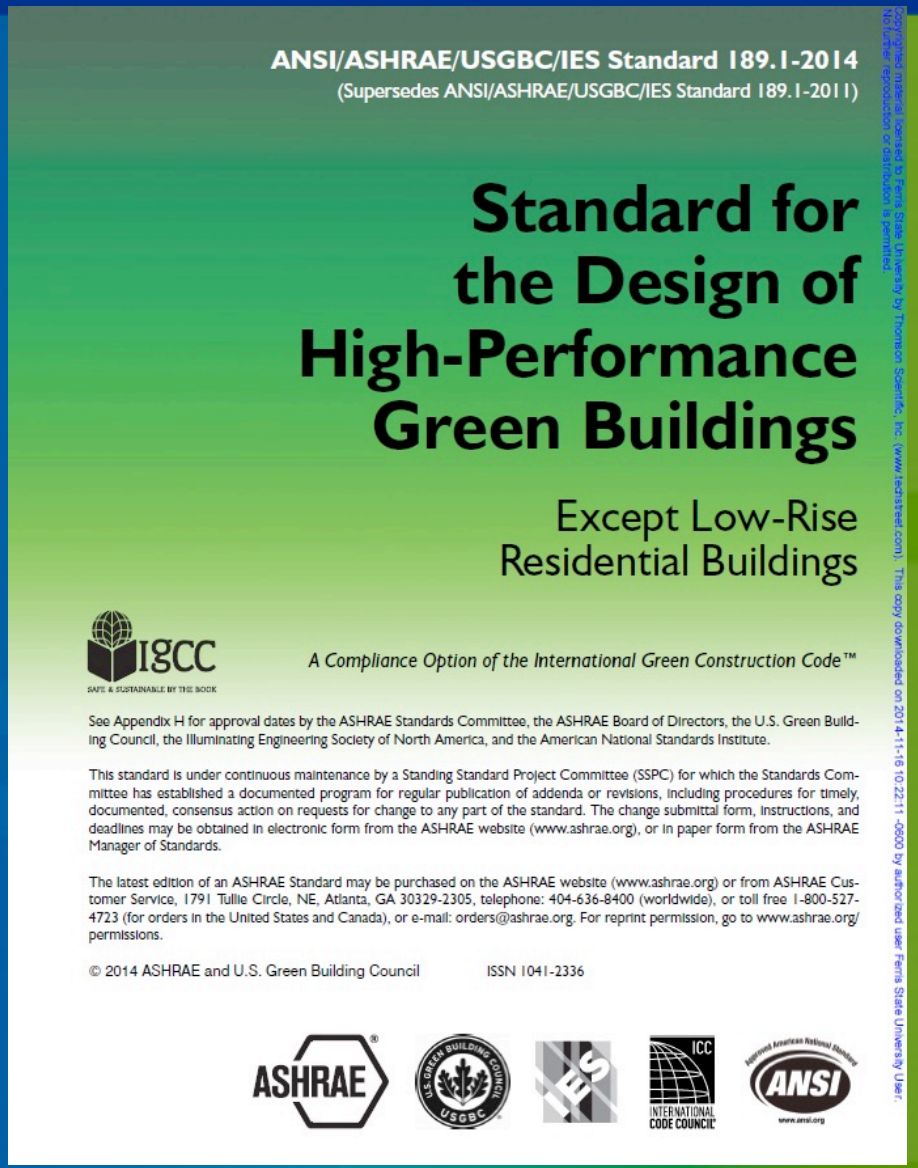
Standard 189.1 Relationship to Other Standards

- ASHRAE

- Built on the LEED Foundation

What is it?

- Standard 189.1 Published January 2009
- Updated in 2011 & 2014 & 2017



ANSI/ASHRAE/USGBC/IES Standard 189.1-2014
(Supersedes ANSI/ASHRAE/USGBC/IES Standard 189.1-2011)

Standard for the Design of High-Performance Green Buildings

Except Low-Rise Residential Buildings

IgCC
SAFE & SUSTAINABLE BY THE BOOK

A Compliance Option of the International Green Construction Code™

See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the U.S. Green Building Council, the Illuminating Engineering Society of North America, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org), or in paper form from the ASHRAE Manager of Standards.

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Sponsors

- USGBC with its affiliated membership including 6,000 corporations, federal agencies, state and local government, etc
- IES as the authority on illumination with over 100 years of experience, publication and service
- ASHRAE with its global resources, publications, continuing education that continue to serve the public
- ICC –agreement to merge with IGCC

Standard 189.1 Intent

- What it is;
  - A standard
  - Applies to all buildings except low-rise residential (same as Standard 90.1)
  - Intended for adoption into model building codes
- What is not;
  - Not a design guide
  - Not a rating system
- Note: even if not adopted by local authorities this standard serves as indication of future trends

Purpose

- The purpose of this standard is to provide minimum requirements for the **site, design, construction, and plans for operation** of high performance, green buildings to:
  - **Balance** environmental responsibility, resource efficiency, occupant comfort and well being and community sensitivity, and
  - Support the goal of development that **meets the need of the present without compromising** the ability of future generations to meet their own needs

Scope

- **Provides Minimum Criteria that:**
  - **Apply to:**
    - **New buildings and their needs**
    - **New portions of buildings and their systems**
    - **New systems and equipment in existing buildings**
  - **Addresses site sustainability, water use efficiency, IEQ, and the building's impact on atmosphere, materials and resources**

What it Covers

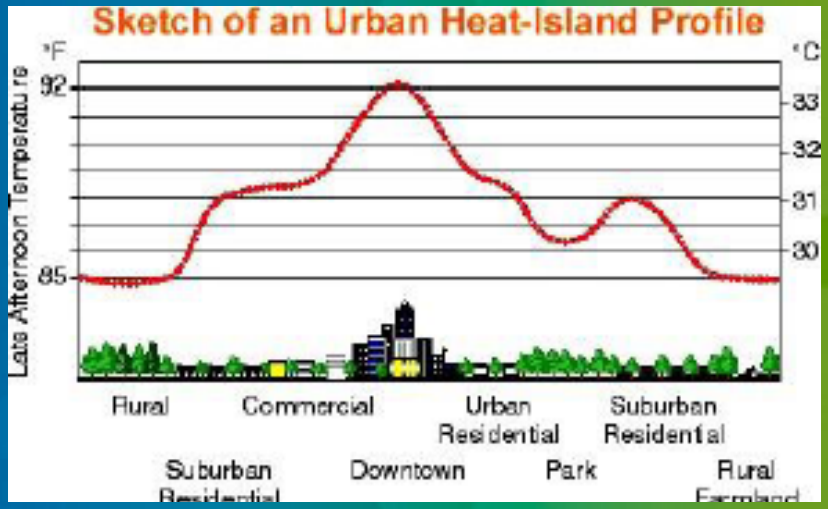
ANSI/ASHRAE/USGBC/IES Standard 189.1-2011
Standard for the Design of High-Performance Green Buildings
Except Low-Rise Residential Buildings

Basic Structure (for each section)

- X.1 – Scope
- X.2 – Compliance
- X.3 – Mandatory
  - (required for all projects)
- X.4 – Prescriptive (option 1)
  - Simple option, few choices, and very few calculations
- X.5 – Performance (option 2)
  - More sophisticated, flexible, but more effort

Chapter 5 Sustainable Sites

- Mandatory Provisions
  - Site Hardscape (minimums requirements – some exceptions)
  - Walls to be shaded up to 20 feet (6 meters) above grade
  - Roofs (minimum requirements for sloping – some exceptions)



Chapter 5 Sustainable Sites

- Mandatory provisions
  - Reduction of light pollution
    - Total site lumen limit
    - Max BUG limit (Backlight, Uplight and Glare) ratings
    - Modifications to Standard 90.1 exterior lighting

Chapter 6 – Water Use

- **Mandatory Provisions of site water use**
  - **Bio-diverse plantings, hydro-zoning and smart irrigation control**

Chapter 6 – Water Use

- Mandatory provisions for building water use
  - Plumbing fittings and fixtures per U.S. EPA Water Sense or ASME Standards
  - Appliances per U.S. EPA Energy Star
  - Water metering (must)
    - >1,000 gal (3,785 Liters)/day

Chapter 6 – Water Use

- Mandatory provisions for HVAC systems
  - Subsystem metering above thresholds
  - Cooling tower limitations on drift water lose
  - Condensation collection for units >19 kW (65,000 Btu/h) for ≥ 72 F (22 C) mean wet bulb

Chapter 6 – Water Use

- **Metering**

TABLE 6.3.3A Water Supply Source Measurement Thresholds

Water Source	Main Measurement Threshold
Potable water	1000 gal/day (3800 L/day)
Municipally reclaimed water	1000 gal/day (3800 L/day)
Alternate sources of water	500 gal/day (1900 L/day)

TABLE 6.3.3B Subsystem Water Measurement Thresholds

Subsystem	Sub-Metering Threshold
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower >500 gpm (30 L/s)
Evaporative coolers	Makeup water >0.6 gpm (0.04 L/s)
Steam and hot-water boilers	>500,000 Btu/h (50 kW) input
Total Irrigated landscape area with controllers	>25,000 ft^2 (2500 m^2)
Separate campus or project buildings	Consumption >1000 gal/day (3800 L/day)
Separately leased or rental space	Consumption >1000 gal/day (3800 L/day)
Any large water using process	Consumption >1000 gal/day (3800 L/day)

Chapter 7 Energy

- General highlights
  - Goal is 30% better than ASHRAE 90.1-2016 (including process loads)
  - Appendix G from Standard 90.1 is incorporated as Normative Appendix
  - Metering for verification
  - Peak load reduction
  - Other areas are increased stringency beyond Standard 90.1

Chapter 7 Energy

- **Mandatory Requirements for on-site renewable power**
  - **Provisions for future installation with minimum rating of 6.0 Btu/ft^2 x roof area in ft^2 (single story) & 10.0 Btu/ft^2 x roof area in ft^2 (multi-story)**
  - **Exceptions (low incident solar or purchase Green Power)**

Chapter 7 Energy

- Mandatory Requirements for Meters
  - Remote or automatic reading (based on criteria of size, energy source & system)
  - Meters communicate to central recording system
  - Data storage for 36 months

Chapter 7 Energy

TABLE 7.3.3.1A Energy Source Thresholds

Energy Source	Threshold
Electrical service	>200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	>1,000,000 Btu/h (300 kW)
Geothermal energy	>1,000,000 Btu/h (300 kW) heating
On-site renewable thermal energy	>100,000 Btu/h (30 kW)

TABLE 7.3.3.1B System Energy Use Thresholds

Use (Total of All Loads)	Subsystem Threshold
HVAC system	Connected electric load > 100kVA
HVAC system	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA Connected gas or district services load > 250,000 Btu/h (75 kW)

Chapter 7 Energy

- Prescriptive Path
  - Set of items clearly laid out
  - Must comply with ALL

- Performance Path
  - Must prove performance

Chapter 7 Energy

- **Prescriptive Path**
  - **Renewable Energy**
    - **Onsite systems minimum equal to mandatory levels**
    - **Exceptions**
      - **Low incident solar regions**
      - **Purchase of Green power in terms of 7 kWh/ft^2-yr (of conditioned space) until a total of 70 kWh/ft^2 is obtained**

Chapter 7 Energy

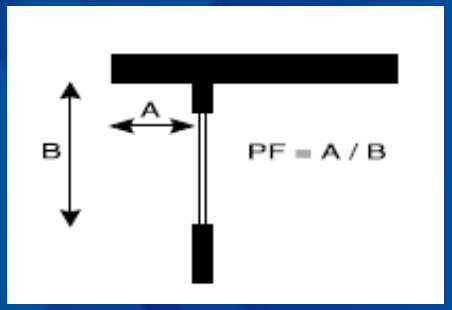
- **Prescriptive Option for Building Envelope**
  - Section 7.4.2 generally has stringent requirements
  - Replaces Tables 5.5-1 thru 8 in Standard 90.1

TABLE A-5 (Supersedes Table 5.5-5 in ANSI/ASHRAE/IES Standard 90.1)
Building Envelope Requirements for Climate Zone 5 (A, B, C) (I-P)

	Nonresidential		Residential		Semiheated	
	Assembly	Insulation	Assembly	Insulation	Assembly	Insulation
Opaque Elements	Max.	Min. R-Value	Max.	Min. R-Value	Max.	Min.R-Value
Roofs						
Insulation Entirely above Deck	U-0.039	R-25.0 ci	U-0.039	R-25.0 ci	U-0.093	R-10.0 ci
Metal Building	U-0.035	R-19.0 + R-11.0 Ls	U-0.035	R-19.0 + R-11.0 Ls	U-0.068	R-13.0 +R- 19.0
Attic and Other	U-0.021	R-49.0	U-0.021	R-49.0	U-0.034	R-30.0
Walls, Above Grade						
Mass	U-0.080	R-13.3 ci	U-0.071	R-15.2 ci	U-0.123	R-7.6 ci
Metal Building	U-0.052	R-13.0 + R-13.0 ci	U-0.052	R-13.0 + R-13.0 ci	U-0.079	R-13.0 + R-6.5 ci
Steel Framed	U-0.055	R-13.0 + R-10.0 ci	U-0.055	R-13.0 + R-10.0 ci	U-0.084	R-13.0 +R-3.8 ci
Wood Framed and Other	U-0.051	R-13.0 + R-7.5 ci	U-0.045	R-13.0 + R-10.0 ci	U-0.064	R-13.0 + R-3.8 ci

Chapter 7 Energy

- **Prescriptive Option for Building Envelope**
  - **Fenestration Overhang PF>0.5**



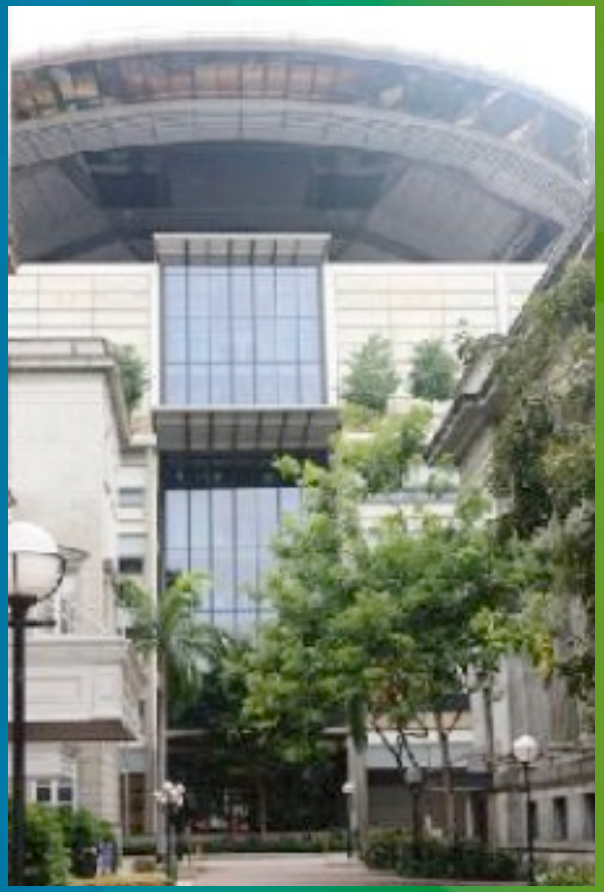
  - **Orientation to minimize solar**
    - **East/West < North/South**
  - **Permanent projections in Climate Zones 1 - 5**

Chapter 7 Energy

- **Prescriptive Option for Building Envelope**
  - **SHGC multipliers (different then Standard 90.1)**

TABLE 7.4.2.6 SHGC Multipliers for Permanent Projections

PF	*SHGC* Multiplier (All Other Orientations)	*SHGC* Multiplier (North-Oriented)
0–0.60	1.00	1.00
>0.60–0.70	0.92	0.96
>0.70–0.80	0.84	0.94
>0.80–0.90	0.77	0.93
>0.90–1.00	0.72	0.90



Chapter 7 Energy

- **Prescriptive Option for HVAC**
  - **Demand Controlled Ventilation requirements**
    - **Space CO_2 sensing – one every 10,000 ft^2 (1,000 m^2)**
    - **Sensing accurate to 50 ppm (plus or minus) for every 1,000 ppm**
    - **Determined by;**
      - **Outdoor Air reference benchmarking**
      - **Design assumptions for occupants**

Chapter 7 Energy

- **Prescriptive Option for HVAC**
  - **Duct Sealing level A everywhere**
  - **Expanded Economizer Usage**

TABLE 7.4.3.3 Minimum System Size for Which an Economizer is Required

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

  - **New for rooftops <5 tons (economizer then mechanical cooling)**
  - **VAV supply air temp reset by at least 5 F**

Chapter 7 Energy

- **Prescriptive Option for HVAC**
  - **Zone controls for limit on reheat**
    - **Reheated, re-cooled or remixed not to exceed Design OA airflow rate or**
  - **Fan Power Limits – 10% less than Std 90.1**

Chapter 7 Energy

- **Prescriptive Option for HVAC**
  - **Expanded heat recovery**

TABLE 7.4.3.6 Energy Recovery Requirement (I-P)

Climate Zone	% Outside Air at Full Design Flow							
	≥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 Flow, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	≥5000	≥5000
1B, 2B, 5C	NR	NR	NR	NR	≥26,000	≥12,000	≥5000	≥4000
6B	NR	≥22,500	≥11,000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥30,000	≥13,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0
7, 8	≥4000	≥3000	≥2500	≥1000	≥0	≥0	≥0	≥0

  - **60% energy recovery effectiveness (enthalpy)**

Chapter 7 Energy

- Prescriptive Option for Power
  - Peak factor/ peak load reduction
  - Reduce peak capacity of the building through demand limiting or load shifting measures (10%)

Chapter 7 Energy

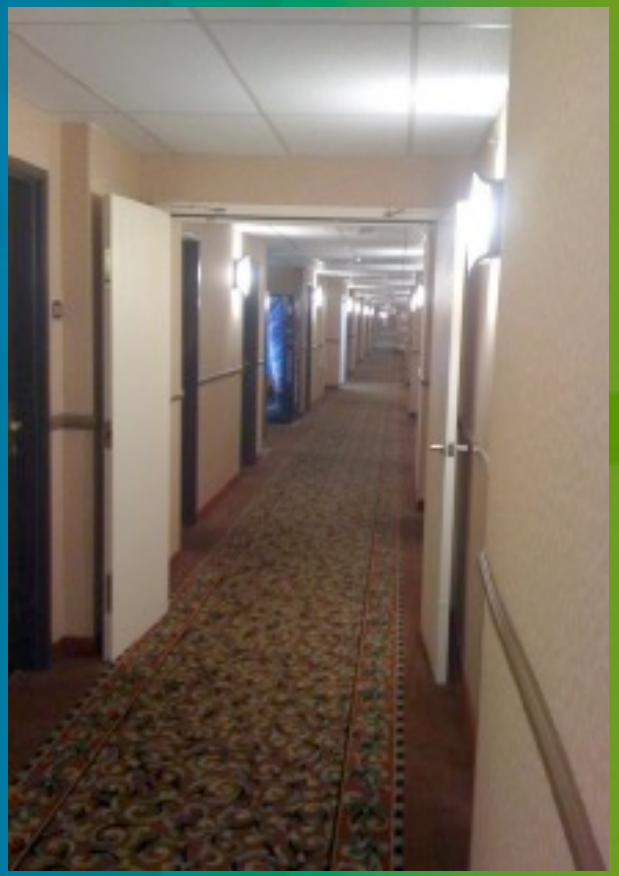
- **Prescriptive Option for Lighting**
  - Interior lighting to use Standard 90.1 and apply "**Lighting Power Allowance**"
  - Area factors available for customized approach

TABLE 7.4.6.1A LPD Factors when Using the Building Area Method

Building Area Type	LPD Factor
Courthouse	0.95
Dining—Cafeteria/Fast Food	0.95
Dining—Family	0.95
Dormitory	0.95
Exercise Center	0.95
Healthcare Clinic	0.95
Hospital	0.95
Library	0.95
Multifamily	0.95
Office	0.95
Penitentiary	0.95
Police Station	0.95
Religious Building	0.95
School/University	0.90
Town Hall	0.95
Transportation	0.95
All Other Building Area Types	1.00

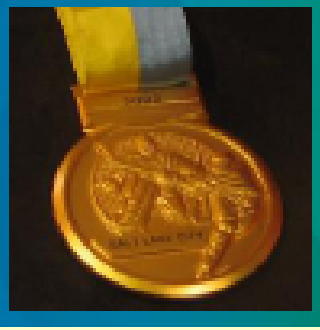
Chapter 7 Energy

- **Prescriptive Option for Lighting**
  - **Occupancy sensor control to reduce power to less than 50% for:**
    - **Hotel/Motel hallways**
    - **Storage aisles**
    - **Library stacks**
  - **Egress lighting control**
    - **<0.1 w/ft^2 continuous with auto shut-off control**
  - **Auto Control with Natural Lighting Integration**



Chapter 7 Energy

- **Performance Based Option**
  - **Demonstrate equivalent performance in Both energy cost and CO_2 equivalent compared to using the prescriptive path**



Using Normative Appendix D "Performance Option for Energy Efficiency"

Chapter 7 Energy

- Performance Based Option
  - CO_2 Equivalent Compared to Building Design with Prescriptive Path
  - Use local utility information
  - Take site energy to get source emissions

TABLE 7.5.3 CO_2e Emission Factors

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

Chapter 8 - IEQ

- Mandatory items for Indoor Environmental Quality
  - Outdoor Airflow
  - Tobacco Smoke Control
  - Outdoor Air Monitoring
  - Filtration and Air Cleaning

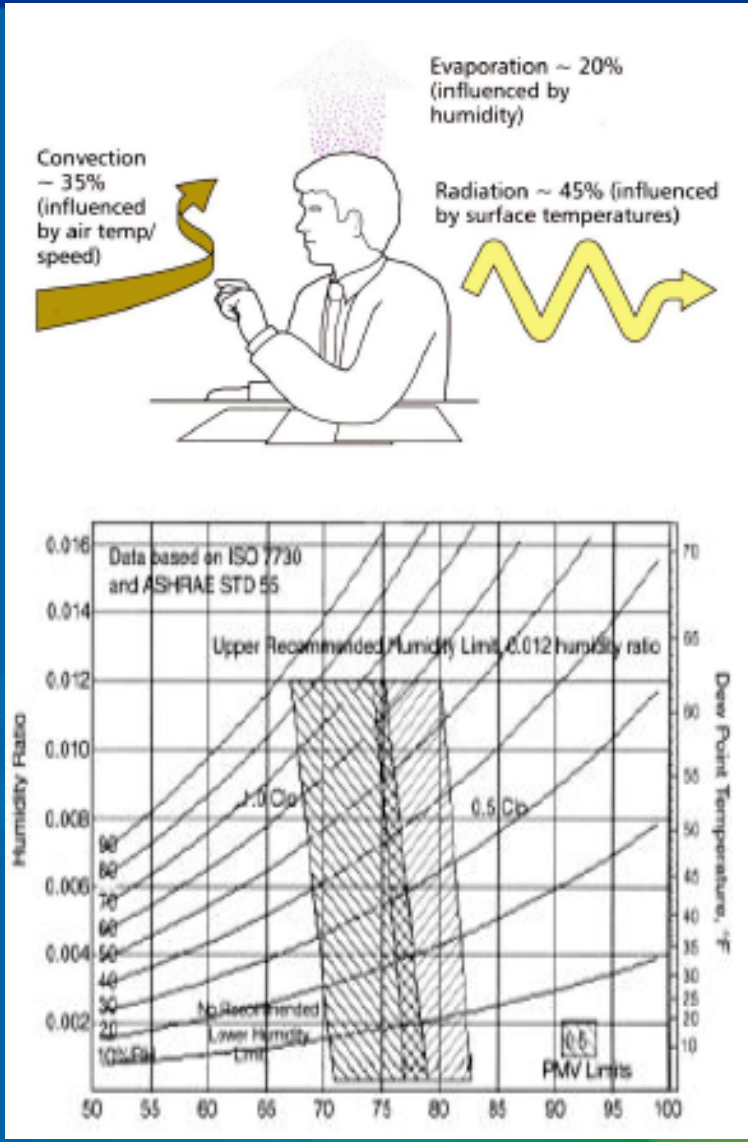
ASHRAE STANDARD
Refers to and modifies
Ventilation
for Acceptable
Indoor Air Quality

Chapter 8 - IEQ

- Section 8.3.1.4 – Tobacco Smoke Control
  - No smoking inside
  - No smoking with 25 feet of entrances, outdoor air intakes or operable windows

Chapter 8 - IEQ

- **Mandatory Requirement on Thermal Comfort**
  - **Comply with Standard 55**



Chapter 8 - IEQ

- Mandatory - Building Entrances must employ a Mat System to control contaminants (some exceptions)
  - Scraper area
  - Absorption surface
  - Finished surface

Chapter 8 - IEQ

- **Other Mandatory**
  - **Daylighting by top lighting for large open office areas >20,000 ft² & ceiling >15 ft & minimum lighting power of 0.5 watts/ft²**

TABLE 8.3.4.1 Minimum Toplighting Area

Lighting Power Density or *Lighting Power Allowances* in Daylight Area, W/ft² (W/m²)	Minimum Toplighting Area to Daylight Area Ratio
1.4 W/ft² (14 W/m²) < LPD	3.6%
1.0 W/ft² (10 W/m²) < LPD < 1.4 W/ft² (14 W/m²)	3.3%
0.5 W/ft² (5 W/m²) < LPD < 1.0 W/ft² (10 W/m²)	3.0%

Chapter 8 - IEQ

- Prescriptive Option
  - Side daylighting (8.4)
    - Offices and classrooms
    - Effective aperture
    - Visible reflectance of interior surfaces
    - Some exceptions

Chapter 8 - IEQ

- Prescriptive Option
  - Office space shading with projections or other techniques
  - Low Emitting Materials
    - Adhesives & sealants
    - Paints & coatings
    - Floor covering
    - Composite wood and other products

Chapter 9 – Building's Impact on Atmosphere, Materials & Resources

- Mandatory Keys to ASHRAE
  - Construction Waste
    - Max of 5% of total project materials
    - Minimum 50% of non-hazardous materials to be recycled or reused
    - Limit on total waste per floor area
    - Off-site storage and sorting is allowed

Chapter 9 – Building's Impact on Atmosphere, Materials & Resources

- Other Mandatory Items
  - Storage and collection of recyclable materials
  - Discarded fluorescent lamps and ballasts

Chapter 10 – Construction & Operation Plans

- Section 10.3.1.1 – Building Acceptance Testing
  - Activities prior to permit and prior to occupancy
  - Designate representative to oversee
  - Construction documents indicate who does what
  - Includes mechanical systems, lighting, renewable energy, energy and water metering devices

Chapter 10 – Construction & Operation Plans

- Section 10.3.1.2 – Building Project Commissioning
  - Full commissioning for >5,000 ft^2
  - Include HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy
  - Design Reviews at 50% and Final
  - Verify installation, operation and training

Chapter 10 – Construction & Operation Plans

- Section 10.3.1.3 Erosion Control
  - Develop and implement an Erosion and Sediment control plan for all construction activities

Chapter 10 – Construction & Operation Plans

- Section 10.3.1.4 – IAQ Construction Management
  - Develop and manage an IAQ Construction Management program plan to include:
    - Air conveyance materials shall not be used during construction
    - Permanent HVAC not used during construction, except for start-up testing
    - Flush-out or baseline IAQ monitoring

Chapter 10 – Construction & Operation Plans

TABLE 10.3.1.4 Maximum Concentration of Air Pollutants Relevant to IAQ

Contaminant	Maximum Concentration, $\mu g/m^3$ (Unless Otherwise Noted)
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-hr)
Particulates ($PM_{2.5}$)	35 (24-hr)
Particulates (PM_{10})	150 (24-hr)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-Butadiene	20
t-Butyl methyl ether (Methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam *	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1,4-Dichlorobenzene	800
Dichloromethane (Methylene chloride)	400
1,4-Dioxane	3000
Ethylbenzene	2000
Ethylene glycol	400
Formaldehyde	33
2-Ethylhexanoic acid*	25
n-Hexane	7000
1-Methyl-2-pyrrolidinone*	160
Naphthalene	9
Nonanal*	13
Octanal*	7.2
Phenol	200
4-Phenylcyclohexene (4-PCH)*	2.5
2-Propanol (Isopropanol)	7000
Styrene	900
Tetrachloroethene (Tetrachloroethylene, Perchloroethylene)	35
Toluene	300
1,1,1-Trichloroethane (Methyl chloroform)	1000
Trichloroethene (Trichloroethylene)	600
Xylene isomers	700

Chapter 10 – Construction & Operation Plans

- Section 10.3.2.1.1 – Site Sustainability
  - Include maintenance procedures needed to maintain healthy vegetation growth for vegetation used for shading compliance

Chapter 10 – Construction & Operation Plans

- Water Use Efficiency
  - Initial measurement and verification (M & V)
  - Procedures to track use
  - Assess water use efficiency, document

Chapter 10 – Construction & Operation Plans

- Energy Efficiency
  - Initial measurement and verification (M & V)
  - Procedures to track and assess energy
    - Hourly load profile
    - Monthly average daily load
    - Monthly and annual energy use
    - Monthly and annual peak demand

Chapter 10 – Construction & Operation Plans

- Indoor Environmental Quality
  - Outdoor airflow measurement, scheduling and documentation
  - Indoor air quality assessment
  - Green cleaning
- Maintenance Plan
  - Mechanical, electrical per Standard 180
  - Documentation

Chapter 10 – Construction & Operation Plans

- **Building Service Life Plan**

TABLE 10.3.2.3 Minimum Design Service Life for Buildings

Category	Minimum Service Life	Building Types
Temporary	Up to 10 years	Non-permanent construction buildings (sales offices, bunkhouses) Temporary exhibition buildings
Medium life	25 years	Industrial buildings Stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

My Thoughts

- Suggestions
- Using Standard 189 to your advantage
- Thinking about the Pyramid

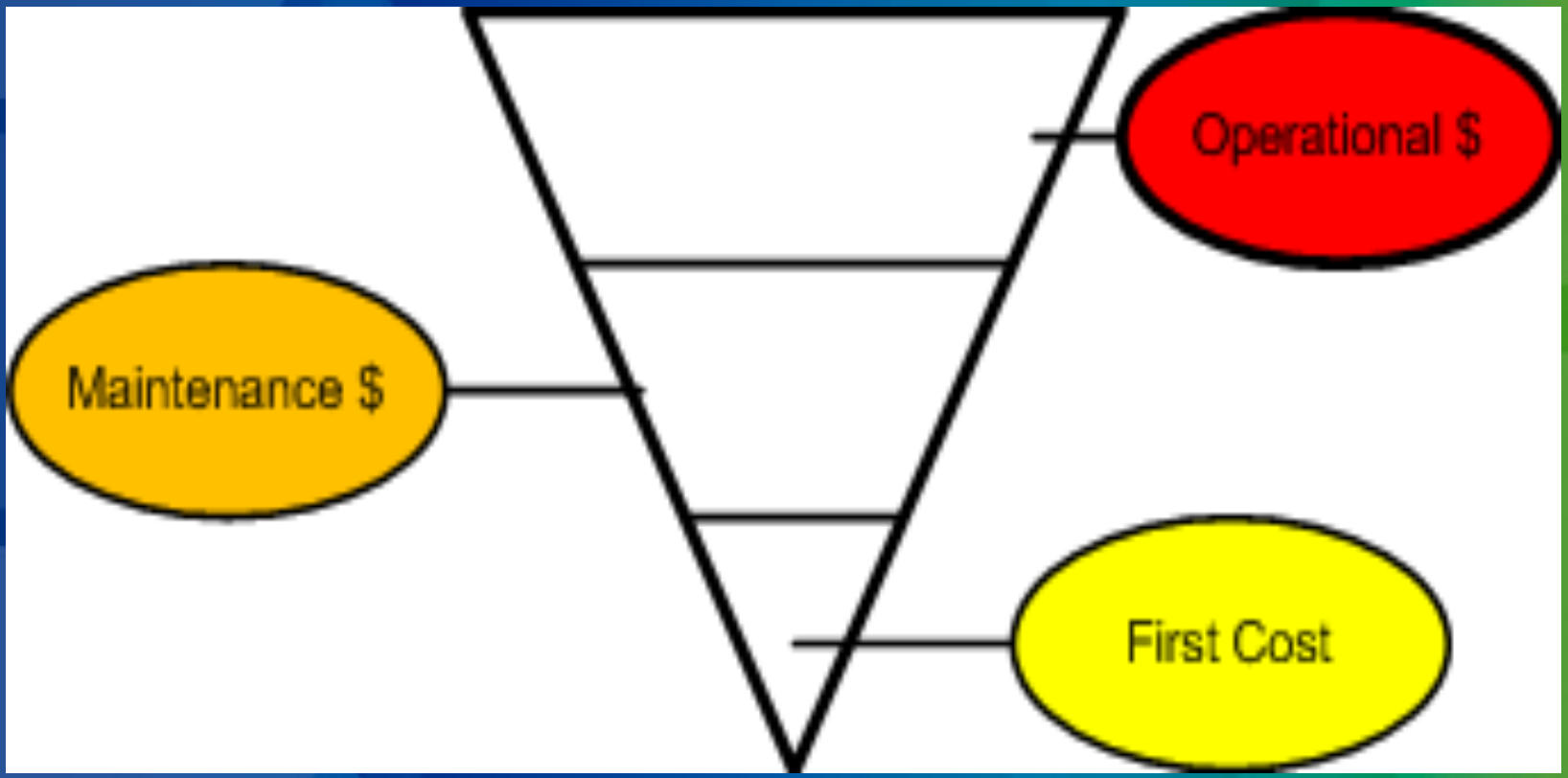
My suggestions

- Get Team “Buy-in” and “Owner Support”
- Early decisions influence everyone
- Look at Building Orientation, Building Exterior Features, and Building Site requirements
- Create the Roadmap for the Building Owner Create the BOP (Building Operational Plan)

Using Standard 189

- Use all of the tools (criteria) to analyze the "Best HVAC System" for the building
  - Site development
  - Water management
  - Energy Management
  - Indoor Environmental Quality
  - Sustainable Practices
  - And True Life Cycle Cost (use input from owner)

Upside Down Pyramid



ASHRAE Standard 189.1

Thank You

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