Green Schools

Better for the environment
Healthier for teachers and students

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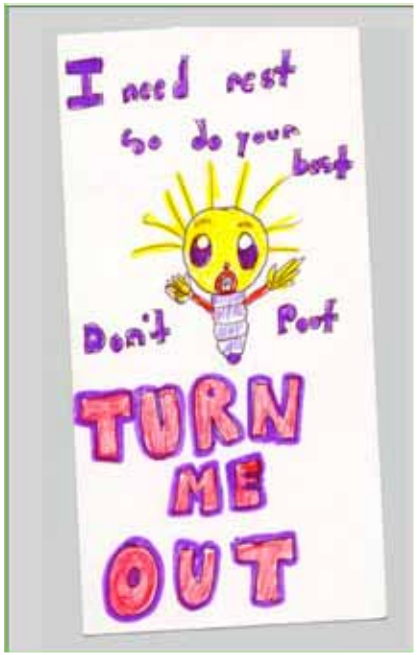
Essential Elements of Quality School Facilities

- How these conditions affect student achievement
- How these conditions help retain quality teachers

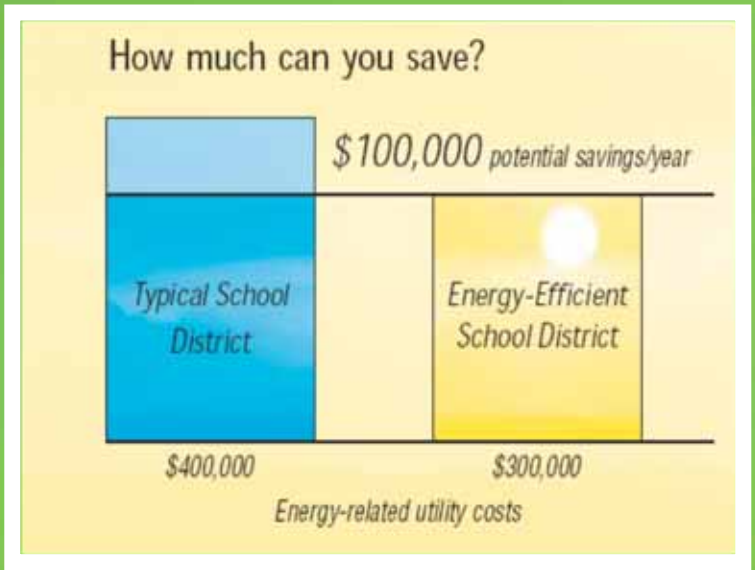


Going Green is Cost-Effective

- Lower energy and water costs, improved teacher retention, and lowered health costs
- Building green schools saves about $12 per square foot
- 4 times the average additional cost of going green.

An energy efficient district with 4,000 students…

- The one-time investment of going green can save as much as $100,000 per year in energy cost
- That's up to a million dollars in a 10 year period, and millions over the life of the facilities



U. S. Department of Energy

Spending less on operating allows:

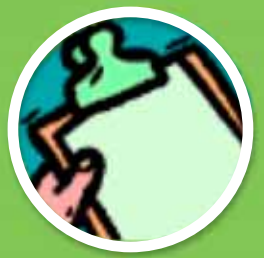
- Hiring of more teachers
- Purchase of computers/instructional materials
- Consideration of critical capital improvements
- Funding next level of energy-savings projects

Improvements that lower energy consumption and also create better places to teach and learn

- Lighting
- Temperature Control
- Acoustics
- Air Quality

LEED® for Schools

- The LEED® rating system was developed by the U.S. Green Building Council and is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings.



LEED® for Schools

- LEED® is like a “nutritional label” for green, healthy school buildings.
- Schools can earn LEED® certification, which provides third party verification that the building was designed and is operating the way it was intended to be.

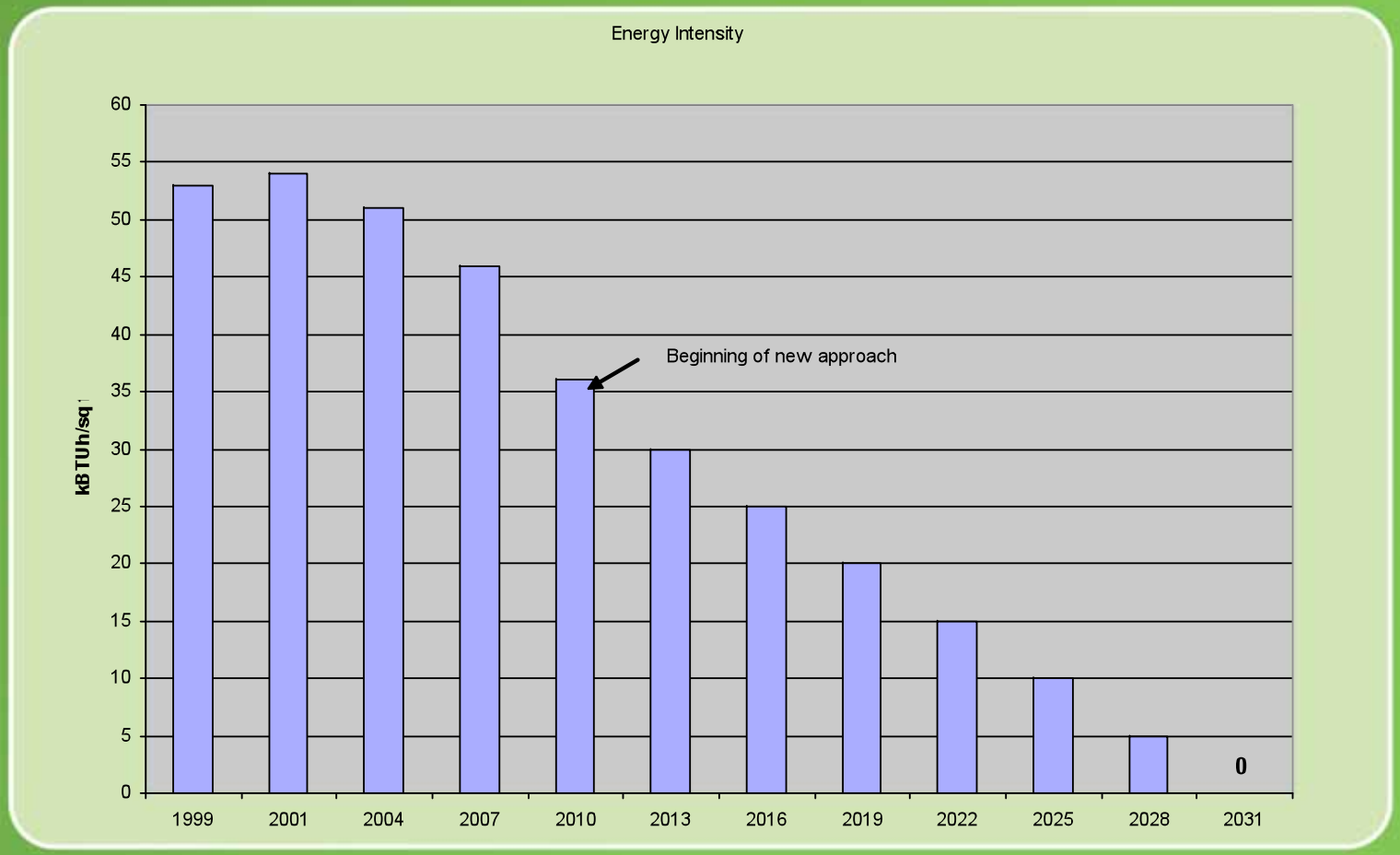
LEED® 2009 – New Construction and Schools

Leadership in **E**nergy and **E**nvironmental **D**esign

- 100 base points, 6 possible innovation in design and 4 regional priority points

Certified	40-49 points
Silver	50-59 points
Gold	60-79 points
Platinum	80 points and above

The Future of 90.1?



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Renewables

- School Solar Program
- What else works for a school

LEED® certified schools:

- Use 30-50% less energy than conventional schools, which lowers utility bills.

LEED® certified schools:

- Reduce harmful CO2 emissions by 40%, which help turn back the clock on global climate change.

LEED® certified schools:

- Use 30% less water

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LEED® certified schools:

- Have higher teacher retention

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LEED® certified schools:

- Have better lighting and temperature controls, which promotes higher student achievement.
- More comfortable indoor environments, improved ventilation and indoor air-quality – all of which contribute to positive health benefits, including reduced instances of asthma, colds, flu and absenteeism.

Students in LEED® certified schools:

- Demonstrate increased performance on reading tests by 20% and on math tests by 24% compared to students in less optimal school conditions.

Point Distribution

LEED® 2009
Schools New Construction and Major Renovations

Total Possible Points**	110*
Sustainable Sites	24
Water Efficiency	11
Energy & Atmosphere	33
Materials & Resources	13
Indoor Environmental Quality	19

** Out of a possible 100 points + 10 bonus points*

*** Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points*

Innovation in Design	6
Regional Priority	4

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LEED® EA Prerequisite 1 Required

- Fundamental commissioning of building energy systems
  - Intent: to verify that the project's energy-related systems are installed, calibrated and perform according to the owner's project requirements, basis of design and construction documents.

LEED® EA Prerequisite 2 Required

- Minimum energy performance
  - Intent: to establish the minimum level of energy efficiency
  - Schools must utilize the EPA target finder rating tool – and
  - Option 1 – whole building simulation using ASHRAE appendix G.
  - Option 2 – comply with ASHRAE advance design guide for schools – under 200,000 sq ft
  - Option 3 – comply with core performance guides – under 100,000 sq ft

Existing Buildings

- Sort your buildings by EUI and ECI
- Target low performing buildings
- Use Continuous Commissioning® or other approach to improve building operation – **Low hanging fruit**
- **Loan Star Program**

HOME RUN

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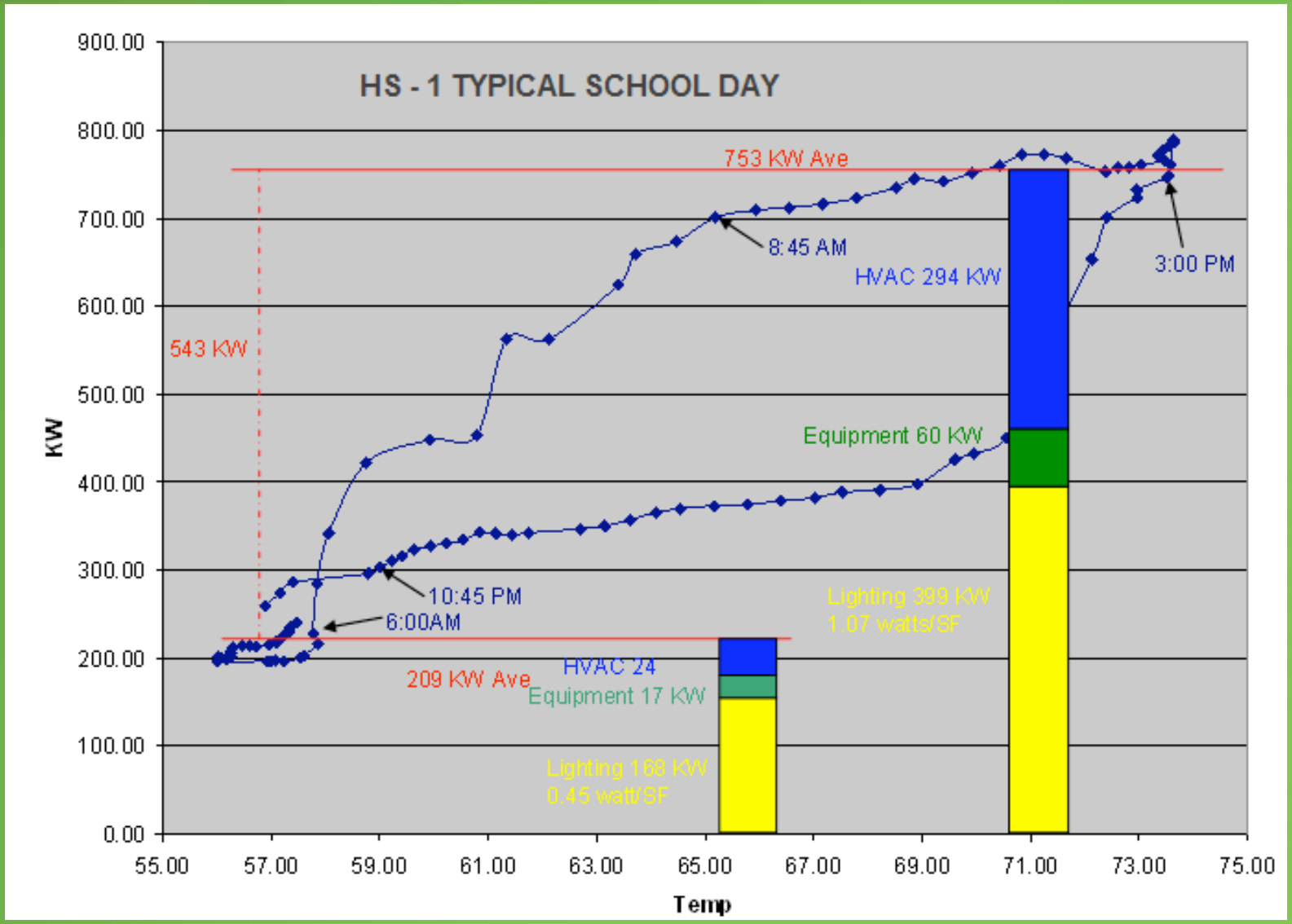
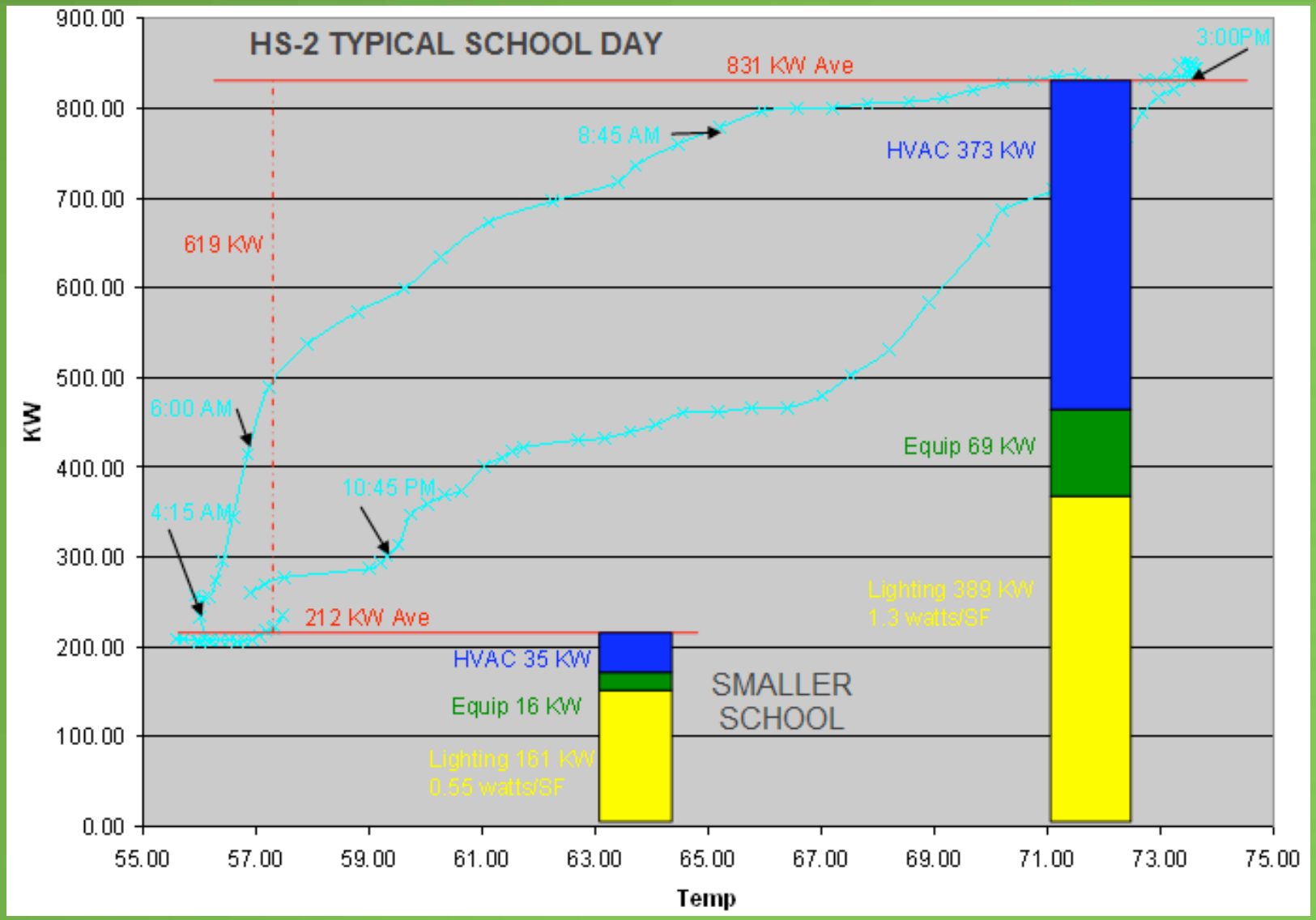
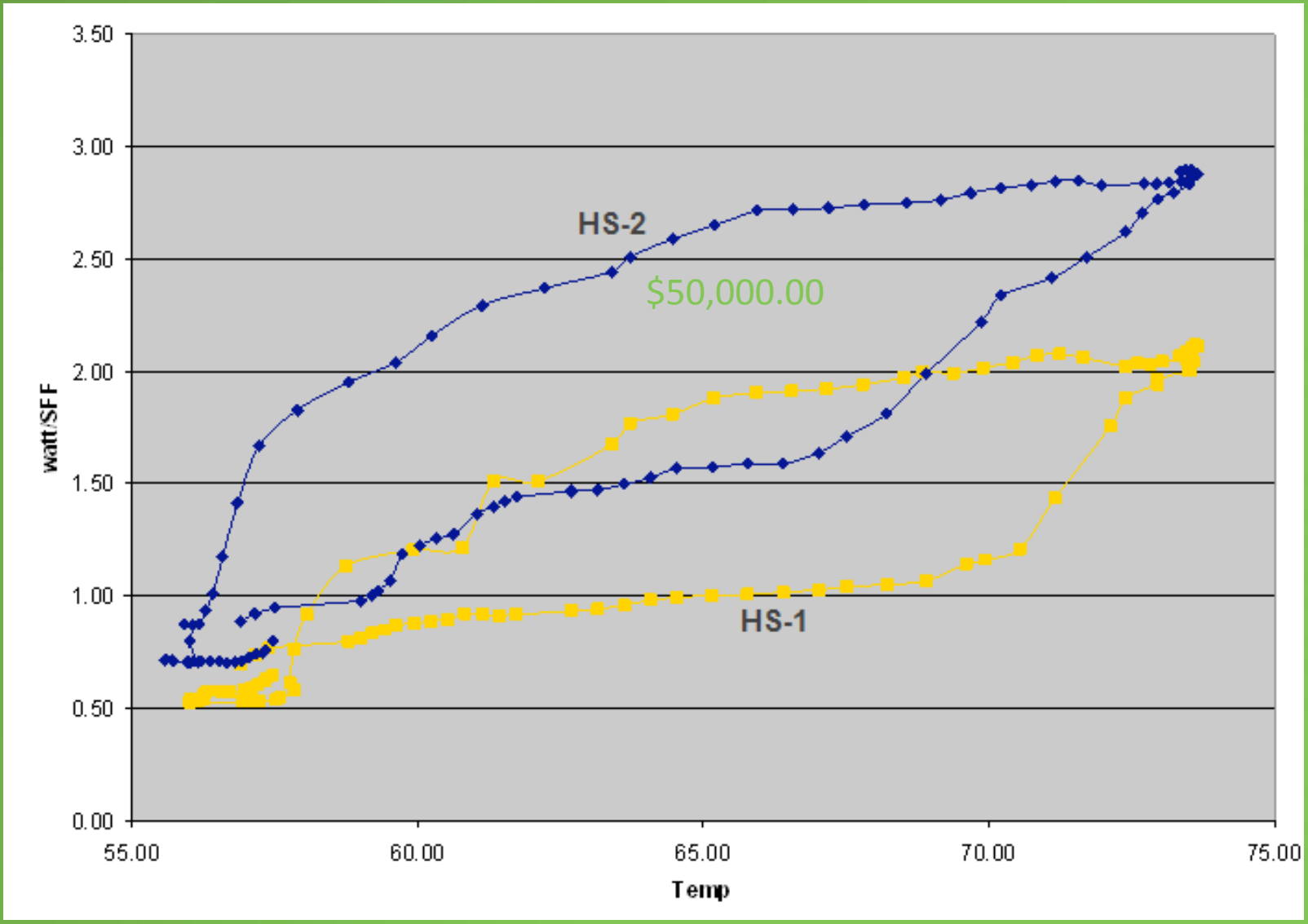
Interval or “Smart Meter”



Interval or “Smart Meter”



Compare Interval Data



Performance Contracting

- Risk = Money
- Parallax View
- New Equipment
- Operational Improvements
- M&V

Keys to Going Green

Financing

Project Planning

Liability

Financing

- American Recovery and Reinvestment Act of 2009 (ARRA).

Funding

- Loans
- Bonds
- Grants

Issues with these options

- Excessive paperwork
- Ongoing reporting
- Requirements to meet certain levels
  - Example: LEED® Silver requirement – if building doesn't meet, may lose funding

Other Option

- Self-performing energy-savings programs
- By carefully structuring your budget and contracts, you can segregate energy savings and use those funds to pay for existing and future green programs

Project Planning

- Whole Project Approach
  - Clearly define long-term goals
  - Get right team in place from beginning
  - Develop contracts that clearly define goals and expectations of all parties

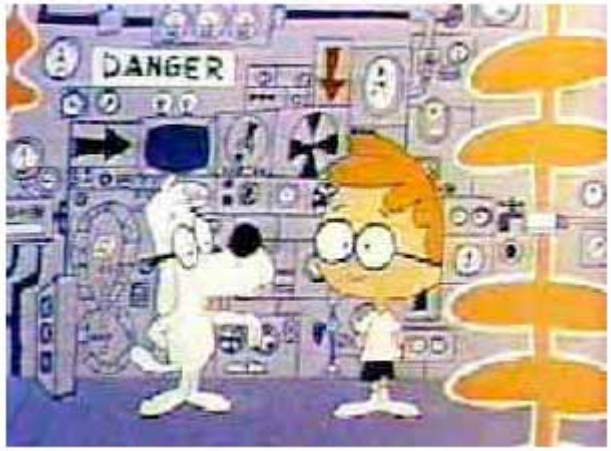
Liability

- Green litigation is a newly developing area of law
- Some considerations include:
  - Liability for failure to achieve certification: if your program fails to achieve LEED Silver certification, who is liable? What are the damages?
  - Liability for failure to perform: if the project fails to meet energy savings goals, is their recourse against the builder/ design team?
  - Liability for new building materials: what liability would the parties have if the new materials being used had long-term effects on the students, for example the reports of higher formaldehyde levels in green homes in California?

Liability

- Green law presents a number of opportunities to reduce cost and become a more responsible steward of the environment. However, there are also dangers and risk associated with any project. It is important to understand those risk and to get your team in place and prepared beforehand to insure the greatest possible benefit from your investment.

The Way Back Machine

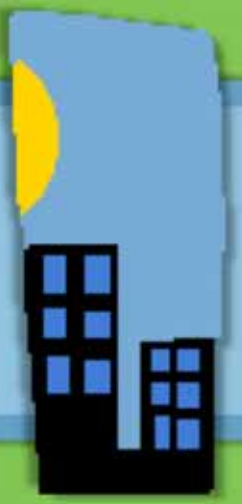


EA Credit 1: Optimize Energy Performance

Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2007 (without amendments) by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Daylighting



One of the most critical physical characteristics of the classroom is lighting

- Affects learner's ability to perceive stimuli
- Affects mental attitude
- Affects performance-academic achievement (5%-26% achievement gains)
- Reduces eye strain
- Positively affects student behavior
- Positively affects attendance
- Growth/development
- Dental health*

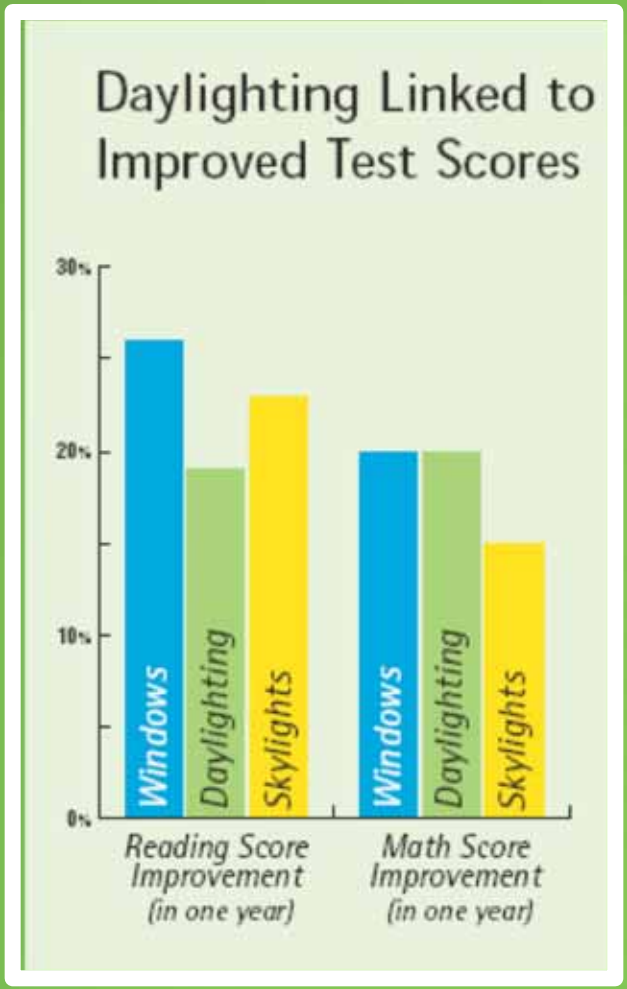
*Hathaway, 1994, The Jordan Institute, 2003

Daylighting

- Increased interest in daylighting
- Student achievement
  - Students with the most classroom daylight progressed 20% faster in one year on math tests and 26% faster on reading tests than those students whose learning environments received the least amount of natural light

Heschong Mahone Group (1999); Plympton, Conway, & Epstein (2000)

Daylighting



U. S. Department of Energy

LEED® Daylighting EQ – 8.1

Requirements

Through one of the three optional methodologies, achieve daylighting in at least the following spaces:

- 75% of all classroom spaces (1 point), or
- 90% of all classroom spaces (2 points), or
- 95% of all other regularly occupied spaces (1 additional point). Project teams can only achieve a point for these other spaces if they have also achieved at least 90% of classroom spaces.

Daylighting defined as 25 horizontal footcandles 30”AFF under best conditions

Good Glass in Houston

We know in a hot humid climate like Houston, that the school design has been to save energy by reducing the amount of glass in the building.

This was a simple solution to the air conditioning. Taking a whole building approach where we integrate building shape, lighting, and air conditioning gives different results. This is a more complicated design and care must be taken by the design professionals.

Light output from lamps is measured in lumens. A lumen is 1 footcandle falling on 1 sq. ft. A footcandle is the amount of light a candle produces measured 1 foot from the candle.

Watt of heat

Lighting Efficacy

Lighting Source	Efficacy (lumens/watt)
Beam Sunlight/ Diffuse Skylight	110–130
High-Intensity Discharge (high pressure sodium, metal halide)	32–124
Fluorescent	55–90
Compact Fluorescent	50–60
Incandescent	10–20

Source: Lawrence Berkeley National Laboratory Lighting Market Source Book for the United States

Sunlight provides more lumens per watt than electrical lamps.

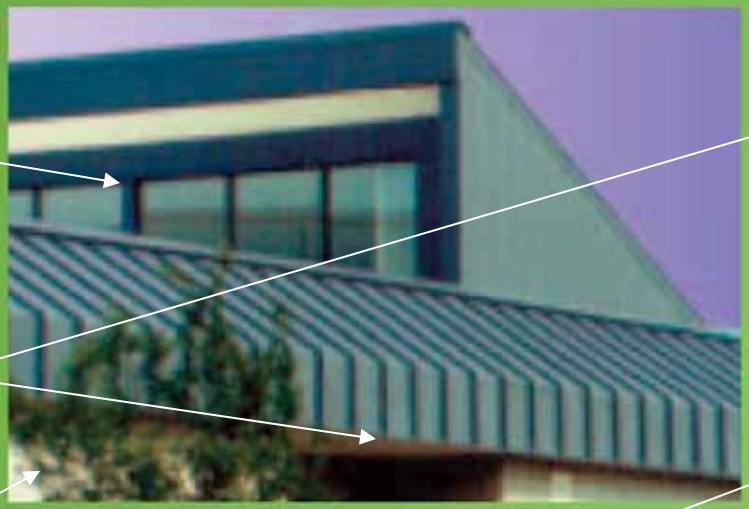
Building Design and Shape

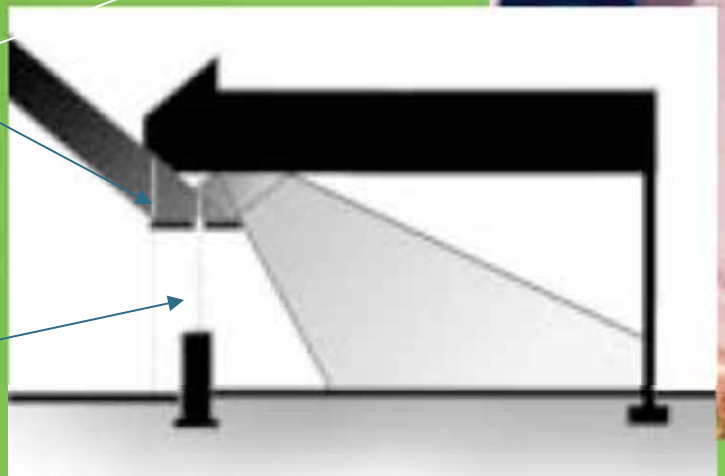
Clerestories

Overhangs

Trees

Light Shelves



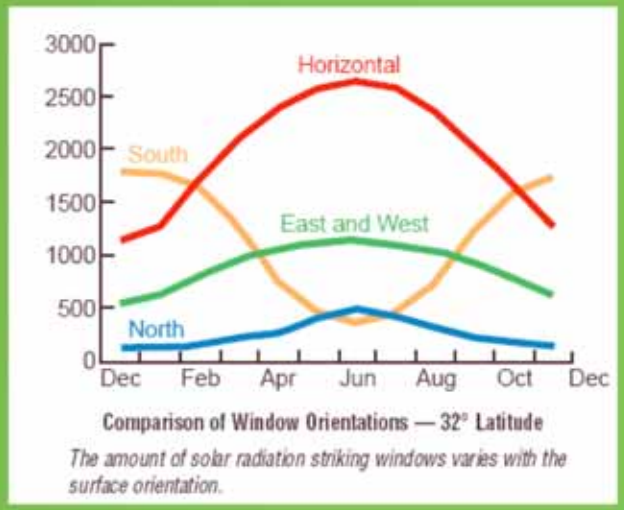


LEED EQ 8.2 Line of sight for 90% of occupied area – 1 Point

Glass Selection, Shading and Orientation

Solar Transmission Values for Typical Glass Types

Glazing Type	Solar Transmission	Equivalent U-Value
Clear, Single	75%–89%	1.11
Clear, Double	68%–75%	0.49
Low-e, Double, Clear	45%–55%	0.38
Low-e, Tinted, Gray	30%–45%	0.38
Low-e, Argon	45%–55%	0.3



Comparison of Window Orientations — 32° Latitude

The amount of solar radiation striking windows varies with the surface orientation.

Light Transmission Values

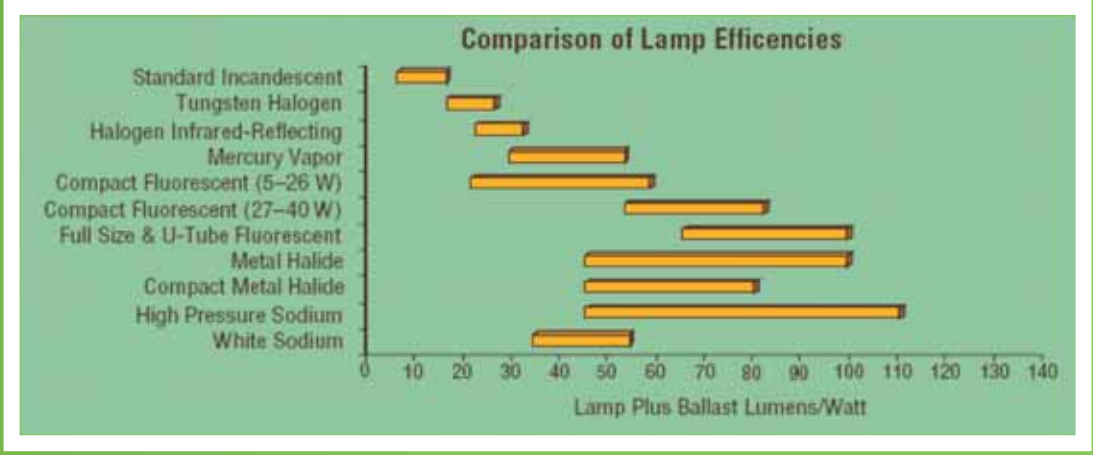
0.9	Standard Double Glazing
0.5–0.9	Internal Venetian Blinds — Drawn
0.4–0.8	Internal Curtains — Drawn
0.4–0.8	Internal Roller Blinds — Drawn
0.7	Heat-Absorbing Glass
0.6	Tree Providing Light Shade
0.5	Internal Blind — Reflective Backing
0.4	Solar Control Glass
0.2	External Blinds — Drawn
0.2	External Shutters — Closed

Adequate Classroom Lighting

- Improves test scores
  - (Jago and Tanner, 1999)
- Reduces off-task behavior
- Plays a significant role in student achievement

What is Adequate?

Room Use	Footcandles	Watts/Sq. Ft.
Reading	20-100	1.2
Demo	100-200	1.4
School	30-50	1.2



EQ Credit 6.1: Lighting System Design and Controllability – 1 Point

- FOR ADMINISTRATIVE OFFICES AND OTHER REGULARLY OCCUPIED SPACES: Provide individual lighting controls for 90% (minimum) of the building occupants in workspaces to enable adjustments to suit individual task needs and preferences.

  AND

- Lighting controls for all educational spaces

  OR

- FOR CLASSROOMS AND CORE LEARNING SPACES, with the exception of chemistry laboratories, art rooms, shops, music rooms, and dance/exercise studios, Provide a classroom lighting system that operates in two modes: general illumination and A/V.
- In general illumination mode, achieve an average illumination at the desk level of 35 to 50 footcandles with a minimum of 25 footcandles at any point more than 3 ft from any wall.
- In A/V mode, not including contribution from the teaching wall light, achieve an average illumination at the desk level of between 10 and 20 footcandles for any point in the room greater than 3 ft from the side walls, 10 ft from the front wall and 6 ft from the back wall, while limiting vertical illumination on the projection screen to no more than 7 footcandles at any point on the screen.

Temperature Control

Thermal Comfort

- Winners of State Teachers' Awards
  - Emphasize their ability to control classroom temperature as central to the performance of both teachers and students

Lowe, 1990; Lackey, 1999, Herschong, Maloney, 2002

66 years ago – New York Commission on Ventilation (1931)

- Commission tried to determine optimal air temperatures in classrooms for healthiest environment for students
  1931 Study - New York Commission on Ventilation

- Experiments were conducted in regular city and rural classrooms, as well as in experimental classrooms on university campuses.

- Students were subjected to varying temperatures – measures of illnesses were taken to compare with temperatures

- When classrooms were not maintained within the narrow band of temperature and humidity tolerances (67-73 degrees F and 50 % relative humidity) there were more cases of student illness than in properly controlled thermal environments

- Temperatures above 74 degrees adversely affect reading and mathematics skills.
- A significant reduction in reading speed and comprehension occurs between 73.4 and 80.6 degrees.
- Ideal temperature range for effective learning in reading and mathematics is between 68 and 74 degrees.

Harner, 1974

The most influential building condition variable that influences student achievement is ***air conditioning.***

F. Lanham 1999

EQ Credit 6.2: Thermal Comfort Controllability 1 Point

- Provide individual comfort controls for 50% (minimum) of the building occupants in workspaces to enable adjustments to suit individual task needs and preferences. Operable windows can be used in lieu of comfort controls for occupants of areas that are 20 feet inside of and 10 feet to either side of the operable part of the window. The areas of operable window must meet the requirements of ASHRAE 62.1-2004 paragraph 5.1 Natural Ventilation.

  AND

- Provide comfort system controls for all shared multi-occupant spaces to enable adjustments to suit group needs and preferences. Conditions for thermal comfort are described in ASHRAE Standard 55-2004 to include the primary factors of air temperature, radiant temperature, air speed and humidity. Comfort system control for the purposes of this credit is defined as the provision of control over at least one of these primary factors in the occupant's local environment.

More Points From Thermal Comfort

- EQ Credit 7.1: Thermal Comfort: Design 1 Point
- EQ Credit 7.2: Thermal Comfort: Verification
- 1 Point

Acoustics

- Most air conditioned classrooms are too noisy.
- Result: speech intelligibility & reduction in overall learning capacity of students
  - Kids with ear infections
  - Second language learners
  - Hearing impaired
  - ADHD
  - Auditory processing
  - Learning disabilities

Learning is Noisy

Learning is Noisy

- "Whether the noise is interior or exterior, student learning suffers," said Nancy B. Nadler, director of the Noise Center and the League for the Hard of Hearing.

- "Deficits in reading and language skills due to poor classroom acoustics are cumulative … the effects of poor classroom acoustics on the very young student can be devastating. "

Research

- Good acoustics are fundamental to good academic performance.
  - Earthman & Lemasters, 1997
- Excessive noise causes stress in students and teachers.
  - Crandall, Smaldino, Flaxer (1995), Nabelek & Nabelek (1994), ASHA (1994)

EQ Prerequisite 3: Minimum Acoustical Performance – Required

- Using the methodology described annexes B through D in Standard S12.60-2002, achieve a maximum background noise level in classrooms and other primary learning spaces of 45 dBA.

  AND

- OPTION 1 - <20,000 CUBIC FEET – All ceiling material has a noise reduction coefficient (NRC) of 0.70 or higher

  OR

- Add sound absorbing materials to room equal in area to the ceiling of NRC 0.70 or higher
- OPTION 2 - >=20,000 - Design classrooms and other core learning spaces to have a reverberation time of 1.5 seconds or less

EQ Credit 9: Enhanced Acoustical Performance 1 Point

- Design classrooms and other core learning spaces to meet the Reverberation Time (RT) requirements of ANSI Standard S12.60-2002, Acoustical Performance Criteria, Design Requirements and Guidelines for Schools. Also design classrooms and other core learning spaces to meet the Sound Transmission Class (STC) requirements, excepting windows, which must meet an STC rating of at least 35.

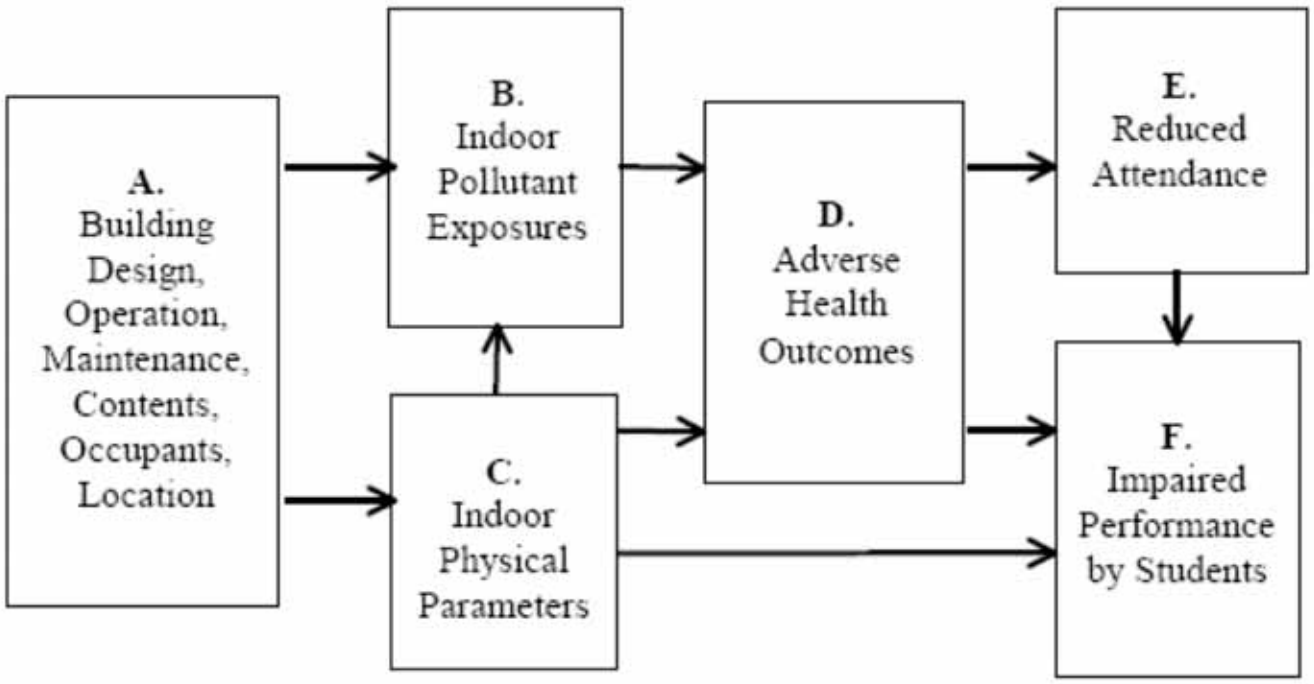
  AND

- Using the methodology described in Standard S12.60-2002, achieve a maximum unoccupied background noise level in classrooms and other primary learning spaces of 40 dBA

Also having vacuum cleaners, buffers, and leaf blowers below 70 dBA can help get a point.

Air Quality

Causal Chains From Building Characteristics To Student Attendance And Performance



[1]Indoor Environment Dept., Lawrence Berkeley National Laboratory, Berkeley, CA, USA
[2]Dept. of Civil and Environmental Engineering, University of California, Berkeley, CA, USA

- Schools are likely to have environmental deficiencies due to chronic funding shortages
  - (U.S. General Accounting Office, 1995).

- Children have greater susceptibility to environmental pollutants due to their relative body size/breathing patterns
  - (Faustman, et. al. 2000)

- Immediate and life long consequence for individual students and for society

In LEED® Certified Schools

- Students and teachers experience fewer sick days
- Instances of asthma are 38.5% lower

Indoor Air Pollutants

- Cause discomfort
- Reduce school attendance and productivity
- Cause or contribute to short- and long-term health problems (asthma, respiratory tract infection and disease, allergic reactions, headaches, nasal congestion, eye and skin irritations, coughing, sneezing, fatigue, dizziness and nausea)
- Can hasten building deterioration

Indoor Air Quality

- EQ Prerequisite 1: Minimum IAQ Performance
- EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control
- EQ Credit 2: Increased Ventilation
- EQ Credit 3.1: Construction IAQ Management Plan: During Construction
- EQ Credit 3.2: Construction IAQ Management Plan: Before Occupancy
- EQ Credit 4: Low-Emitting Materials
- EQ Credit 5: Indoor Chemical & Pollutant Source Control
- EQ Credit 10: Mold Prevention

No Child Left Behind

- The nation needs to attract the best possible teachers to the profession.

Teacher Retention

- Approximately one-quarter of all beginning teachers leave teaching within four years (Benner 2000; Rowan et al. 2002)
  - Poor salary
  - Poor administrative support
  - Student discipline problems

The results of a survey of teachers in Washington, D.C., shows that school facility quality has a “substantively significant” effect on teacher retention.

"…teachers might be willing to take lower salaries in exchange for better working conditions."

Antos and Rosen 1975; Chambers 1977; Murnane 1981; Baugh and Stone 1982; and Hanushek and Lugue 2000

Quality Facilities Keep Qualified Teachers

- "The Effects of School Facility Quality on Teacher Retention in Urban School Districts" (February 2004)
  - Temperature
  - Classroom lighting
  - Noise levels

- Improving school facilities may be the most cost-effective way to influence a teacher's decision to remain at a school.

Curricular Connections

ID Credit #3 – The School as a Teaching Tool – 1 point

WiseWatt

- Commit to implementing the curriculum within 10 months of LEED® certification
- Explore relationship between human ecology, natural ecology, and the building ecology
- Meet local, state curriculum standards
- Be approved by school administration
- Provide 10 or more hours of classroom instruction per student

Smart Energy Choices – Win-Win

- Community: tax money optimized
- Reduced environmental impact of power generation
- Student achievement
- Teacher retention
- Teach kids about environmentally responsible energy choices

In Conclusion

- Improving the quality of school facilities can be expensive.
- However, improving school facilities positively impacts student achievement.
- Benefits for teacher retention can be greater than those benefits gained by pay raises.
- Facilities improvement is a one-time expense (standard offer and other funds are sometimes available)

Questions

Contact the speakers at:

www.wisewatt.com

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