Reducing Energy in Heating, Cooling and Lighting

Green and Healthy Property Management

Prepared with Assistance from:
Tohn Environmental Strategies &
Steven Winter Associates

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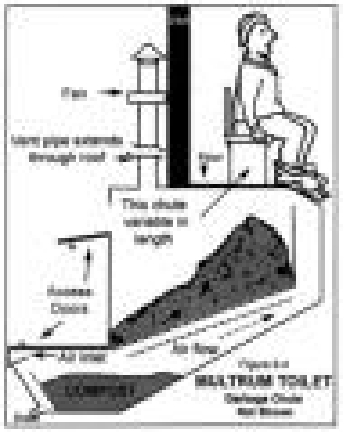
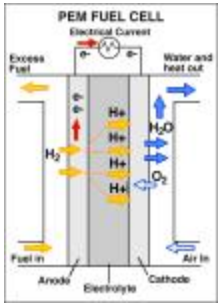
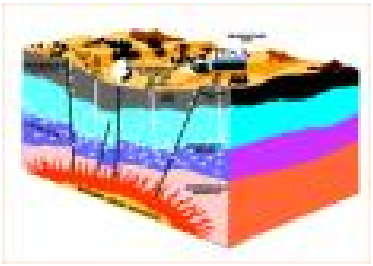
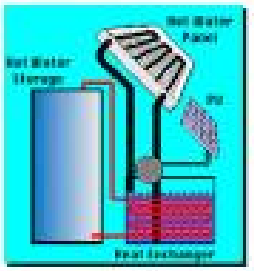
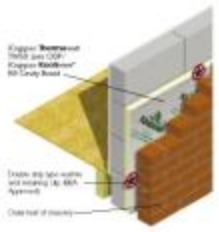
Where Do You Start?











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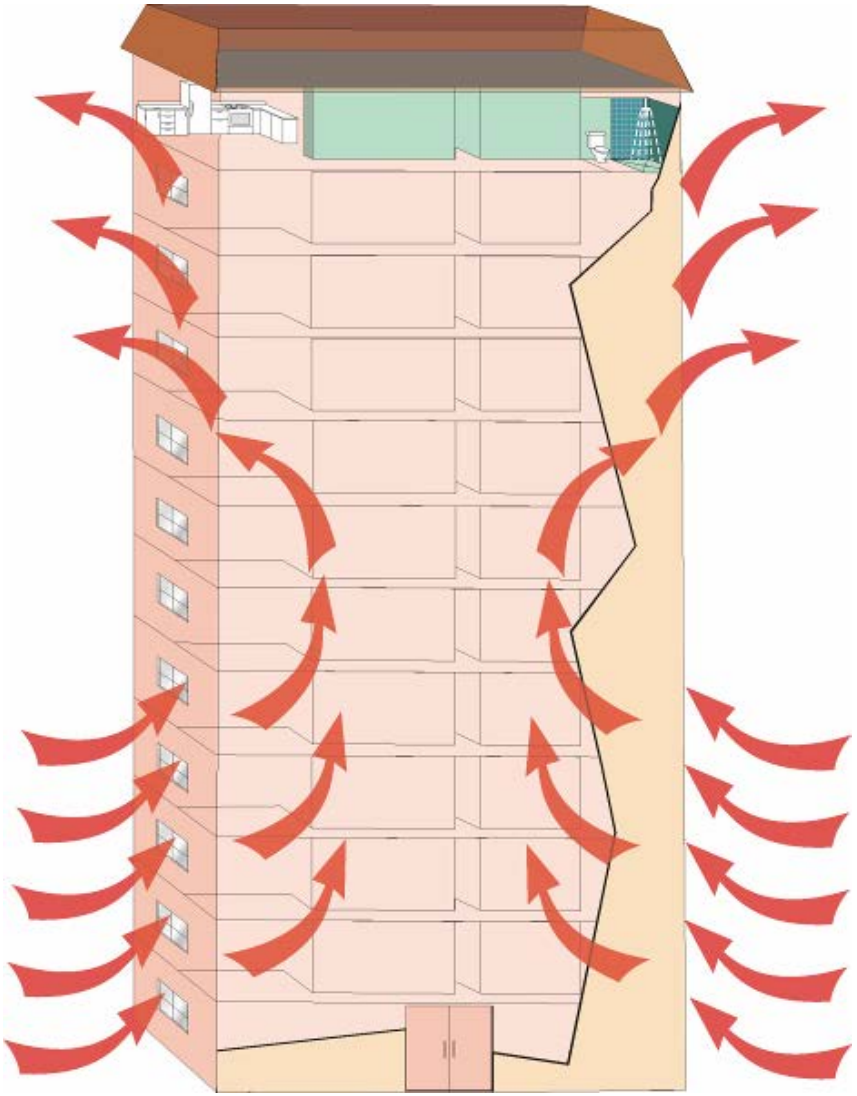
High Performance Building Strategies

- **Design and build a better building envelope**
- **Build tight, ventilate right**
- **Size the HVAC to the building load**
- **Reduce avenues for water penetration (flash =cash)**

- **Specify high efficiency HVAC, appliances, & lighting**
- **Specify materials with fewer pollutants**
- **Reduce water usage in buildings**
- **No unproven technologies, gadgets, or high costs**

Stack Effect



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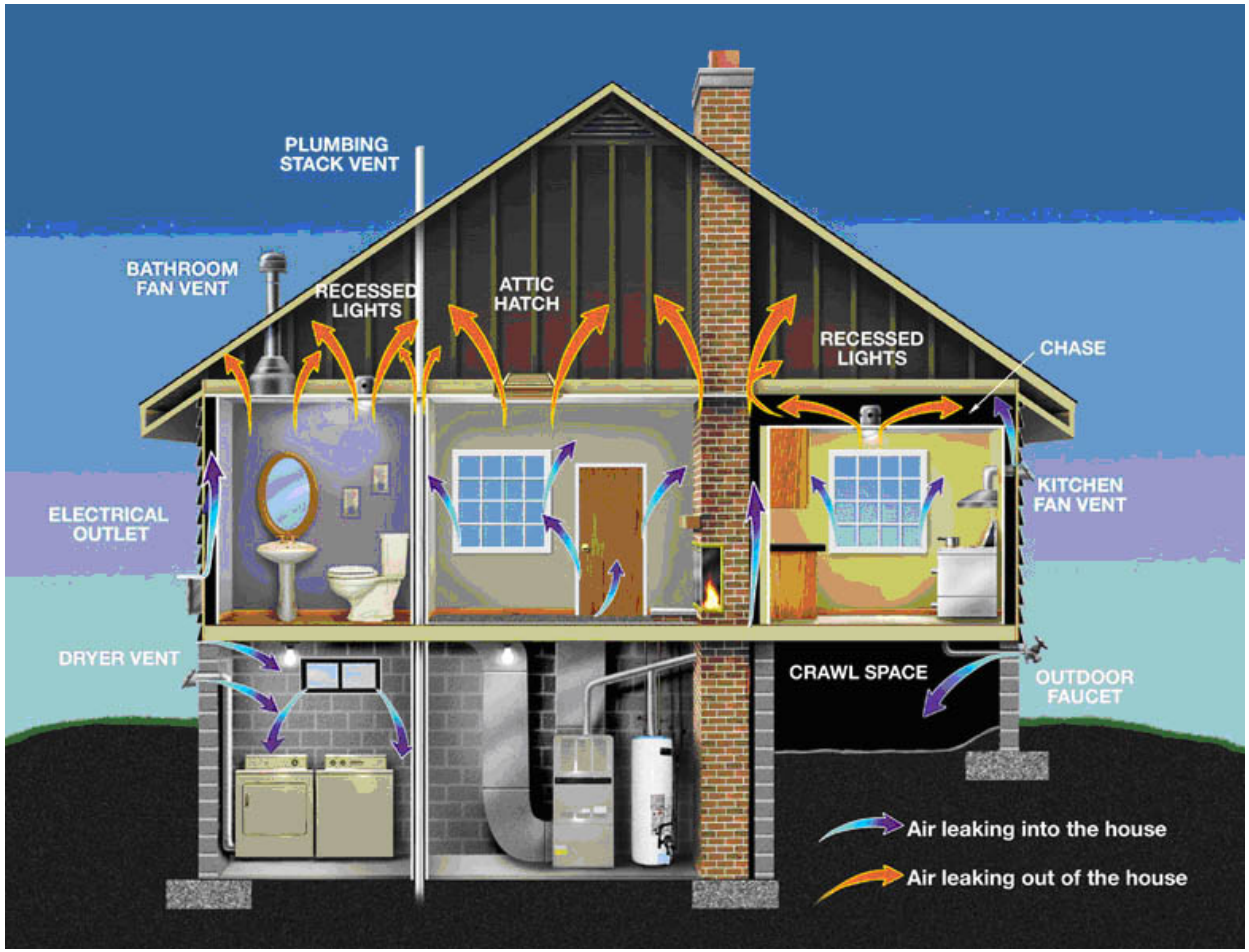
Building Energy Loss

- By Infiltration and Ventilation
  - By air movement into, through, and out of conditioned spaces
  - Stack and wind effects, shafts & by-passes
  - Exhaust & supply fans

It's all in the envelope



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What wastes the most energy in my building?

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A physicist would consider your building a "*system*"

- The building consists of an envelope
    - walls, floors, windows, roofs, doors
- But also equipment:
    - elevators, lights, boilers, Domestic Hot Water heaters, chillers, air conditioners, motors, plumbing, etc
- And all of which are connected to the most important part of the system…

The building occupants!

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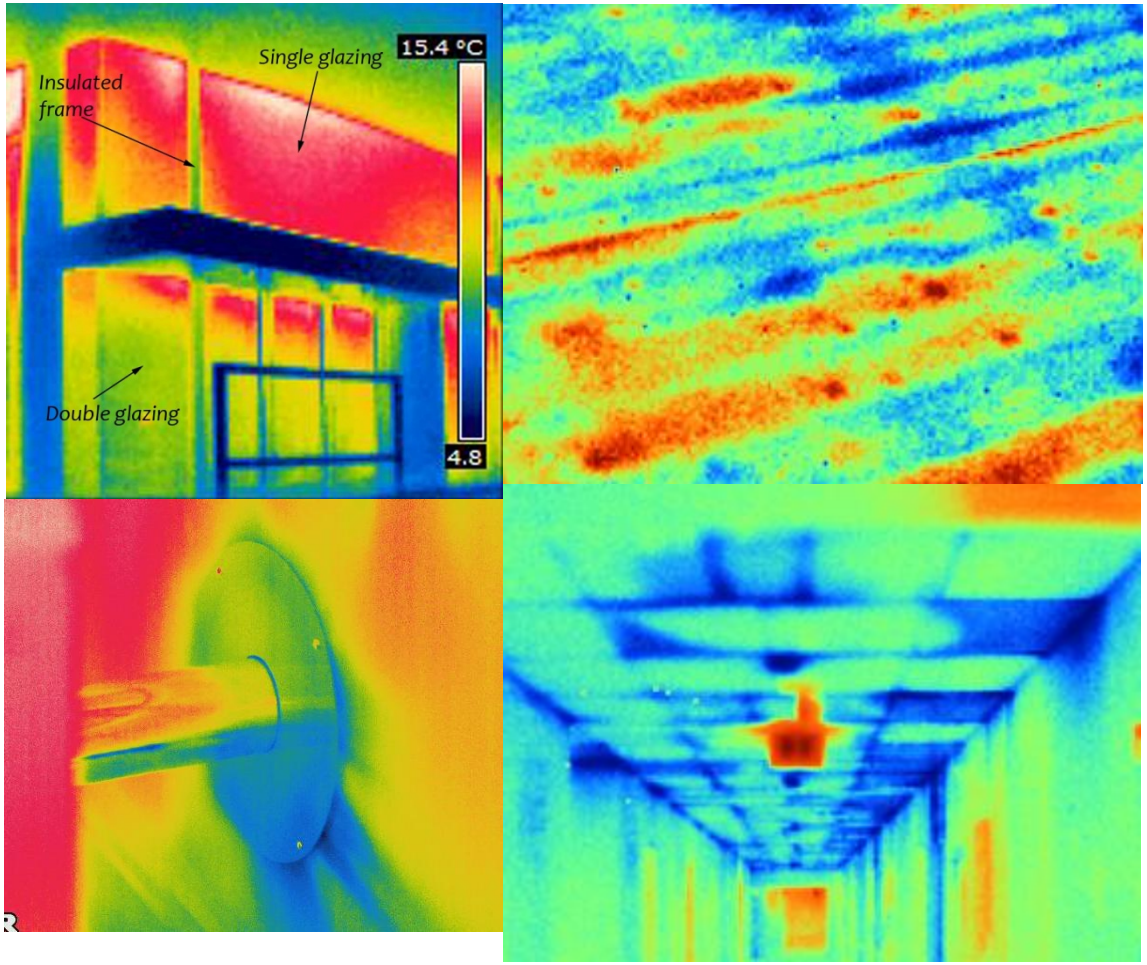
Most common energy hogs

- Building envelope
  - Non-insulated roof
  - Broken windows
  - Single-pane windows
  - Poor air-sealing tightness



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Most common energy hogs

- Building equipment
  - Non-insulated piping in basement
  - Leaks (steam, water)
  - Inefficient or oversized boiler/burner
  - Poor or no heating control equipment
  - Poor heating Distribution: balancing problems
  - Incandescent lighting
  - Obsolete refrigerators
  - DC motor elevators

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Most common energy hogs

- Common area lighting on 24h/day
- Occupant behavior and poor use of equipment
  - Controls are not set properly: typically generates overheating
  - Window opening during winter time
  - Apartment lights on 24h/day
  - Lack of maintenance on mechanical equipment

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Top Strategies for Greening Existing Buildings

1. Air Sealing
2. Lighting & Appliances
3. Heating & Domestic Hot Water (DHW)
4. Insulation
5. Motors & Pumps
6. Windows
7. Preventative Maintenance!

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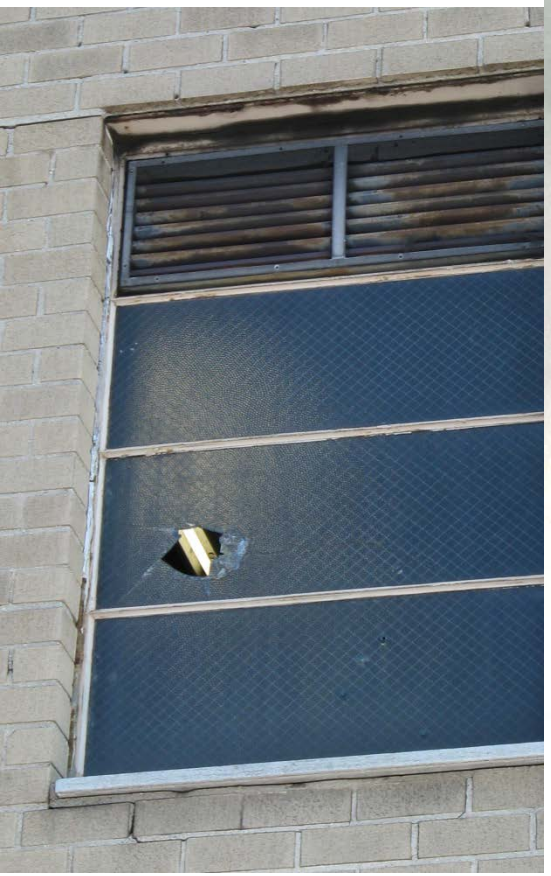
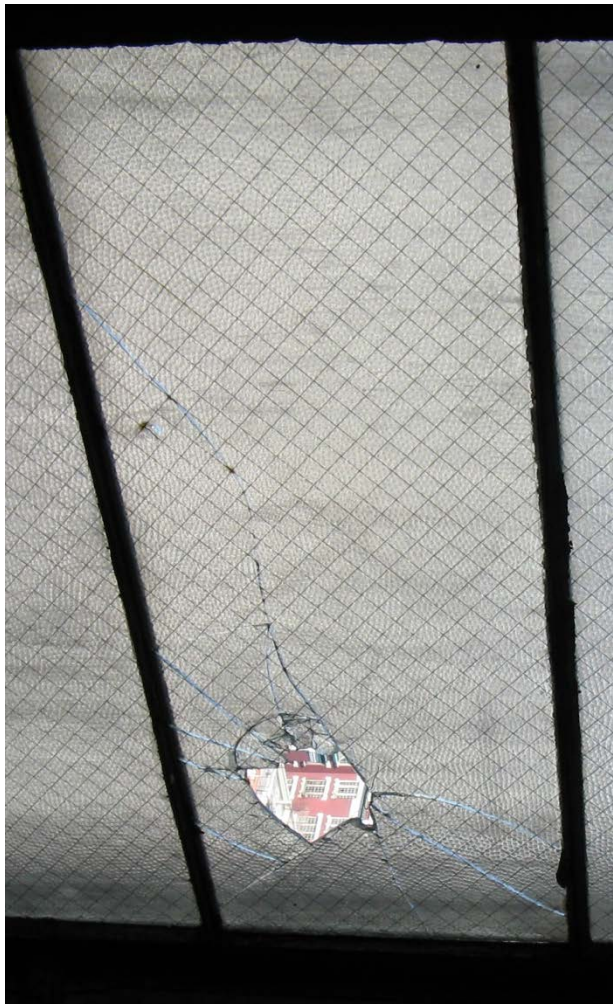
AIR SEALING

Holes High and Low in the Building





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So, all this heat crawls into these bypasses, where does it end up?

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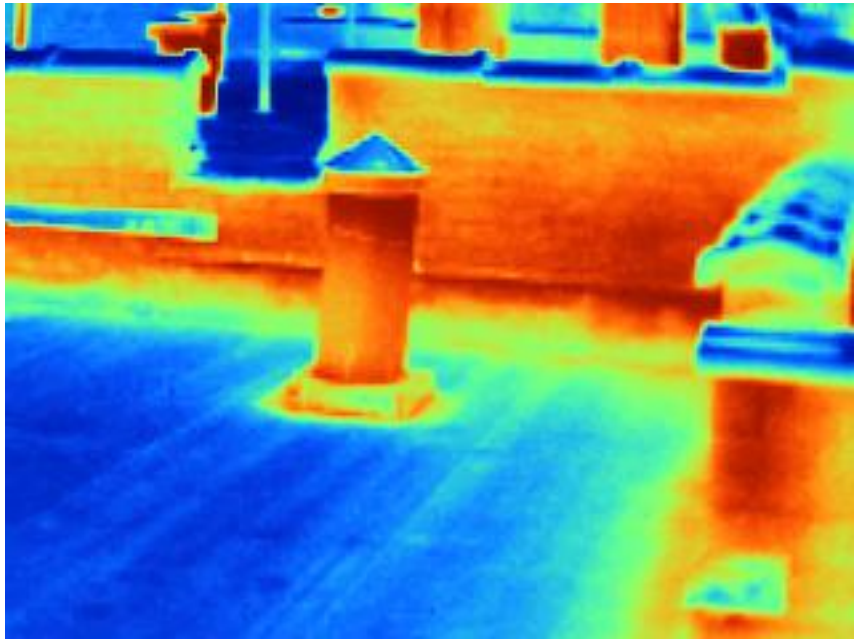

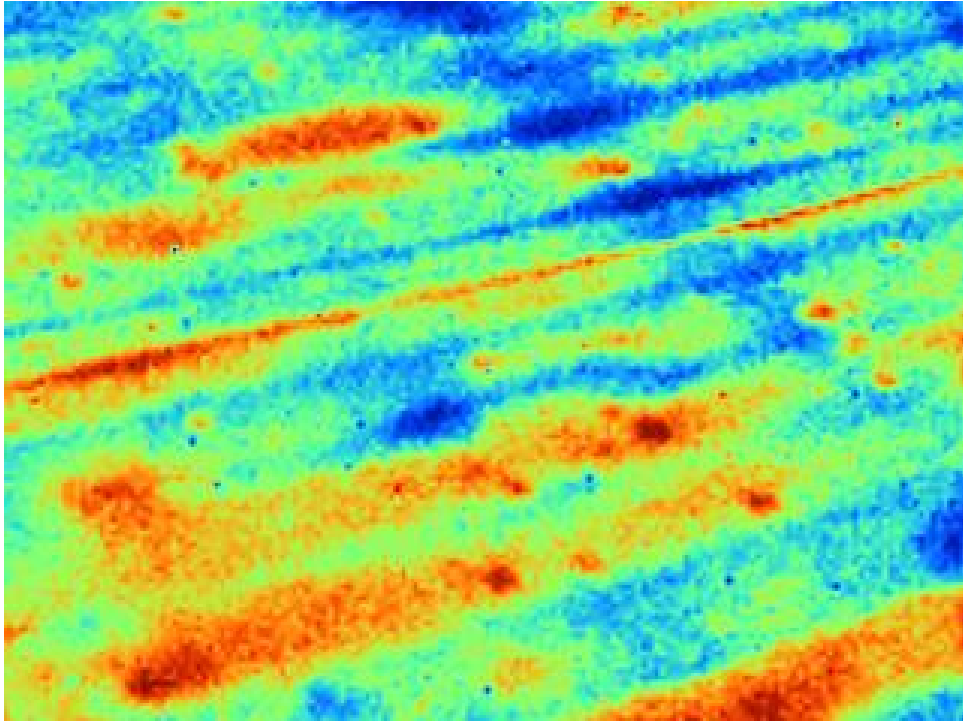

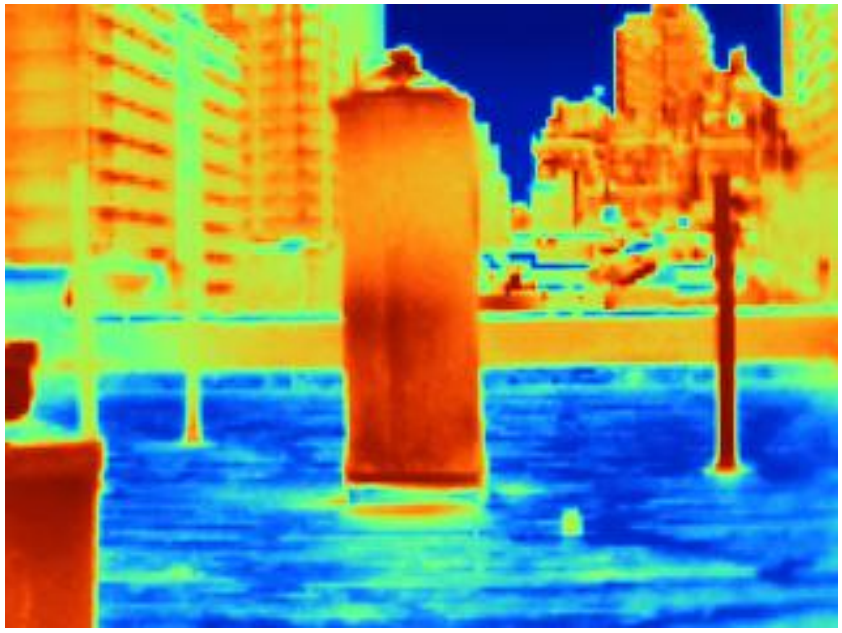

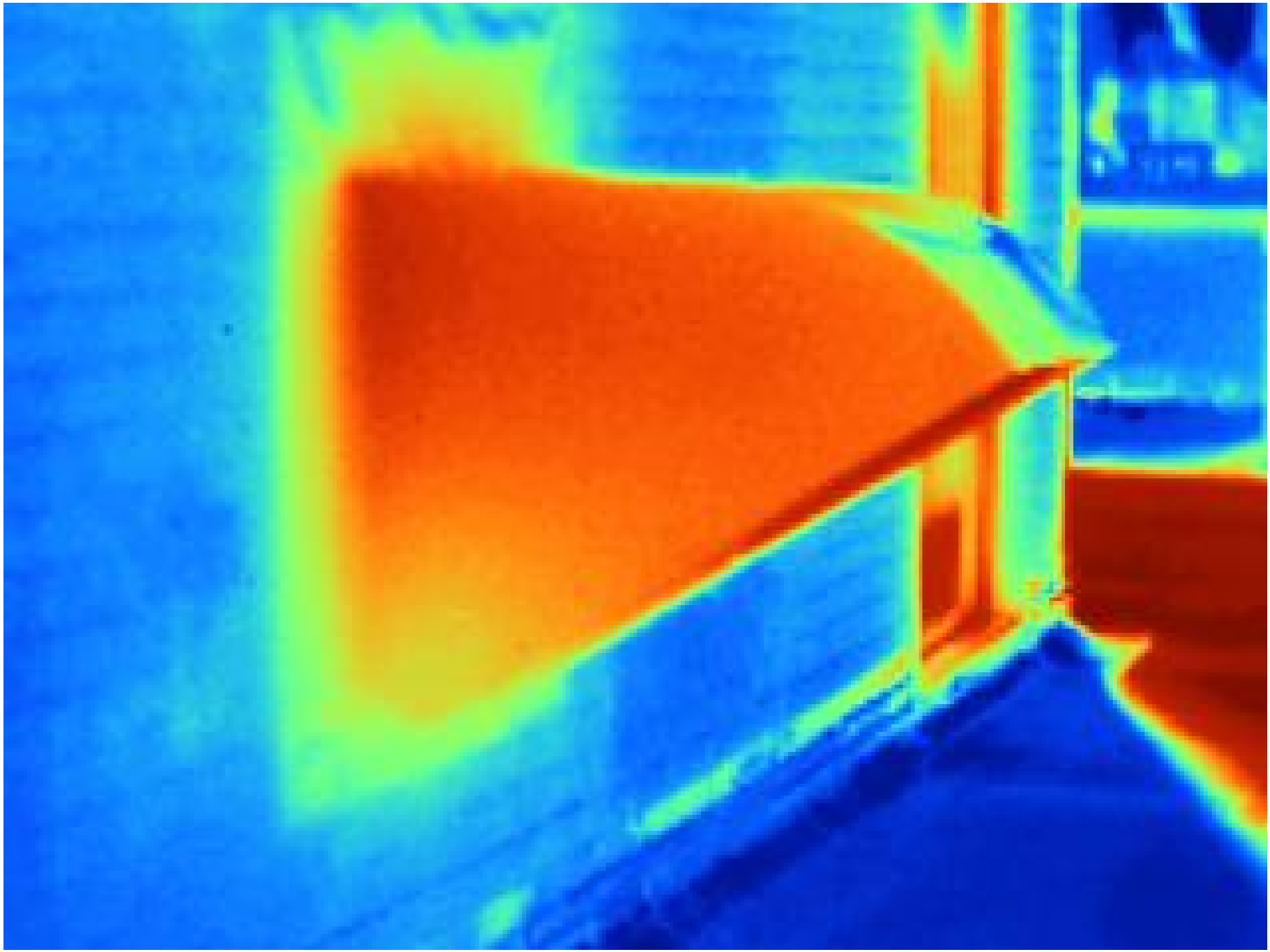

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Windows Not the Best Opportunity for Savings

"Typical" percentage of total envelope area for a 5-story walkup building:

		Typical	*Recommended*
Walls	60%	R-11	R-19
Roof	20%	R-30	R-49
Windows	15%	R-1.5	R-3*
Basement	3%	R-9	R-13
Doors	2%	R-1.5	R-3*

This is dependant on your climate, but only varies from 1.5-3.5.

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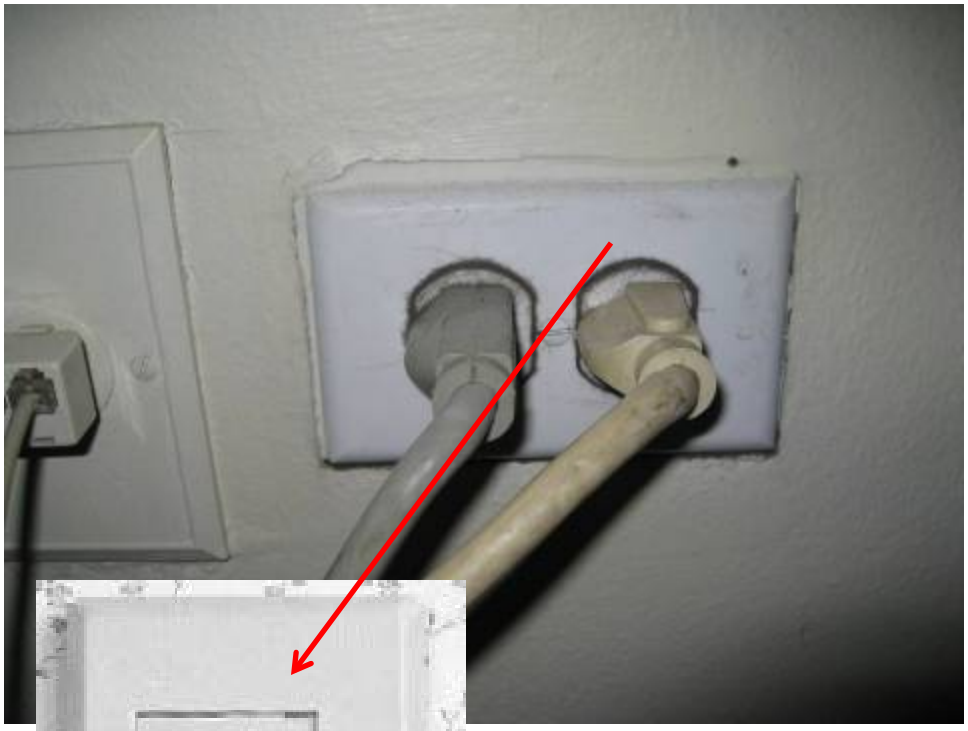
Most Common Air Sealing Opportunities

- Electrical penetrations
- Plumbing penetrations
- Window framing
- Wall to floor connection
- Doors and vestibules
- Basement ceiling
- Radon…?
  - Checking concentration before sealing

Air Leakage – Compartmentalization



Cardinal Care Covers: meant for safety but helps in air sealing.

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Pipe and Plumbing Chases

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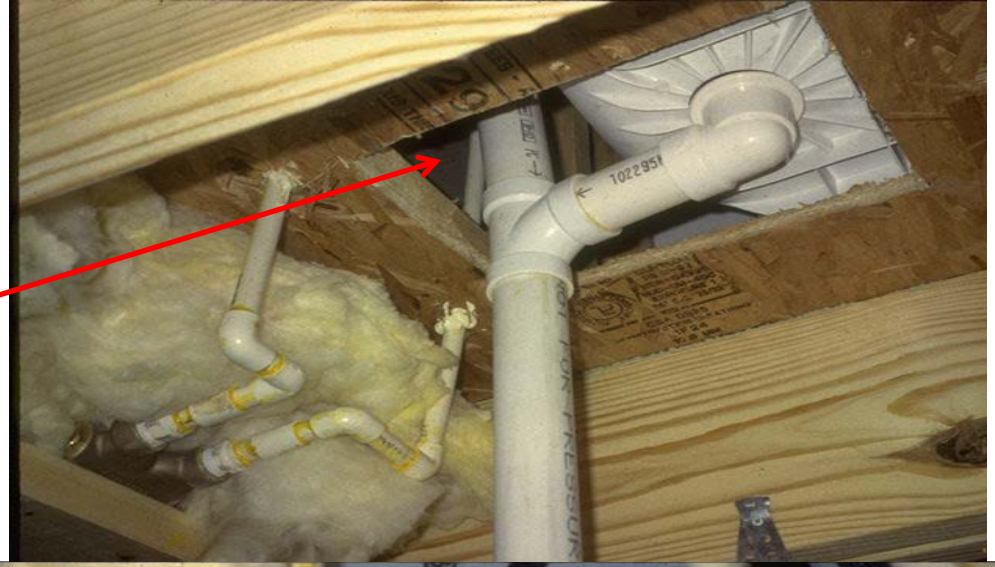
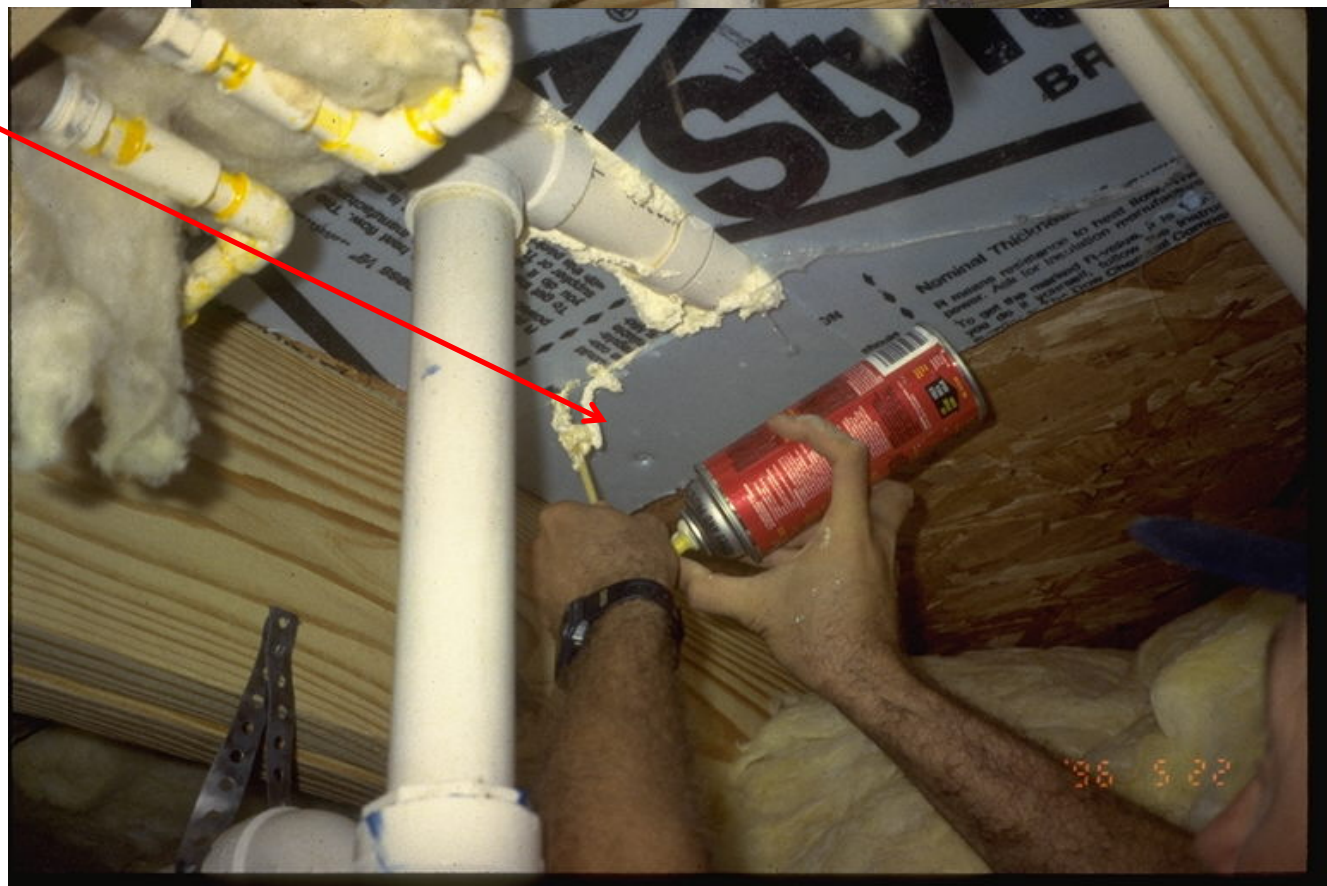
Under side of the bathtub being insulated and air sealed.





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AIR SEALING

Specifications needed:

- "Concealed spaces within partitions, walls, floors, roofs, stairs, furring, pipe spaces, column enclosures, etc. that would permit passage of flame, smoke, fumes, or hot gases from one

  floor to another floor or roof space, or from one concealed area to another, shall be *sealed* to form an effective draft barrier, or shall be filled with noncombustible material"

- oops, that's "Firestopping"

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Lighting

Don’t ignore because:

- It could be the highest electricity usage and cost
  - For some buildings it’s 40% of the cost.
- Fluorescents use 1/3 of the energy used by incandescent lighting and last 10 times longer

Before you retrofit, beware of:

- **Code minimums**
- **Retrofit vs. Replace**
- **Rewiring**

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Screw-in base CFLs

Tubular

Globe

Flood lamp

Spiral

2

Lamar Occusmart dimming fixture - Savings and Payback

This assumes changing 20 fixtures and reducing to 20% light levels.

HOURS/DAY LIGHTS ARE ON	24.00
HOURS PER DAY SPACE IS OCCUPIED (Note: Average Stairwells are Occupied less than 5% per 24 hr Day (1.2 hrs.))	2.00
ENERGY RATE kWh ($)	$0.200
TOTAL WATTAGE OF EXISTING SYSTEM (1 FIXTURE)	68
TOTAL WATTAGE OF PROPOSED SYSTEM (1 FIXTURE - FULL LIGHT)	64
TOTAL STANDBY WATTAGE (1 FIXTURE)	12
TOTAL NUMBER FIXTURES (EXISTING SYSTEM)	20
TOTAL NUMBER FIXTURES (PROPOSED LAMAR OCCU-SMART SYSTEM)	20
NEW FIXTURE COST (1 FIXTURE)	$250.00
APPLICABLE REBATE (PER FIXTURE)	
COST PER WATT PER YEAR	$1.75
ANNUAL COST TO OPERATE EXISTING SYSTEM (PER FIXTURE)	$119.14
TOTAL ANNUAL COST TO OPERATE EXISTING SYSTEM	$2,382.72
ANNUAL COST TO OPERATE LAMAR OCCU-SMART SYSTEM (1 FIXTURE-FULL OUTPUT)	$112.13
TOTAL ANNUAL COST TO OPERATE LAMAR OCCU-SMART SYSTEM (FULL OUTPUT)	$2,242.56
ANNUAL COST TO OPERATE 1 FIXTURE (BASED UPON OCCUPANCY)	$28.62
TOTAL ANNUAL COST TO OPERATE OCCUSMART SYSTEM (BASED UPON OCCUPANCY)	$572.32
ANNUAL SAVINGS PER FIXTURE (0% OCCUPANCY- REDUCED OUTPUT)	$91.10
ANNUAL SAVINGS PER FIXTURE (BASED UPON OCCUPANCY)	$83.51
TOTAL ANNUAL SAVINGS (BASED UPON OCCUPANCY)	$1,810.40
PAYBACK (YEARS) BASED UPON OCCUPANCY	3.08
PAYBACK EXPRESSED IN RETURN ON INVESTMENT	32.49%

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2

Opportunities for Occupancy, Photo Sensors & Bi-level Lighting

- Boiler rooms
- Storage rooms
- Garbage rooms
- Equipment rooms
- Elevator rooms
- Slop sink rooms
- Meter rooms
- Offices
- Laundry rooms
- Apartments?
- Exterior lighting during the day!!!!!
- Garage lighting

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What's wrong here?

Lens of photosensor

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What's wrong here?

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Air Conditioners

- Need to be sized to the apartment load
- If they are too big, they will cool the room but not remove humidity
- Need to be Energy Star
- Cannot put a window unit in a sleeve
- Sleeve units are less efficient

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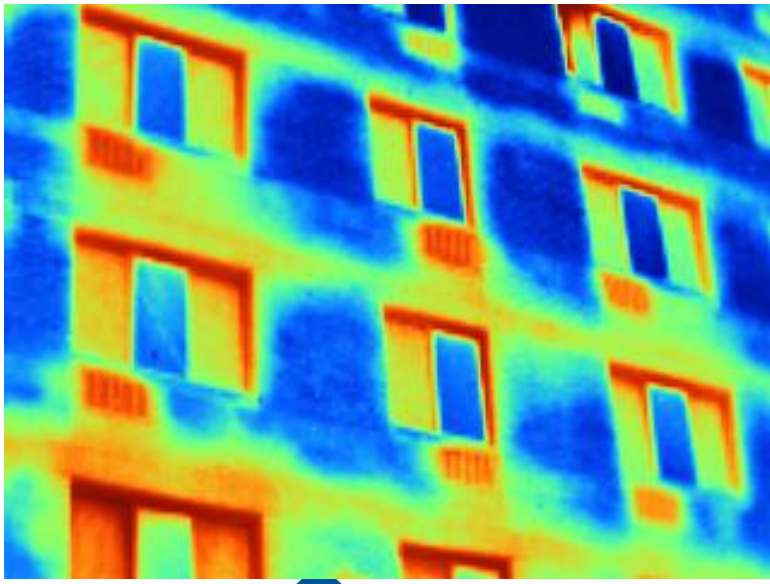
AC COVERS

- For window units, they cover and protect the condensing unit while stopping some air leakage.
- For sleeve units, they also protect the uni and prevent leakage through the sleeve.



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Get the American Home Appliance Manufacturers (AHAM) guide to purchasing and sizing room A/C units:

http://www.cooloff.org/

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Refrigerators & Dishwashers

- Refrigerators
  - Specify Energy Star
  - Use a Kill-o-Watt meter to determine real usage of older models
- Dishwashers
  - Specify Energy Star
  - Uses less water than hand washing dishes

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Clothes Washers and Dryers

- Usually leased with a service contract
- Ask for Energy Star washers
  - Front load washers use less water, less hot water, and wring clothes out better
  - Drying time is shorter, clothes are cleaner
- Dryers should NEVER be electric, gas is more efficient
- Your supplier carries Energy Star appliances and will install if you pester them
- Require that all gas dryers be vented to the exterior. Require CO detectors in all rooms with gas dryers.

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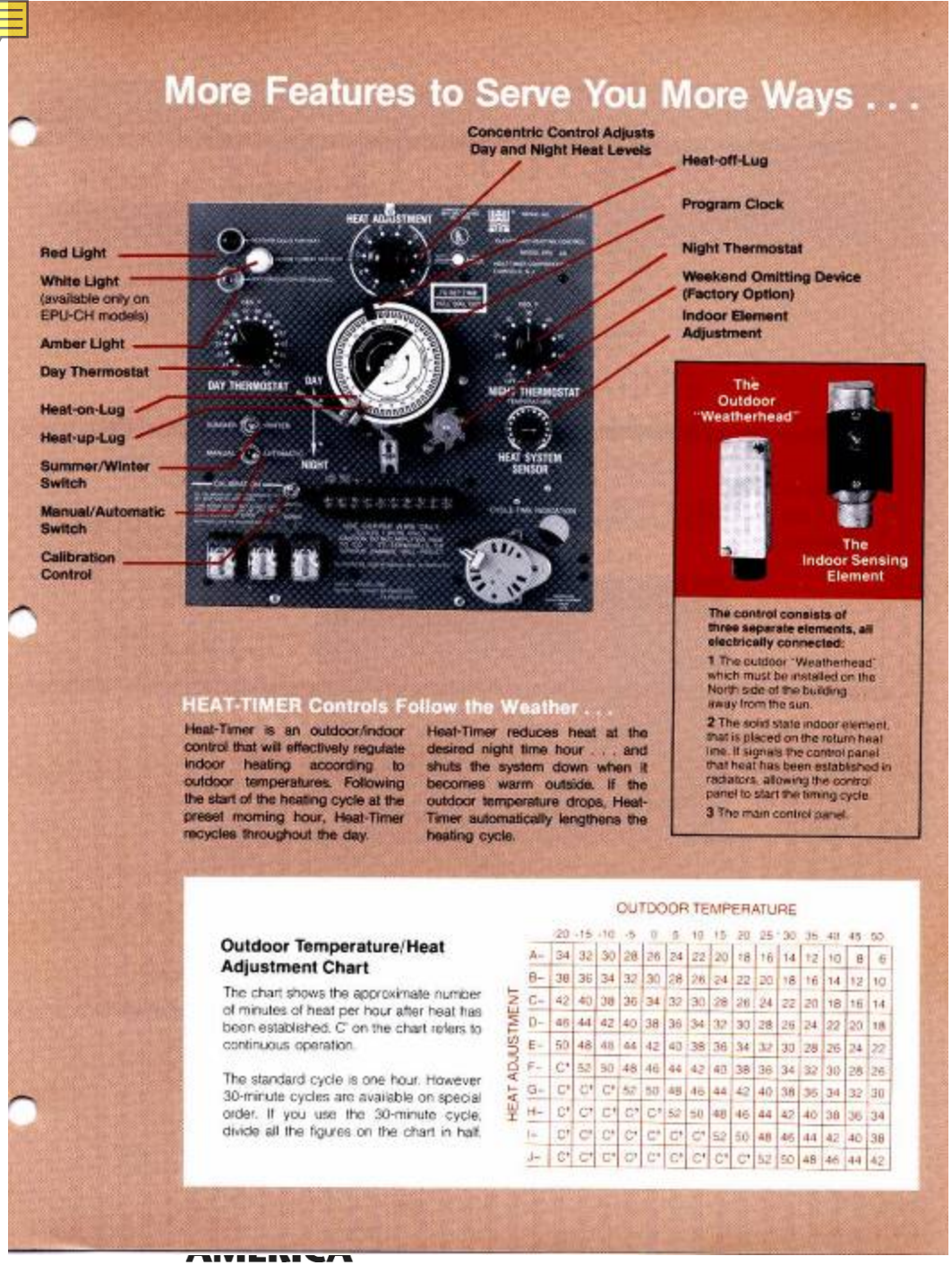
Lighting & Appliances

Energy Saving Solutions:

- Specify Energy Star (ES) lighting: all bulbs, all fixtures, all exit lights
- Specify ES appliances: refrigerators, dishwashers, washing machines (even contracted from laundry services), ventilation fans, etc.
- Specify high efficiency motors (MotorMaster computer software free!)
- Use any incentives available for electrical upgrades (www.dsireusa.org)

HEATING/DHW EQUIPMENT

- Specify heating systems – don't just replace with same
- Stop specifying inefficient/cheap equipment (min efficiency 85% efficient)
- Specify Energy Star equipment
- Have the equipment sized to load, make your engineer show the math (Ask for the Manual J report)
- Consider DHW storage from boiler or combined DHW/furnace



Who has seen one of these before?

Who has a building manager who uses it correctly?

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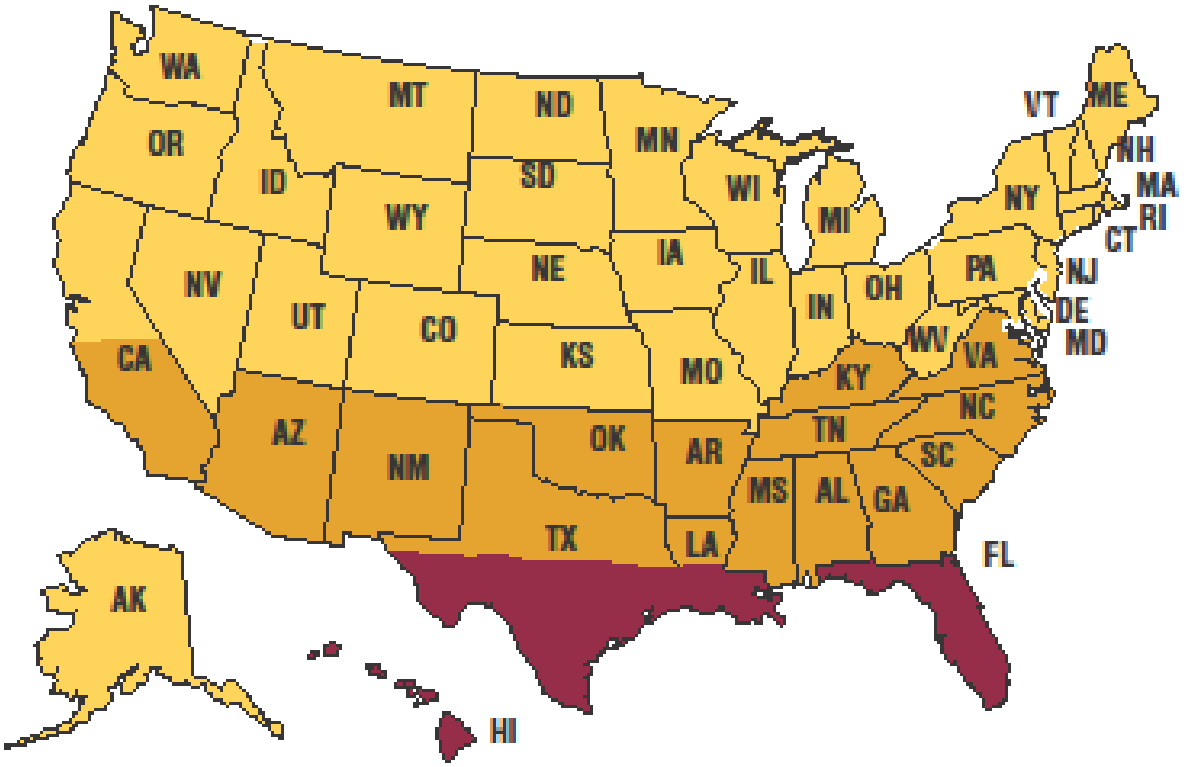
INSULATION

Insulation is incorrectly or poorly installed, or sometimes not installed at all.

R-Values for Optimum Home Energy Savings and Comfort



Ceilings: R-49
Walls: R-21
Floors: R-30
Basement Wall: R-13

Ceilings: R-49
Walls: R-15
Floors: R-30
Basement: R-13

Ceilings: R-38
Walls: R-15
Floors: R-30
Basement Wall: R-13

www.naima.org

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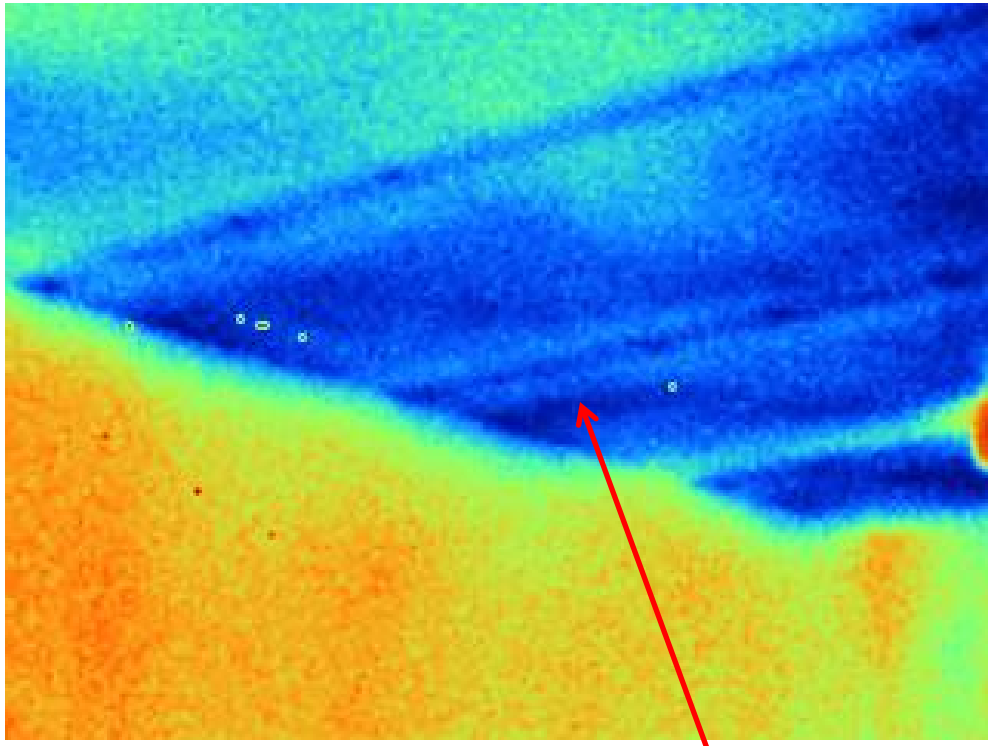
4



Missing insulation in the ceiling

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INSULATION

Solutions:

- Use infrared imaging as a method of identifying missing and/or sagging insulation
- Train and oversee insulation subs
- Fit insulation in place and cut around plumbing and wiring boxes to fit in place without compression
- Change framing practices; specify framing to be optimum value engineered (OVE) framing

MOTORS

- Elevator
- Fans
- Boiler Pumps
- Hot Water Pumps
- Water Booster Pumps
- Many others specific to your buildings

Motors use ½ of all electricity in the US!

To find the most efficient replacement motors available, download the FREE MotorMaster software:

http://www1.eere.energy.gov/industry/bestpractices/SoftwareToolDownload.asp?prodID=5&CustID=32945&ProdName=MotorMaster+%204.0

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“Cool” suggestions for improving chiller operation

- Oil-free, magnetic bearing Turbocor compressors: can save up to 40% of electricity on electric chillers. New high efficiency chillers include this technology: McQuay, Smardt,… but retrofit kits can be installed on existing chillers.
- Soft start capability
- Variable Frequency Drives on circulating pump motors, condenser water pumps motor, cooling tower fans.

WINDOWS

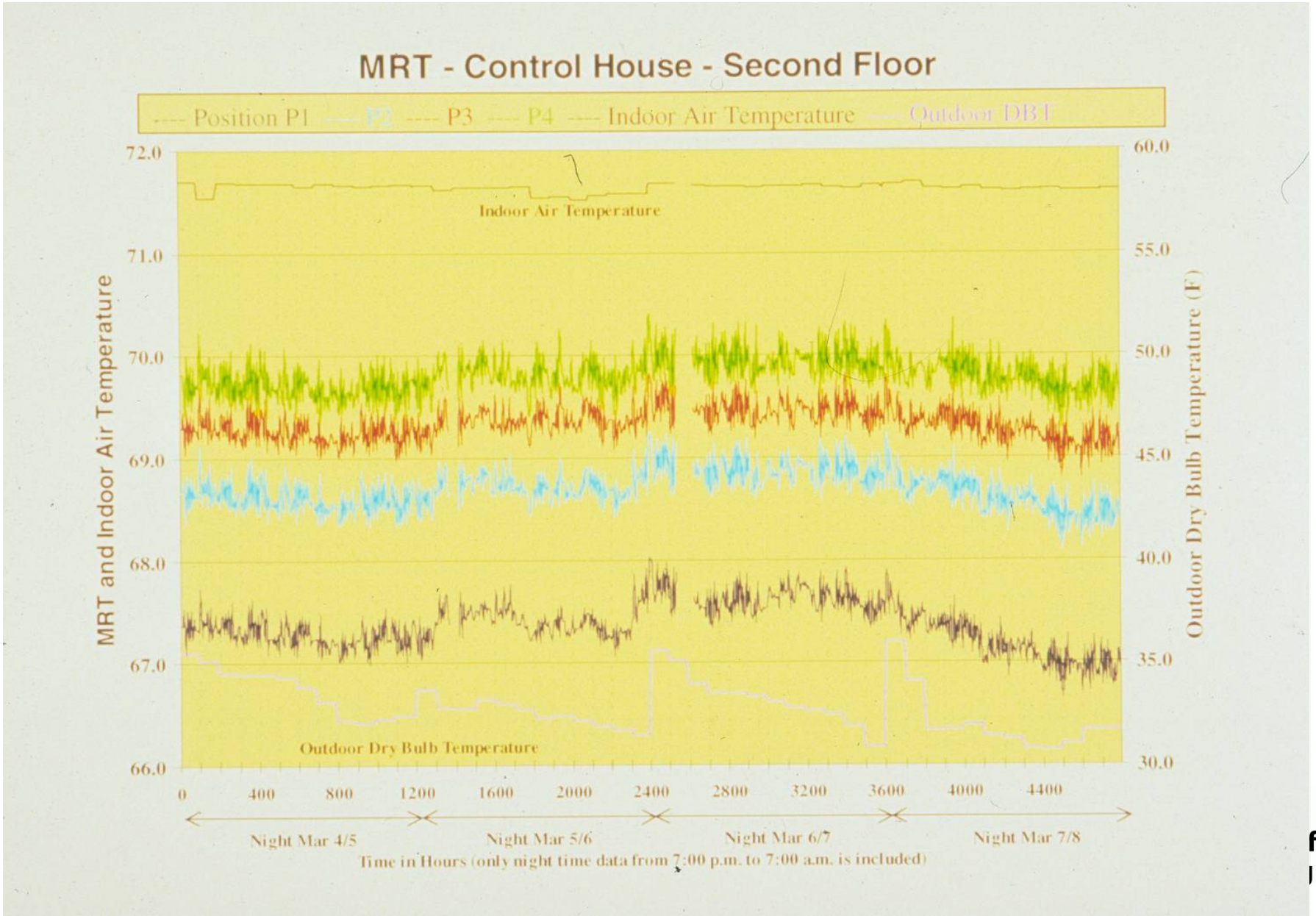
Poor window specifications and resistance to the use of vinyl or other higher performing windows cause poor performance and complaints.

(they are rarely cost-effective as an energy item)

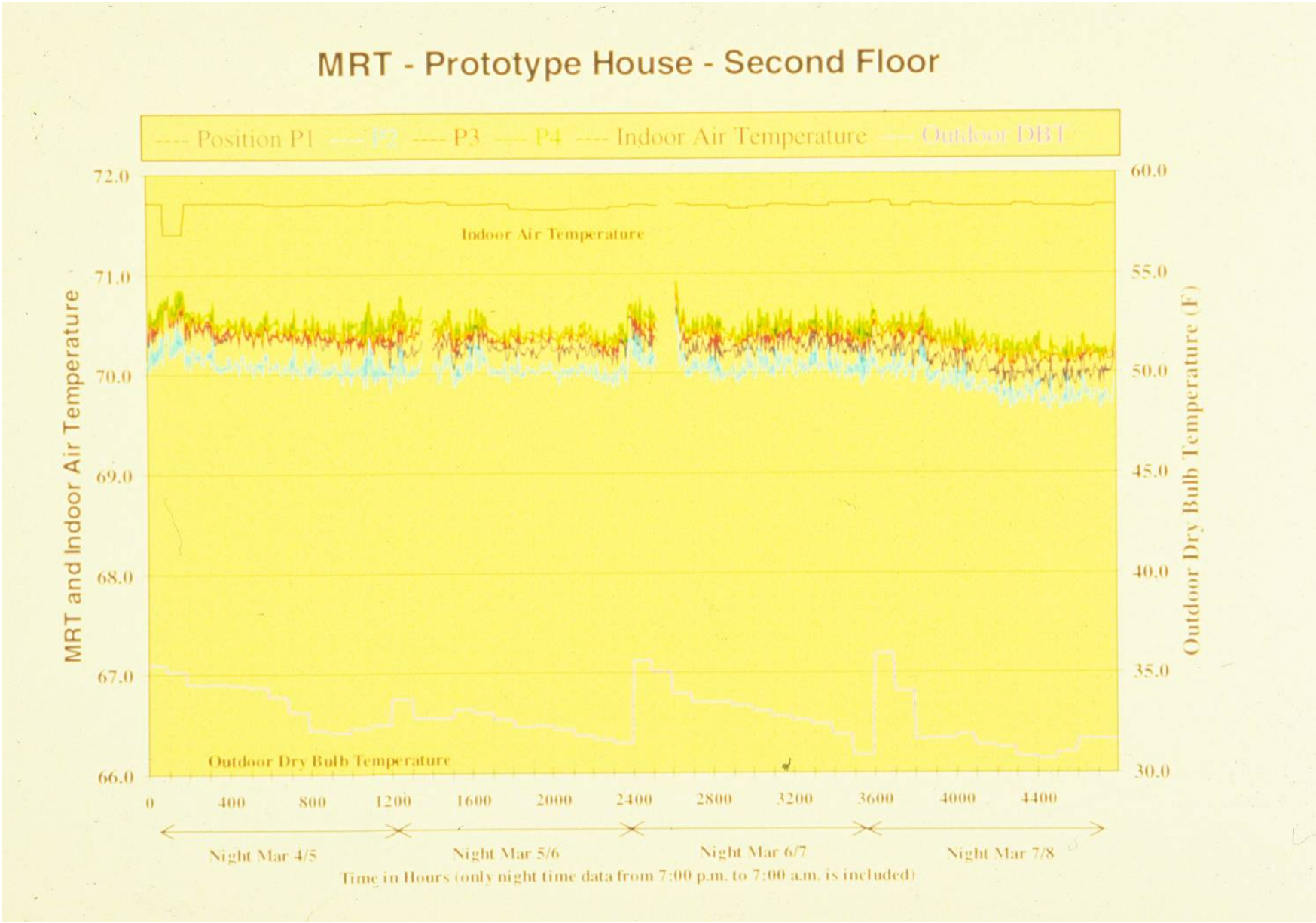
Windows

Measuring Effectiveness of Low-E Coatings

No Low-E Coating



Retrofitted w/ Low-E Coating



Retrofitting w/ Low-E Coating*

- Low-E window film = $3/sf
- New window = $40/sf
- Low-E film provides 6.6 times greater energy cost savings that total replacement with low-e windows
  - In the south, savings were 10.2 times greater
- Retrofitting averaged 5% total building energy cost savings, but ranged as high as 10% in the southern climate zone

*Source: Comparative Analysis of Retrofit Window Film Replacement w/ High Performance Windows, *Steve DeBusk Global Energy Solutions, 2005*

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New windows need to have:

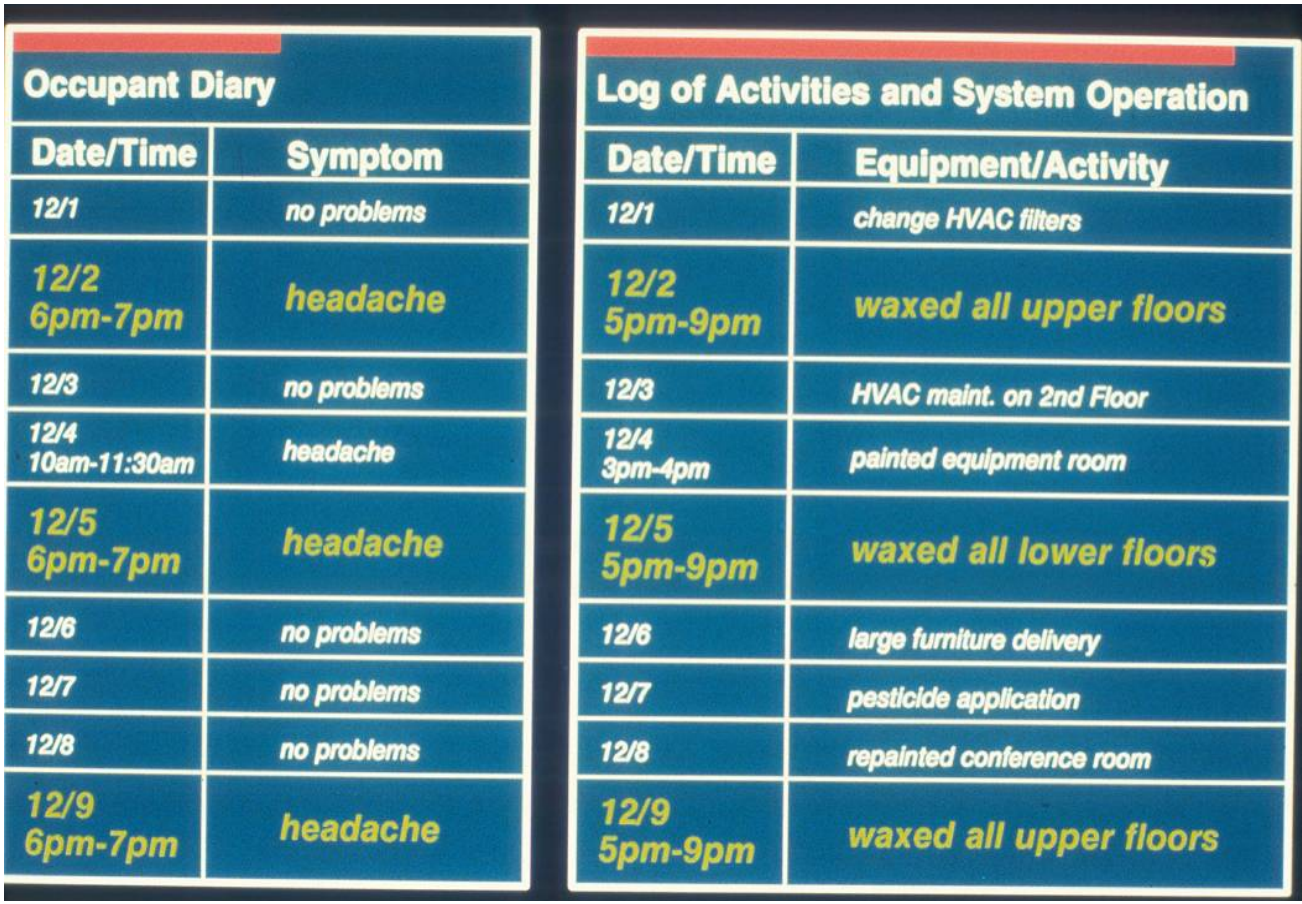
- Minimum double pane
- Frame that conducts less heat/cold
- Proper installation procedures
- Low emissivity (low-e) coatings particular to your region
- Overall R-Value established by NFRC

Preventive Maintenance

- Scheduled maintenance rather than emergency calls for services can significantly reduce operating costs
- Keep documentation on:
  - Equipment inventory
  - Inspection and maintenance schedule
  - Work order system
  - Response policy and procedures
  - Contractors and vendors
- Keep electronic records

Log book

- One book per building
- Log date of event
- Compare complaints and building activities



Occupant Diary

Date/Time	Symptom
12/1	no problems
12/2 6pm-7pm	headache
12/3	no problems
12/4 10am-11:30am	headache
12/5 6pm-7pm	headache
12/6	no problems
12/7	no problems
12/8	no problems
12/9 6pm-7pm	headache

Log of Activities and System Operation

Date/Time	Equipment/Activity
12/1	change HVAC filters
12/2 5pm-9pm	waxed all upper floors
12/3	HVAC maint. on 2nd Floor
12/4 3pm-4pm	painted equipment room
12/5 5pm-9pm	waxed all lower floors
12/6	large furniture delivery
12/7	pesticide application
12/8	repainted conference room
12/9 5pm-9pm	waxed all upper floors

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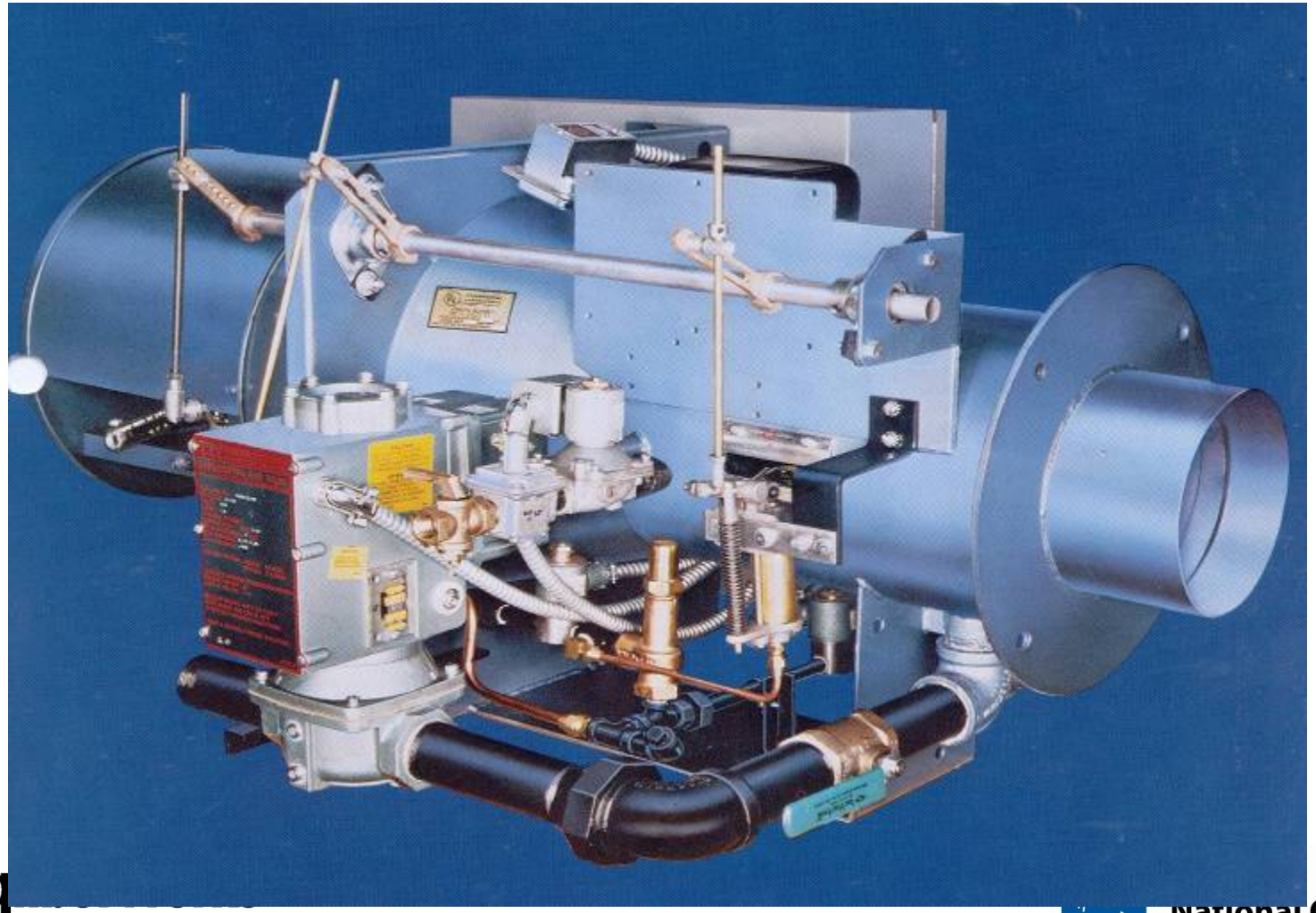
All heating and hot water appliances that burn fuel should be tested annually

- Boilers
- Hot water makers
- Furnaces

This burner is worthless if not properly adjusted!



This control panel is worthless unless properly adjusted!

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What are you going to do today?

Go to www.dsireuse.org and see what incentives are available in my area.

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What are things you're going to do in next week?

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What are things you're going to do in next month?

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What are things you're going to do in next year?

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The Checklist

- Get all of your energy usage and cost
- Vow to cut the biggest costs by 20%
- Change all your lights to compact fluorescent
- Shut off stuff when you're not using it
- Shut off Phantom Loads
- Turn the temperature of your heat and hot water down
- Turn you're A/C temperature UP
- Find Hole, Seal Hole
- Stop using your windows to control heat

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4. Insulation
5. Motors & Pumps
6. Windows
7. Preventative Maintenance!

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Evaluating Multifamily Buildings

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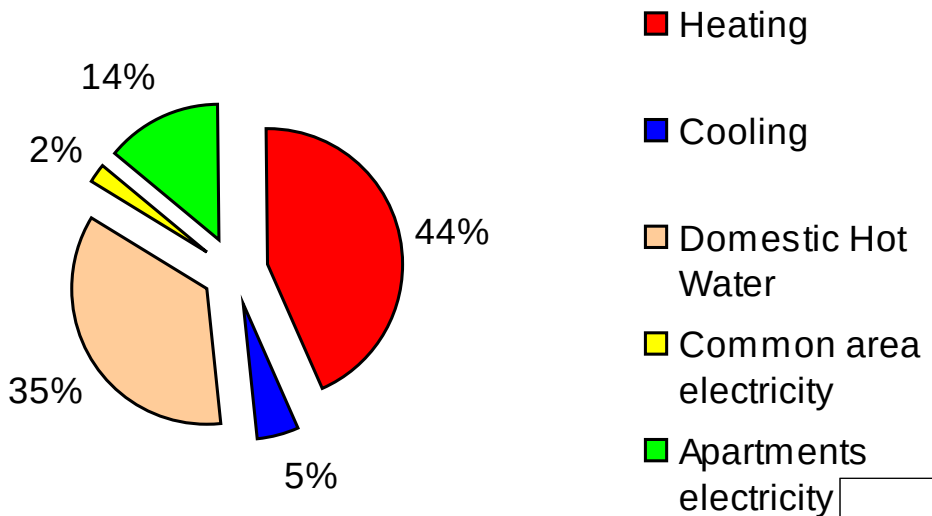
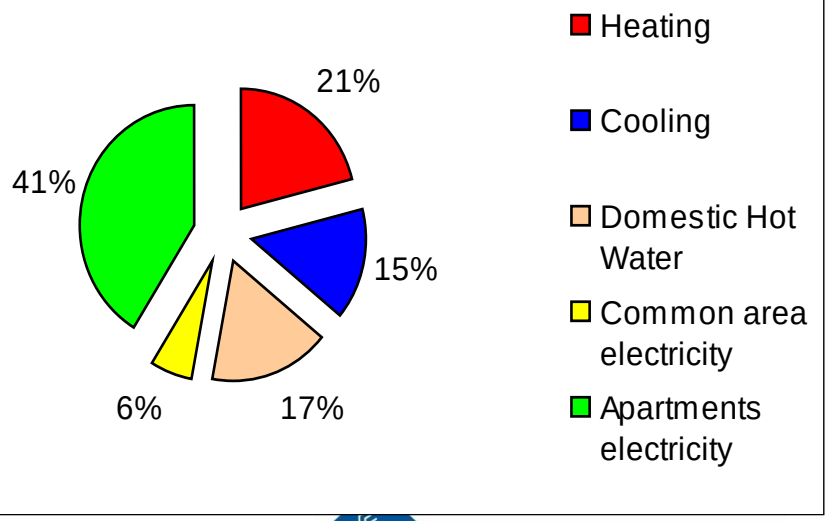
Energy usage per end-use



Usage vs. Cost

Energy costs per end-use



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Energy Audits

- Follow ASHRAE and BPI Standards for auditing
  - BPI is specific to MF buildings
- Different levels of auditing by increasing complexity
  - Walkthrough audits
  - Weatherization audits
  - Whole building audits
  - Investment grade audits
  - Depending on the consultant, you could be provided with a wide range of information

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Who can do an energy audit?

- Building Performance Institute certified:
  - Multifamily Building Analyst
  - Building Analyst
  - Affiliated Organization
- Certified Energy Manager
  - Association of Energy Engineers
- Weatherization Agencies

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Typical Scope of Work

- Boiler replacement
  - Atmospheric to condensing; separate smaller boiler for DHW
- Air sealing
- Ventilation balancing and aerosealing
  - CAR damper installation
  - Duct cleaning
  - Roof fan replacement
- Lighting change
  - CFLs in the units or LED strips
  - Bi-level fluorescent lighting in common areas
  - LED exit signs
  - Motion sensors wherever applicable

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Typical Scope of Work

- Low-flow faucet aerators and showerheads
- Thermostatic radiator valves (TRVs) and orifices
- Added insulation to the roof cavity
- AC covers
- Energy Star appliances
- Replace motors with premium efficiency motors
- Weatherstripping doors

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Importance of Training & Tools for Building Staff

- Building staff need to understand, know how to operate and optimize the new equipment in their building
  - Use videos for on-site tools
  - Importance preventative maintenance and action plan
- Energy Efficient Building Operator (EEBO) Training
  - Building Performance Institute (BPI) certification for all building operators
- A push towards building efficiency causes a need for trained operators

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Implementation, Construction Management & Quality Control

Coordination: construction team, project team, building occupants, building users

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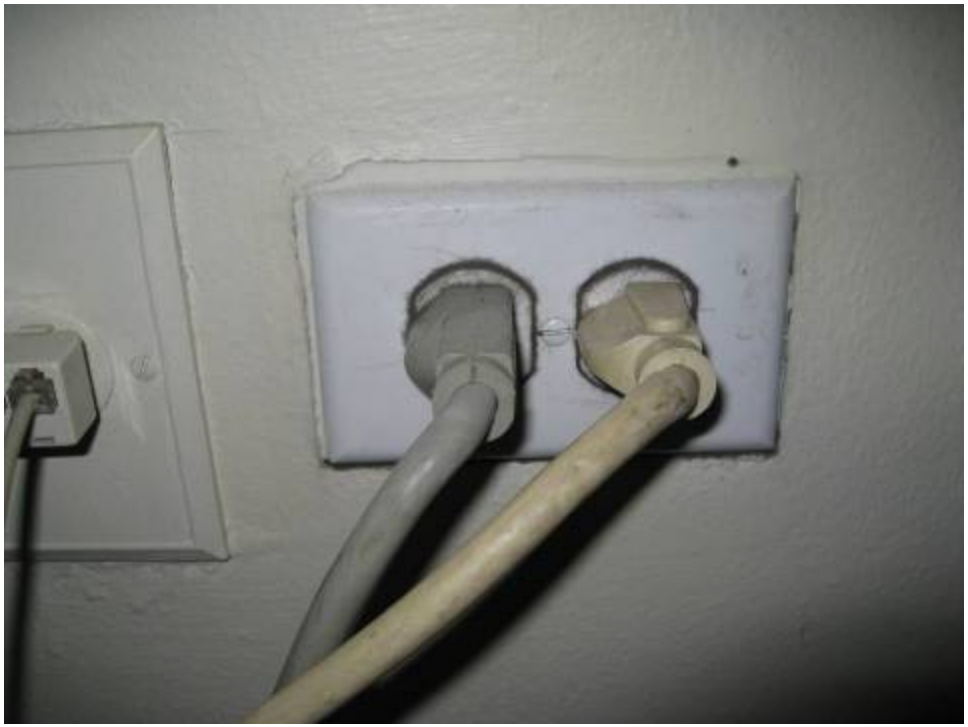
Air Leakage – Compartmentalization



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Case Studies

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6 Small Buildings in Brooklyn

- 6 small affordable housing buildings
- All 15-16 units
- Same owner
- Same atmospheric gas boilers in every one
- All gut rehabbed in the late 80's

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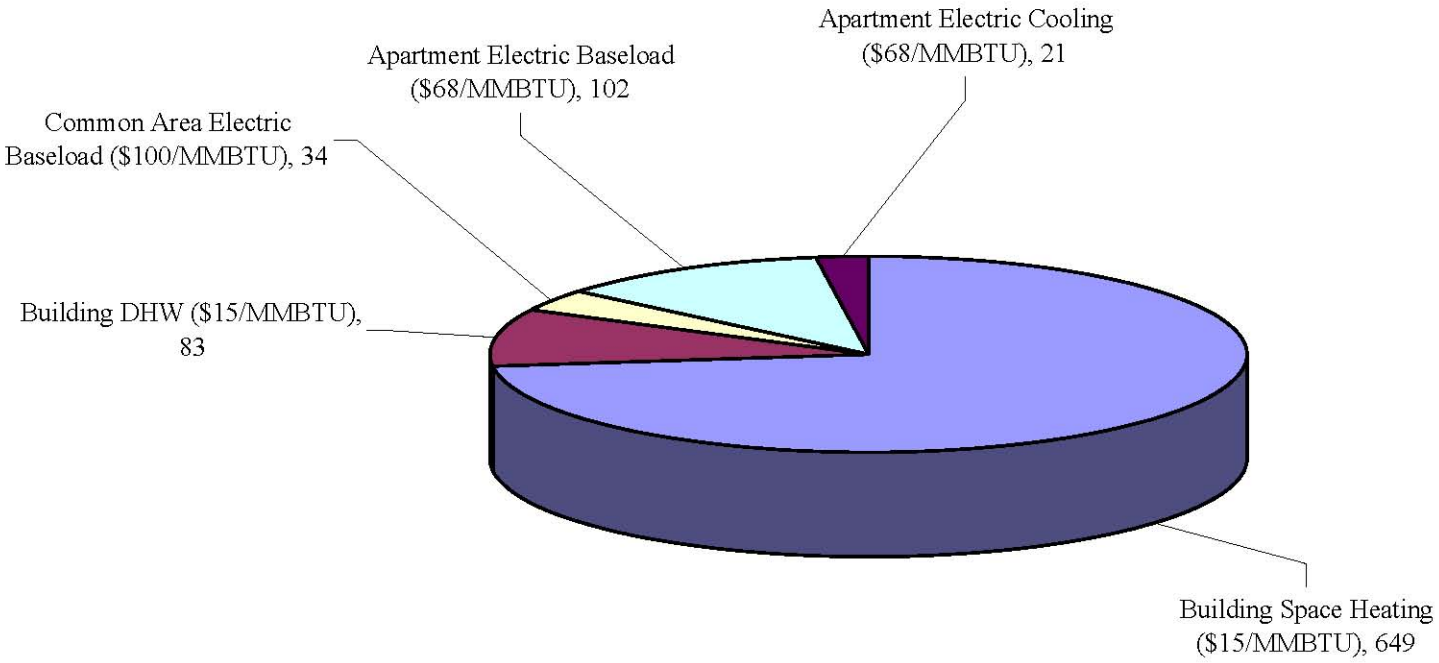
Annual Energy Consumption Breakdown (MMBTUs)



Typical Energy Consumption Breakdown of the 6 Buildings

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Audit Process

- Visiting apartments
- Interviewing staff and tenants
  - Find the person who's worked there the longest
- Benchmarking
- Combustion efficiency testing
- Air leakage testing

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Scope of Work

- Air sealing
  - Very common energy efficiency measure
- Energy efficient lighting and appliances
- Low-flow aerators and showerheads

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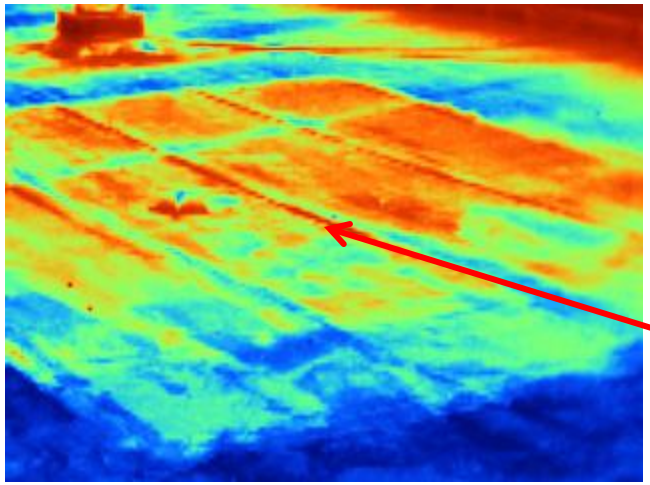
Scope of Work

- Boiler replacement
  - Fix the existing controls
- Upgrade roof insulation

Boiler Control Turned Off



Bad roof insulation

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2 Story Garden Style Building

- 1987 refrigerators and heat pumps
- Kitchen, laundry and bath venting into the attic
- Old commercial kitchen ventilation not sealed off
- Moisture damage throughout the building
- No controls for the boiler
- 100% outdoor air
- T12 and Incandescent lighting

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Possible Scope

- Replace all refrigerators and heat pumps
- Combine groups of attic vents and vent through the roof
- AIRSEAL
- Properly decommission commercial kitchen equipment
- Airsealing and fixing the ventilation will fix moisture problem and save energy
- Energy recovery
- Full lighting retrofit

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Conclusion

- You can always find ways to increase efficiency
- Talk to the tenants and maintenance staff
  - Building psychology
- Investigate all possible funding opportunities for the owner
- Know when to call in the experts

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