Multifamily Retrofit and Remodeling Strategies

HUD Energy Training Broadcast Series

June 14

Single Family Rehab and Retrofits: Focus on Low-Rise Buildings

September 18

New Construction Techniques – Energy Star Qualified New Homes, Green Building and Beyond

All webcasts 1-4 p.m. Eastern

Today's Faculty

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Performance Systems Development

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Domus Plus

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HUD Office of Energy
Washington DC

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Environmental Protection Agency
Energy Star Program

20th Street Apartments

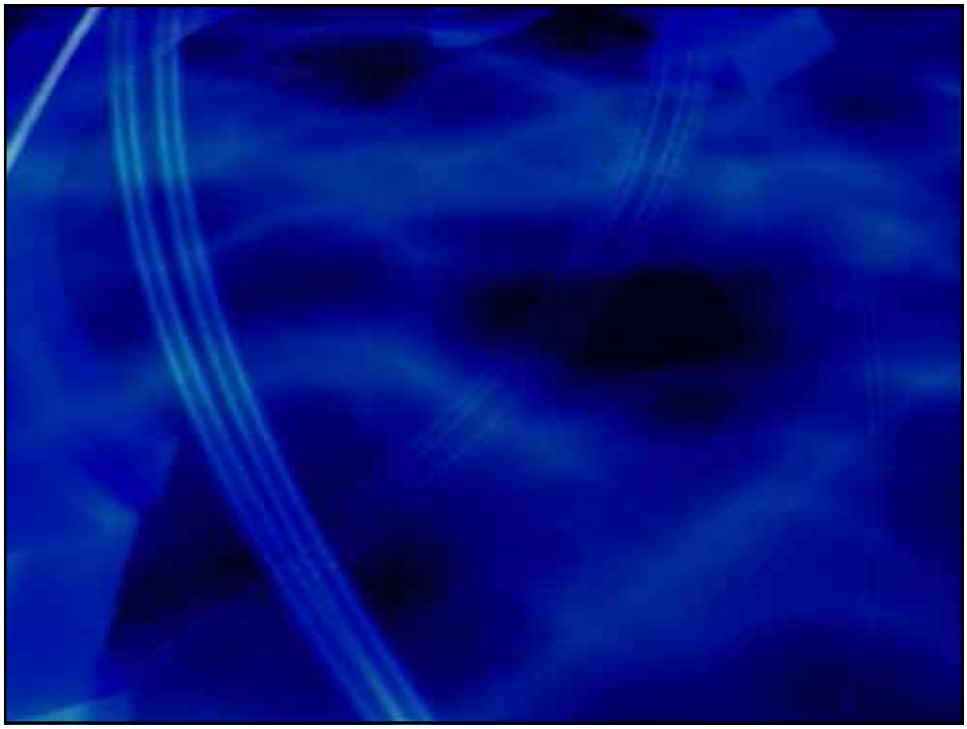
- Project: *34 units multifamily acquisition and rehabilitation*
- Condition: *Built 1960's; Inefficient radiant ceiling heating system; limited insulation, and single-pane windows and sliding doors*
- Measures: *Solar hot water heaters, attic and wall insulation, Energy Star refrigerators, dual glazed windows, CFL, Setback thermostats*
- Costs: *$643,000 / $110,000 Green premium*
- Annual Savings: *$11,375 annually*
  - Electric use reduced: 39%; Natural gas use reduced: 22%

Mary Elizabeth Inn

- **Project**: *88 units multifamily renovation (San Francisco, CA)*
- **Condition**: *Built: 1914; Renovation project*
- **Measures**: *Energy audit, windows, appliances, energy efficient boiler; lighting retrofit*
- **Benefits**: *37% reduction in energy consumption over existing conditions*

Morningside Villa Apartments

- **Project**: *50 unit multifamily energy retrofit*
- **Conditions**: *Gas furnace health & safety issues, rusted ductwork, inadequate cooling, poor insulation*
- **Measures**: *New sealed duct system and passive return system; Room pressure relief; 12 SEER HVAC equipment; Insulated attic to R-30 blown cellulose; Performed Duct Blaster on duct system*
- **Cost**: *Covered by AZ weatherization program*
- **Savings**: *$140 per year per unit*



Multifamily Gut Rehab: Energy Efficient Strategies

- ***Illinois Energy Efficient Affordable Housing Construction Program***
  - ***Maureen Davlin, Program Manager***
- **Energy Efficiency**
  - **Insulation**
  - **Air Sealing**
  - **Ventilation**
  - **Heating/Domestic Hot Water**

Illinois Energy Efficient Affordable Housing Construction Program

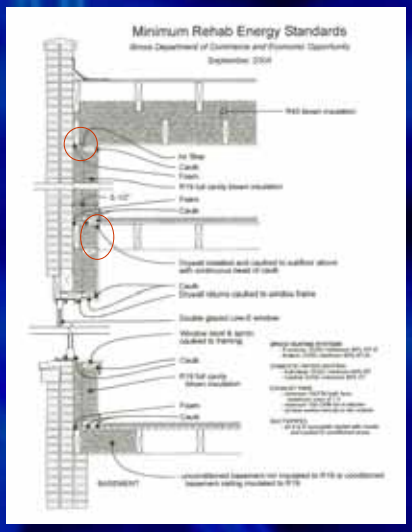
- Initiated in 1988
- 98 buildings (1,975 units) completed
- 78 non-profits have participated
- $2,500 grant/unit
- Rehab costs around $75/sqft

Multifamily Rehab

- 1,000 ft^2 average unit size
- $400 average annual heating bill (@ $.88/therm)
- $1,022 without energy work
- 4 year payback

Energy Efficient Measures

- Insulation
- Air Sealing
- Ventilation
- Heating/Domestic Hot Water



www.illinoisenergy.org

Insulation

- Insulating value of a 12” brick wall is around 2.40.
- Batt insulation may be difficult to install properly on the walls

Batt Insulation

Spray Cellulose

Spray Cellulose

- Recycled newspaper
- R-value of about 3.75/in
- High density
- Treated with fire retardant

Spray Rock Wool

Wall Insulation

- Wall cavities completely filled with insulation
- Added R-value of 17.00

Roof Cavity Insulation

Windows

Windows

- Double glazed windows with a low-E coating

ENERGY STAR Qualification Criteria				
	Windows and Doors		Skylights	
Climate Zone	U-Factor [1]	SHGC [2]	U-Factor (2001 NFRC rated at 20 degrees) [3]	U-Factor (RES97 rated at 90 degrees) [4]
Northern	0.35 or less	Any	0.60 or less	0.45 or less
North/Central	0.40 or less	0.55 or less	0.60 or less	0.45 or less
South/Central	0.40 or less	0.40 or less	0.60 or less	0.45 or less
Southern	0.65 or less	0.40 or less	0.75 or less	0.75 or less

Air Sealing

Effective Air Barrier?

Air Tight Drywall Approach

Air Tight Drywall Approach

Air Tight Drywall Approach

- Drywall sealed to framing members with caulk or foam

Air Tight Drywall Approach

- Drywall sealed to subfloor

Seal all holes in exterior drywall

- **Drywall returns caulked to window frames**

Stack Effect

Plumbing Walls

- Plumbing walls sealed at each floor

Heating/Water Heating

Direct Vent Sealed Combustion

- 90% furnaces

Direct vent sealed combustion

- Water heaters

Central Heating Systems

Weil-McLain *GV4*
Boilers

105,000 Btuh

A.O. Smith *Cyclone*
Water Heaters

125,000 Btuh (60 gallons)

Blower Door Testing

The blower door test can be a “hair raising” experience

Ventilation

- Both bathrooms meet code

Bathroom Exhaust Fans

- Minimum 75 CFM at 0.25” wc
- Vented to the outside
- Low sone (1.5 or less)

Kitchen Exhaust Fans

- 150 CFM vented to the outside (no recirculating fans)

847 W. Sunnyside (12 units)
4130 N. Kenmore (14 units)

- Buildings completed, August 1992
- R11 batts w/ metal framing
- Airtight Drywall Approach
- DVSC Furnaces, 90% AFUE
- Central domestic water heater (standard efficiency)
- Double-glazed low-E windows

	Initial	2004-05	%
847 Sunnyside:	$243	$279	+ 15%
4130 N. Kenmore:	$264	$277	+5%

963 W. Cullerton (25 units)

- Completed October, 1997
- Wet spray cellulose in sidewalls
- High efficiency boiler *Lochinvar*, 87%
- Airtight Drywall Approach
- Double glazed low-E windows

	Initial	2004-05	%
963 W. Cullerton:	$231	$212	-8%

If housing is to be truly affordable, it has to be energy efficient.

Brickyard Creek Apartment

- Program: *92 unit multifamily rehabilitation (Red Bluff, CA)*
- Condition: *Built 1970s. Mater metered, inefficient boiler, hot water and HVAC systems; outdated appliances; excessive energy costs*
- Measures: *Facility energy audit; high efficiency gas systems, windows, appliances, Lighting inventory; retrofit to individually metered*
- Costs: *$5.3 million rehabilitation*

Park Terrace Apartments

Solar Improvements:
- 40 Fireball Solar Collectors
- 800 Gallon Solar Storage
- Cost: $43,000
- Payback: 6 years; 16.74% RR

- Project: *92 units (Yuba City,CA)*
- Condition: *Built: 1974; Inefficient boilers, excessive energy costs*
- Measures: *Facility energy audit; new solar hot water system, windows, efficient room air conditioner*
- Cost: *$6,759,443*
- Savings: ~$9,000 annual savings
  - 50% energy reduction for hot water
  - Exceeds Title 24 energy standards by 15%

Flanders Pointe Apartments

- **Project**: *82 units multifamily energy retrofit (Tustin, CA)*
- **Condition**: *Built 1960. Single pane windows; no attic/roof insulation;*
- **Measures**: *Attic insulation(R-30); domestic hot water pipe insulation; air conditioner tune-up; exterior solar window shades; and a central boiler demand controller*
- **Annual Savings**:
  - *Building - 34,000 kWh; $47,591*
  - *Tenants - $580/year reductions*

Phoenix Home Energy Efficiency Study

Study sponsored by the EPA, performed by Advanced Energy Corporation

- **Baseline Homes**
  - R-30 attic
  - R-19 wall
  - 56% low-e
  - 12 SEER
- **Performance Guarantee**
  - R-30 attic
  - R-19 wall
  - 100% low-e
  - 11.9 SEER

The Performance Guarantee homes out performed the Baseline by

33%

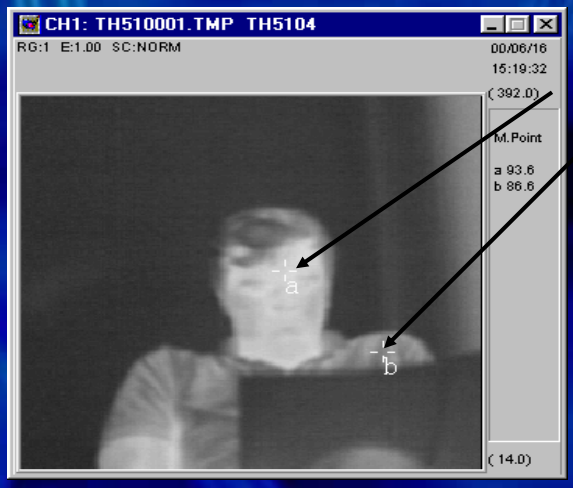
How is it done?

Getting The Basics Right

Retrofit Goal

- Get the basics right!
  - Duct leakage
  - Pressure balance
  - Insulation performance

Infrared Camera



White is hotter 93.6°

Dark is cooler 86.6°

The shirt is insulating his body.

A Primer on Air Flow

- For air to flow you need a hole and a pressure.
  - No hole, no flow
  - No pressure, no flow

We have spent billions of dollars sealing holes with mixed results, when was the last time someone talked to you about controlling pressures?

Pressures in Buildings

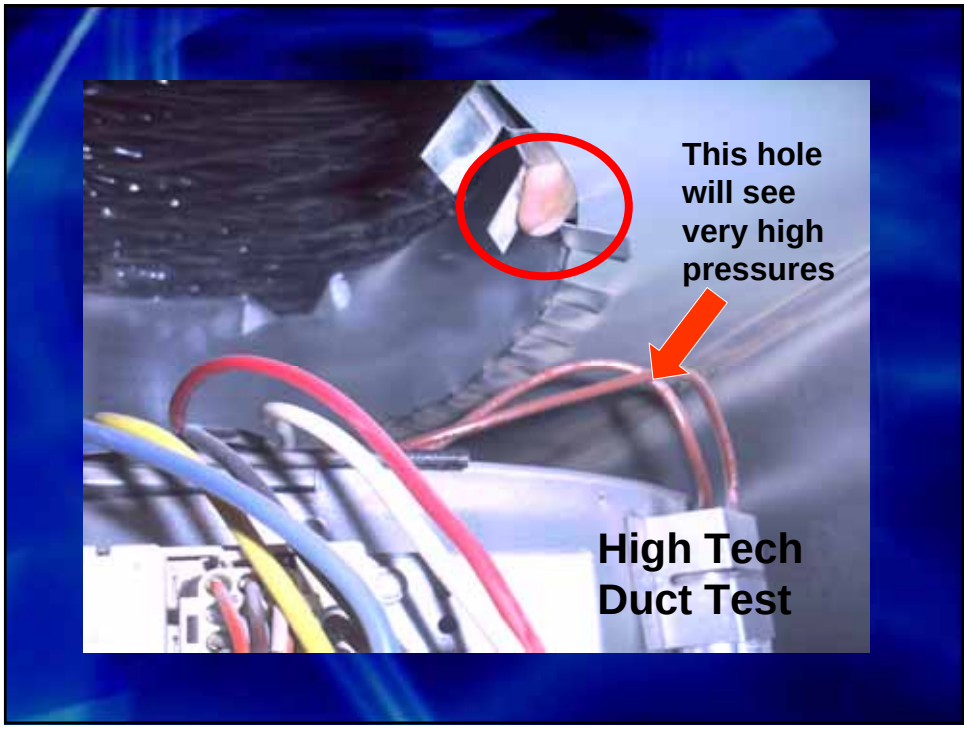
- New studies are finding that on average, pressure created by fans cause 3 to 10 times the amount of air leakage that natural (wind and stack) pressure cause.
  - We first look at holes that see high pressures (ducts).
  - Next look at reducing pressures.
  - Then we will look at holes in the building envelope.

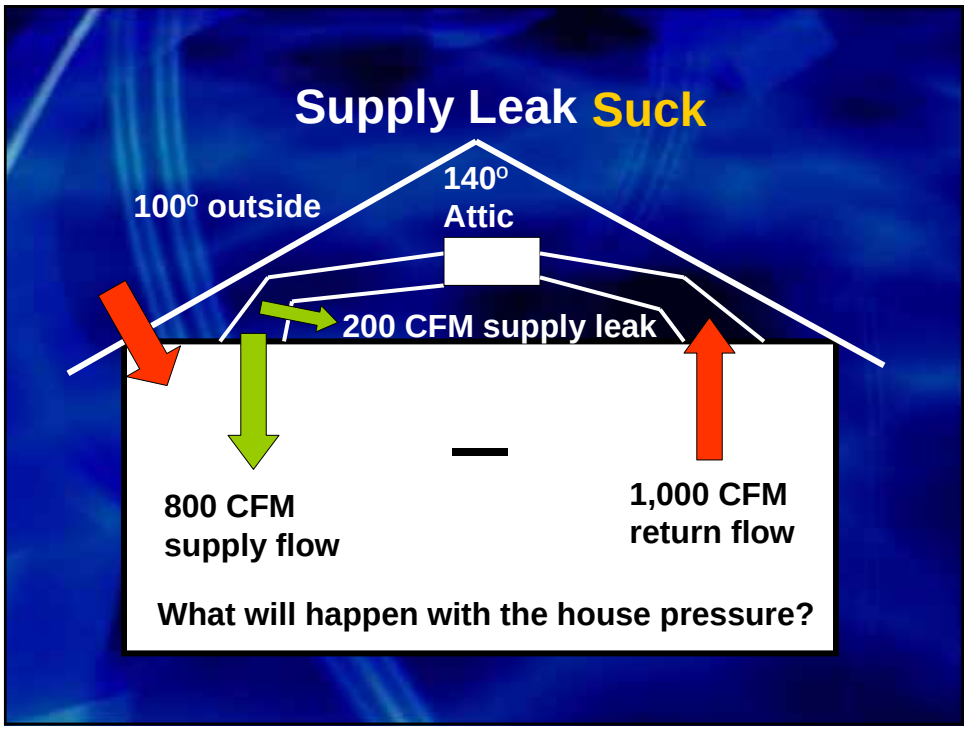
Duct leakage

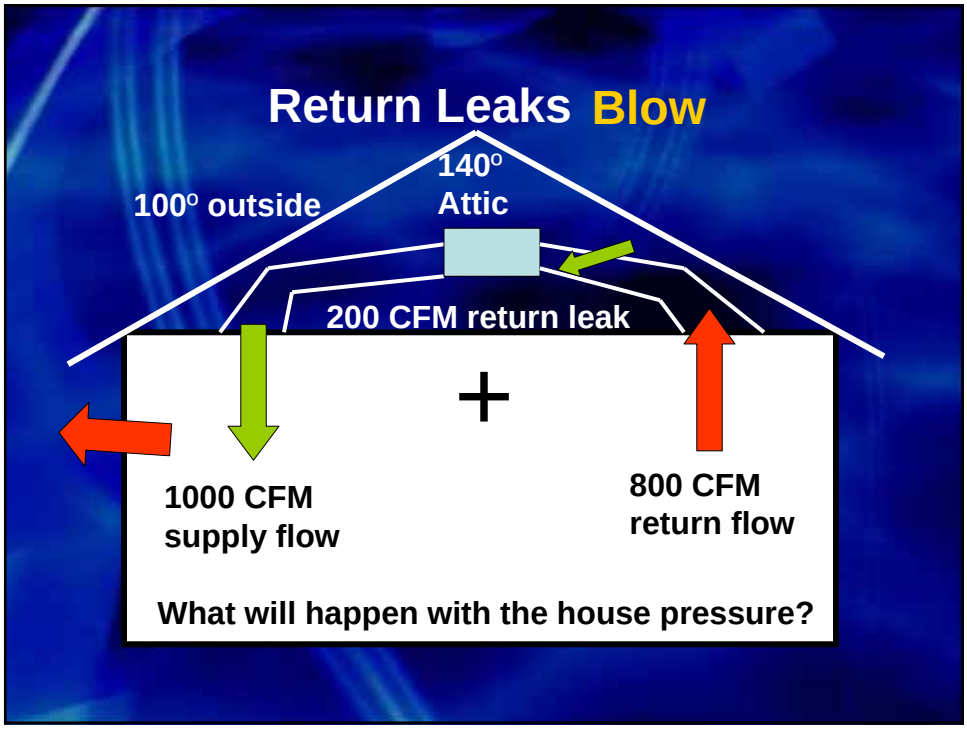
- National studies find an average of 300 CFM of duct leakage (1 ton = 400 CFM). On a 2000 sq. ft. home, that's 15% of rated air flow. (AZ 371 CFM)
- Studies from Florida estimate that 10% of Florida's electrical generation capacity is duct leakage.

This is more common than you may think.

Now the air handler is an exhaust fan!


This hole will see very high pressures
High Tech Duct Test


Supply Leak Suck
100° outside
140° Attic
200 CFM supply leak
800 CFM supply flow
1,000 CFM return flow
What will happen with the house pressure?

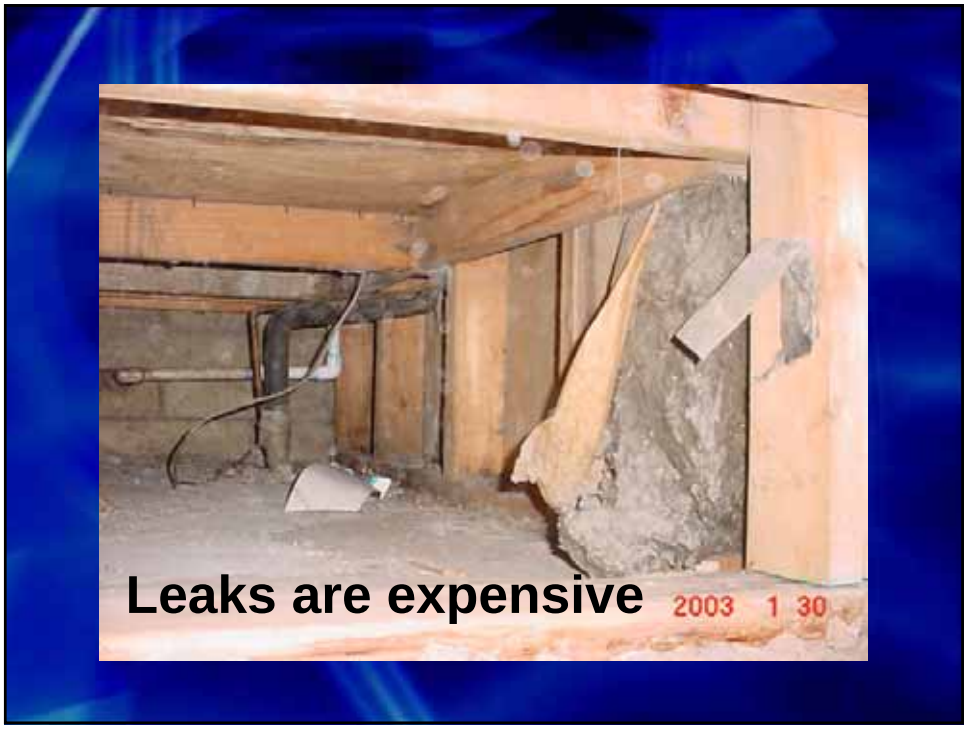

Return Leaks Blow
140° Attic
100° outside
200 CFM return leak
+
1000 CFM supply flow
800 CFM return flow
What will happen with the house pressure?


At least the air you are blowing through the tape and into the attic is filtered
2003 2 4


Ducts must be sealed with mastic, not duct tape

Boot to sheetrock, easy to get at

Boot to sheetrock, easy to seal


Leaks are expensive
2003 1 30


Mastic is cheap
2003 2 3

Get the hint: We like mastic!

Multi-family: Replacing the heating and cooling systems

We did as much fabrication as possible in the parking lot

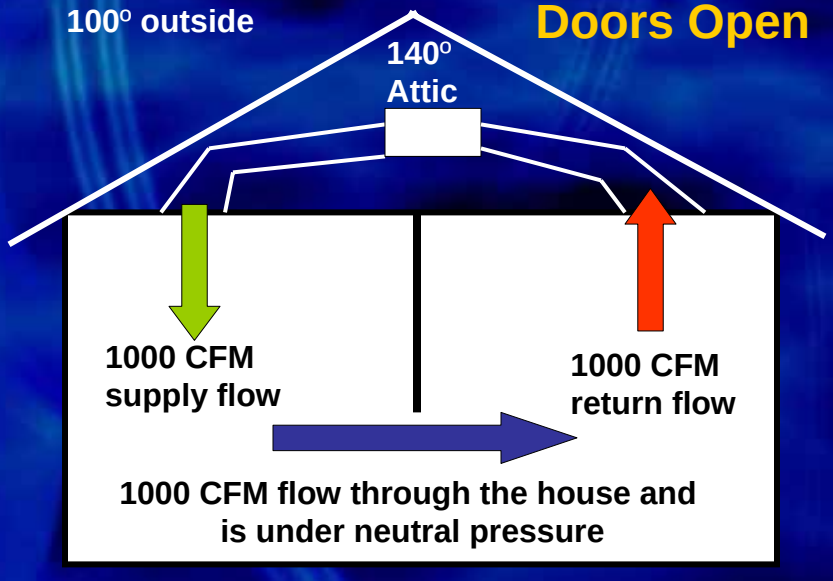
Limited the amount of work completed in the attic
Note: it gets hot in Arizona attics

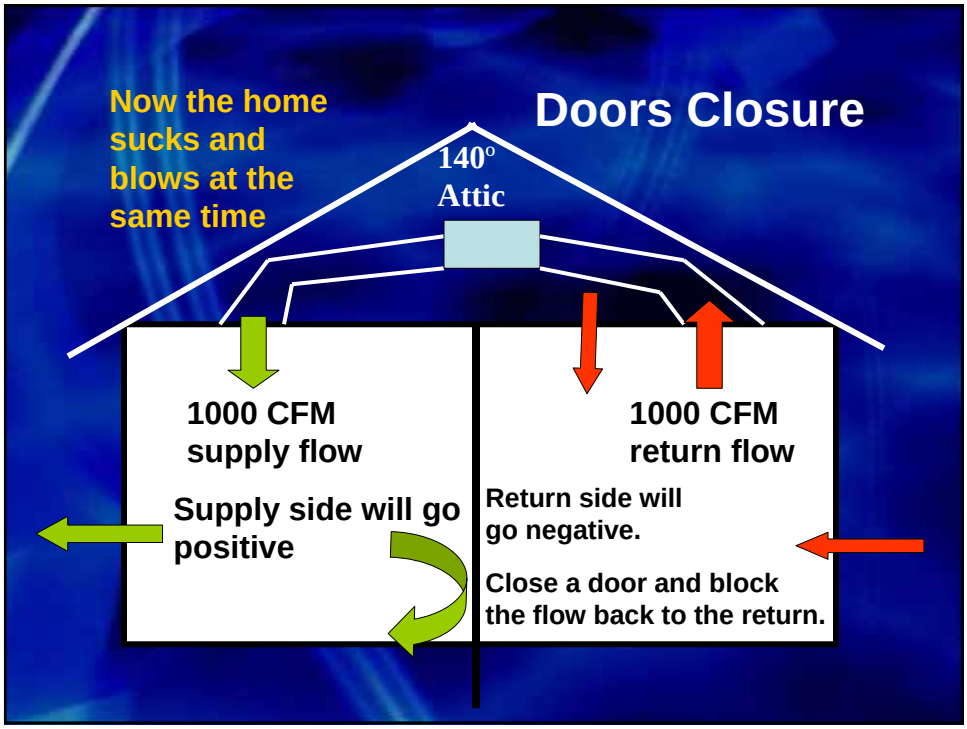
Only leakage was in the air handler box.

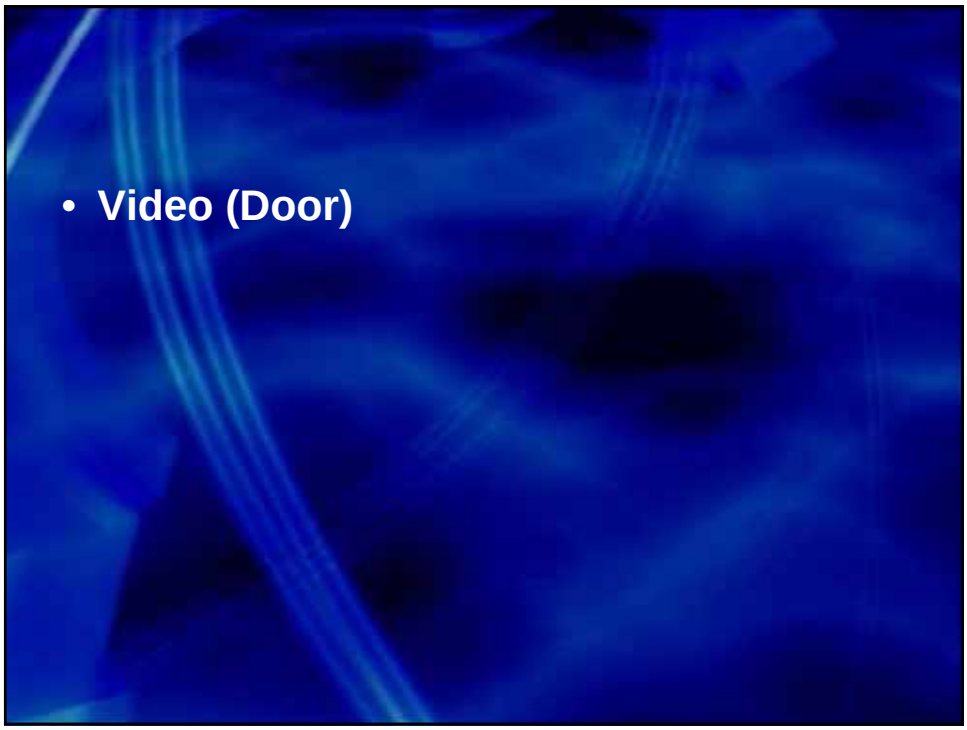
Doors and Energy Use

- What doors in your home account for the most heating and cooling costs?
  - Front and back doors
  - Patio doors
  - Doggie doors
  - Interior doors

Doors Open

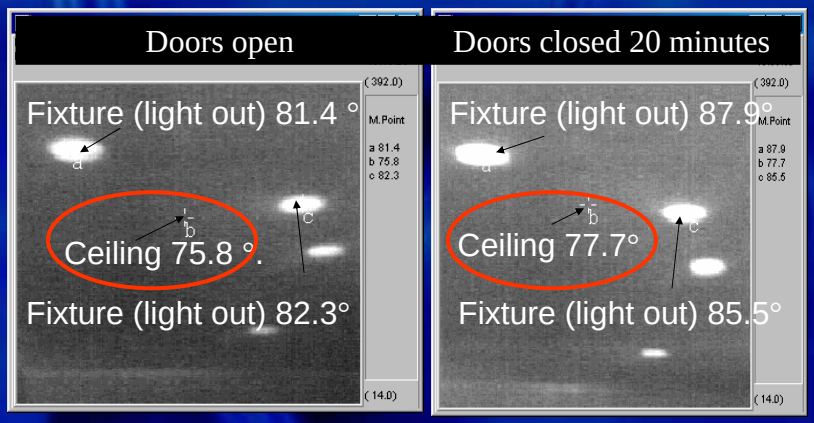



Now the home sucks and blows at the same time
Doors Closure
140°
Attic
1000 CFM supply flow
1000 CFM return flow
Supply side will go positive
Return side will go negative.
Close a door and block the flow back to the return.


• Video (Door)

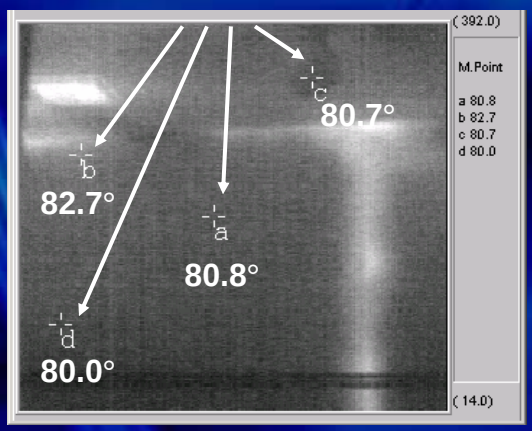
Impact of Room Pressure (Door Closure)

Increased infiltration, hot air coming in the can lights.



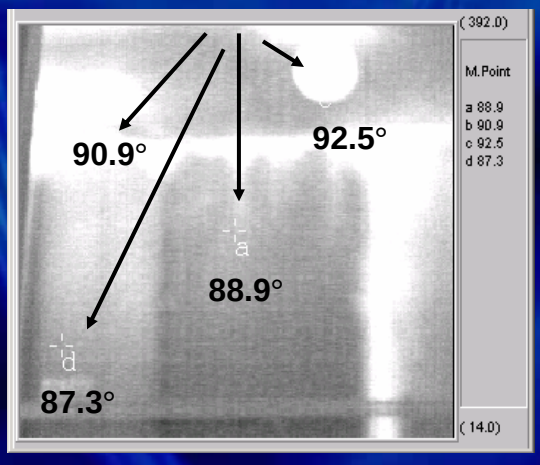
What about the sheetrock temperature?

The following video is a time lapse infrared of a home under negative 3 Pa pressure for 40 minutes. Note starting temperatures.



- Video (Infrared Camera)

Temperatures after 40 minutes.
8 to 12 degree increase in surface temperatures.



Room Pressures

- No pressure greater than +/- 3 Pa. created by the air handler (doors closed).
- Test and verify.
- Room pressures can have a large impact on health, safety, comfort, durability and energy.

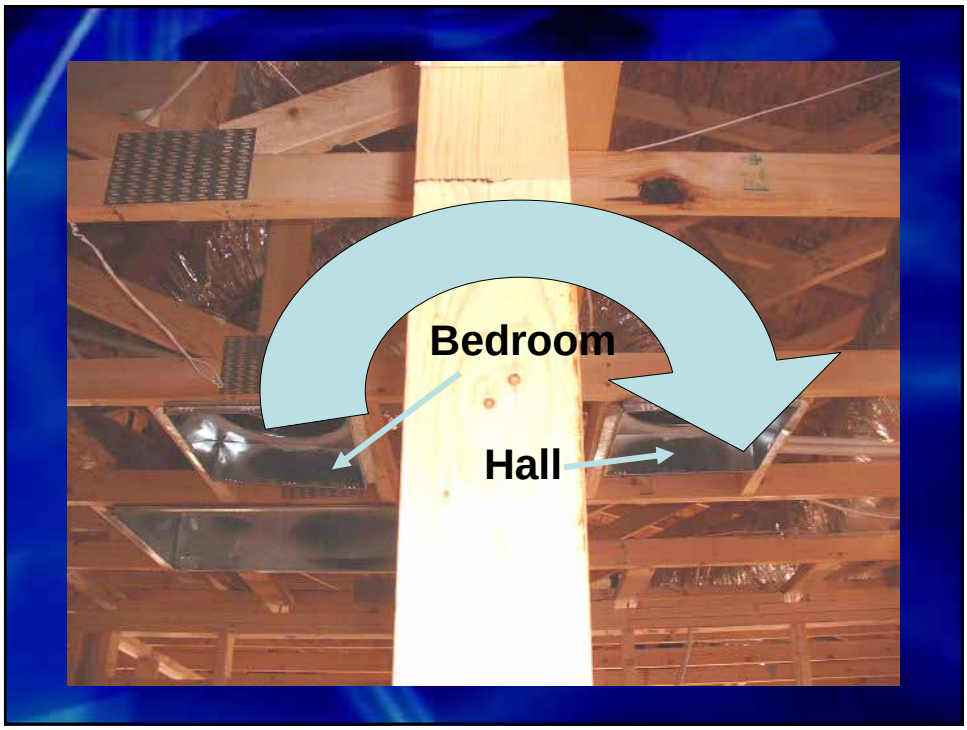
Remove all doors?

Cheap Pressure Relief

Problems with light and sound

Don't install vents in the door

For each CFM in, need .75 sq. in. free vent area out. (we just say 1 CFM in, 1 inch vent out)



- Video (Jump Duct)

R-value vs. Performance

Designed heat flow vs. real heat flow

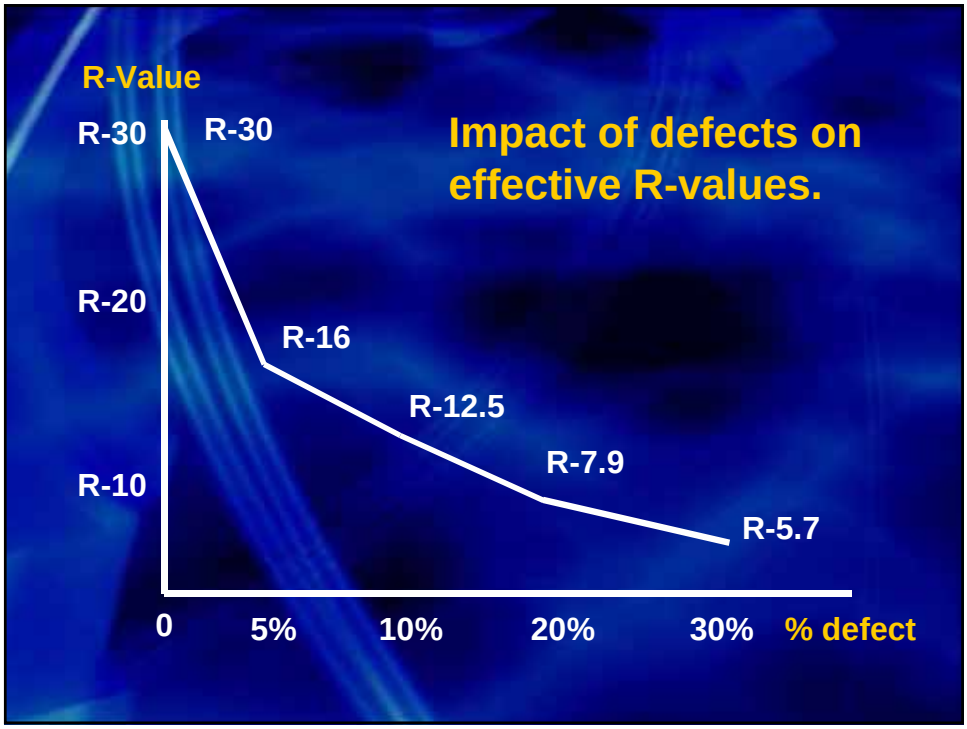
100% R30

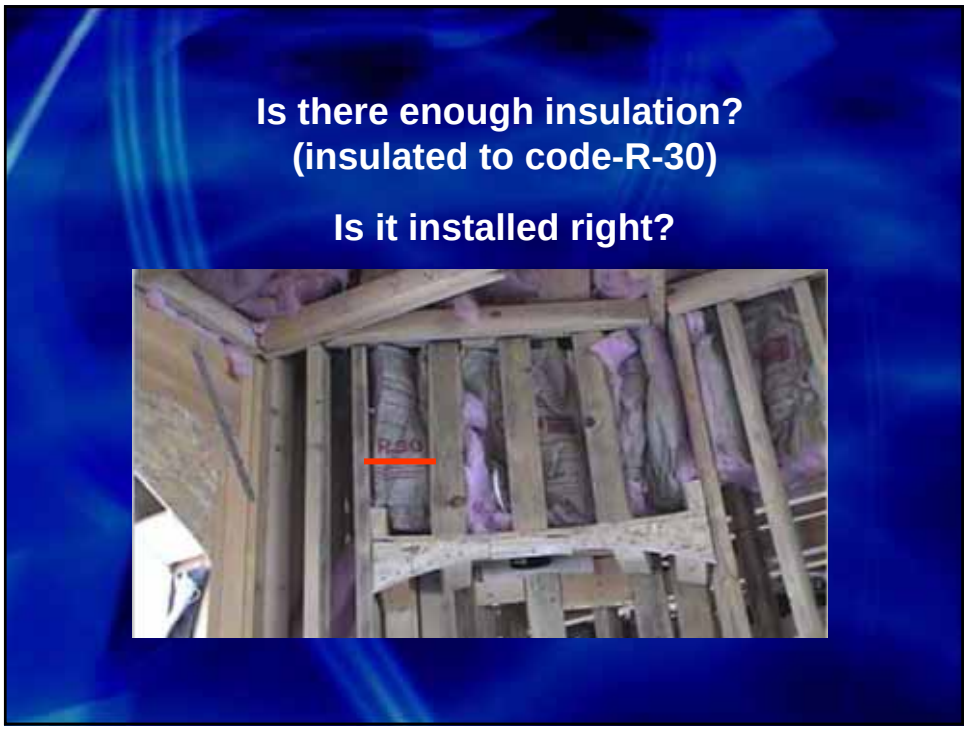
- .033 (R30) x 1000 x 20 = 660 BTUs

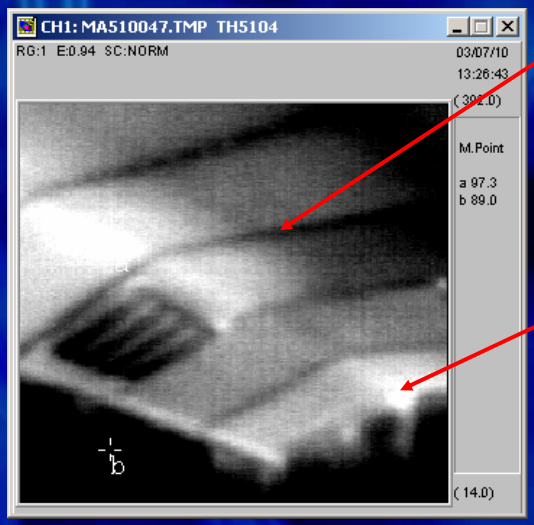
95% R30 - 5% uninsulated

- .033 (R30) x 950 x 20 = 627 BTUs
- .5 (none) x 50 x 20 = 500 BTUs

- Total BTUs (same as a R16) 1127 BTUs
- Small defects can have a large impact, today's complex home design is tough on the insulators.


R-Value
R-30
R-30
Impact of defects on effective R-values.
R-20
R-16
R-12.5
R-7.9
R-10
R-5.7
0
5%
10%
20%
30%
% defect


Is there enough insulation?
(insulated to code-R-30)
Is it installed right?



Why is the wood (R-4) cooler than the R-30 batt?

Wood is letting less heat in than the batt.

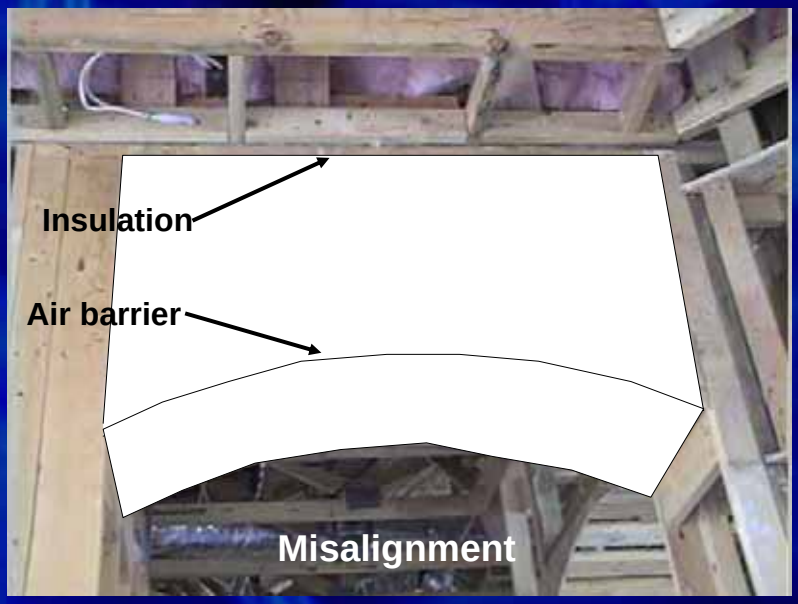
If it's insulated, why isn't it insulating?

- **Defects are allowing hot or cold air to pass through or around the insulation.**
  - **Air is a fluid (just like water). If water would pour through a material, air can also pass through it.**
- **This will drastically impact the effectiveness of the insulation.**

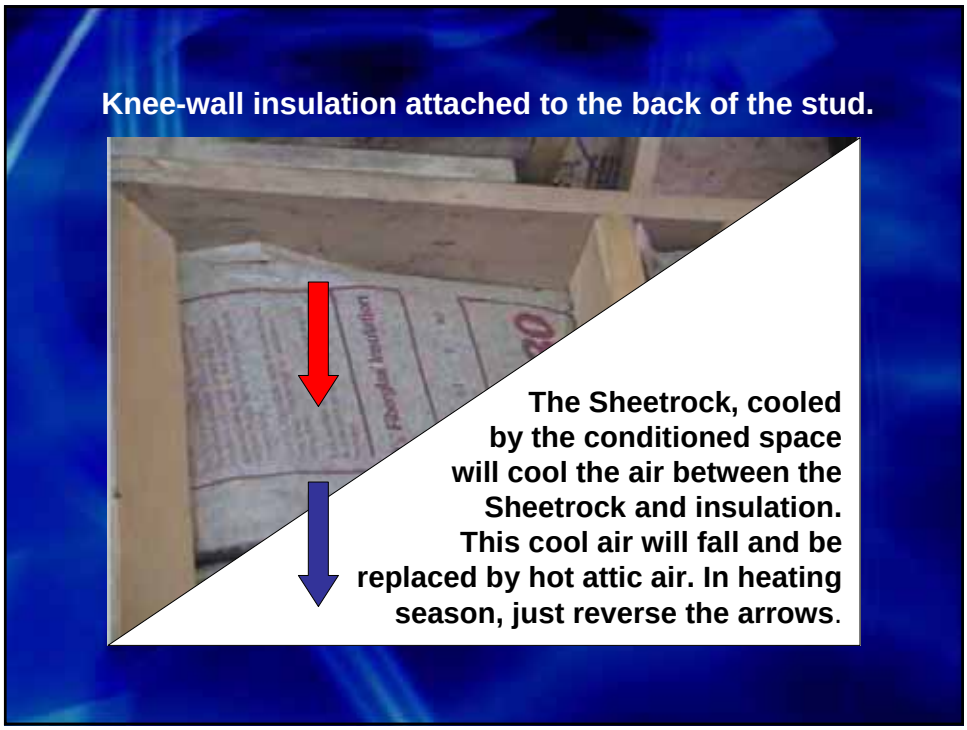
Misalignment

- The house must have a continuous air barrier. (Stops air flow)
- The house must have a continuous thermal barrier. (Stops heat flow)
- The air barrier and thermal barrier must be in 100% contact.
- If not, hot/cold air will pass through or around the insulation.

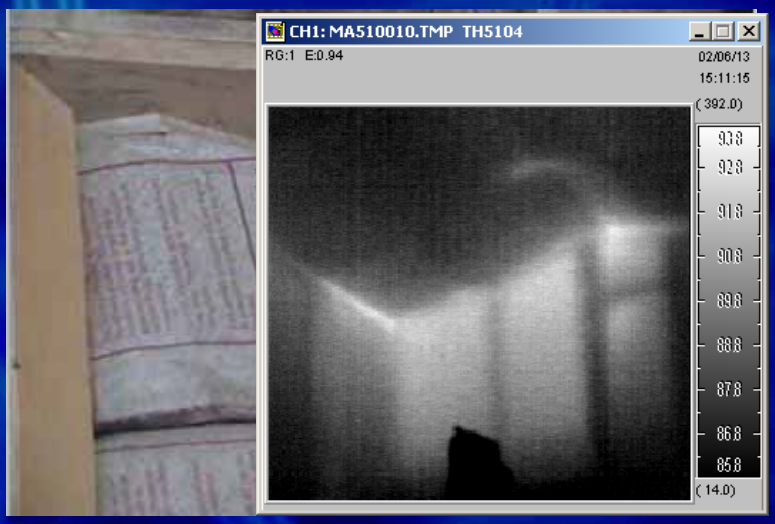
We have missed this one!



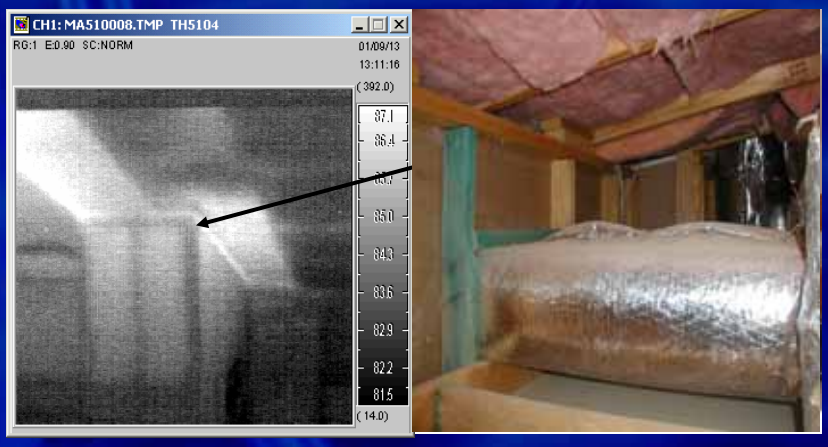

CH4: MA510011.TMP TH5104
RG:1 E:0.90 SC:NORM
01/07/05
14:00:55
(392.0)
93.7
91.7
89.7
87.7
85.7
83.7
81.7
79.7
77.7
(14.0)
Insulation is placed here
But the heat is getting here


Knee-wall insulation attached to the back of the stud.
The Sheetrock, cooled by the conditioned space will cool the air between the Sheetrock and insulation. This cool air will fall and be replaced by hot attic air. In heating season, just reverse the arrows.

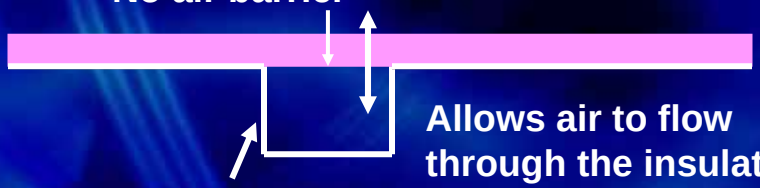
Knee-wall insulation attached to the back of the stud.



The Key to Insulation Performance
Stop Air Flow



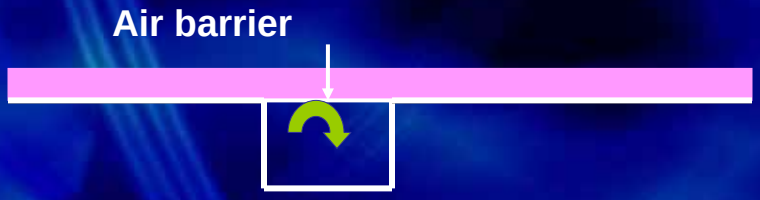
The insulation is suspended over the soffit and does not touch the Sheetrock.



Now these surfaces are uninsulated exterior surfaces (but the air is filtered)

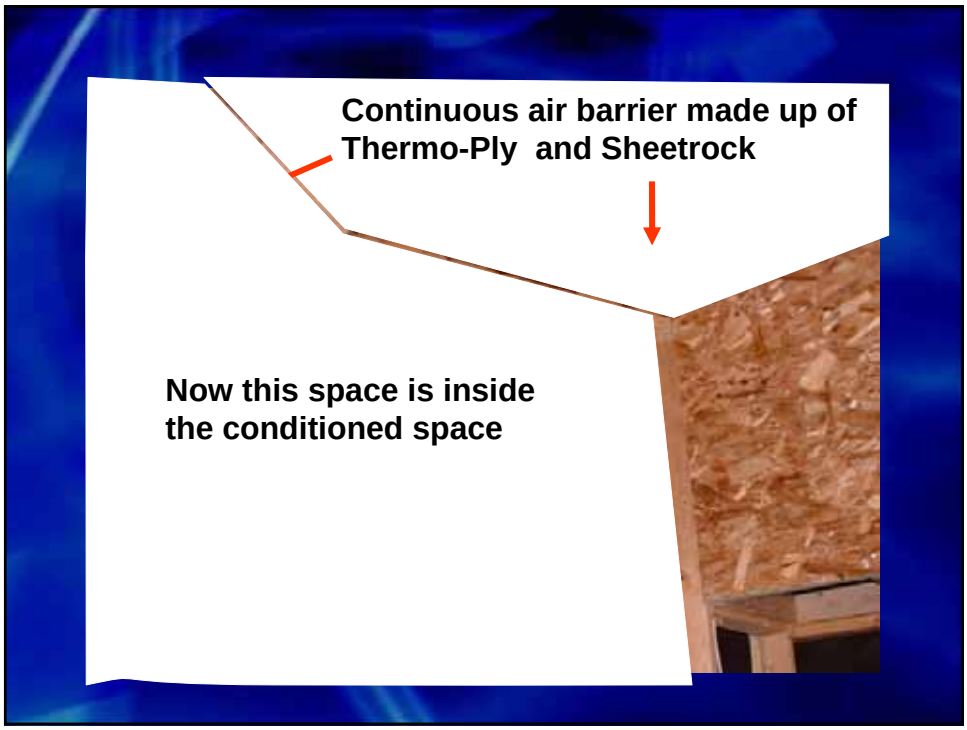
Air barrier installed by the framer

Now the insulation is in contact with an air barrier.



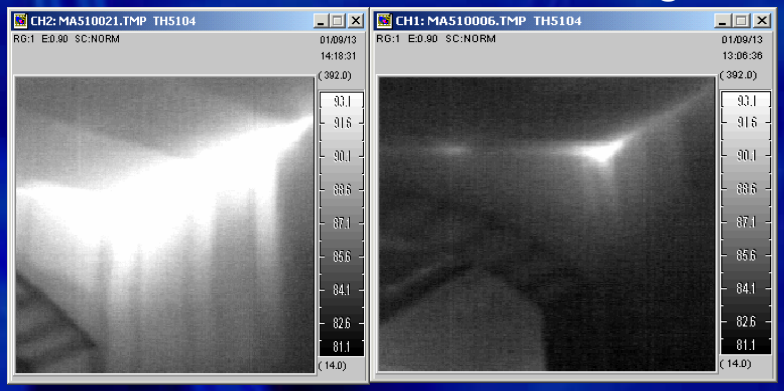
Stops air flow through the insulation and brings that space “inside”.


Installation
of air barrier


Continuous air barrier made up of
Thermo-Ply and Sheetrock
Now this space is inside
the conditioned space

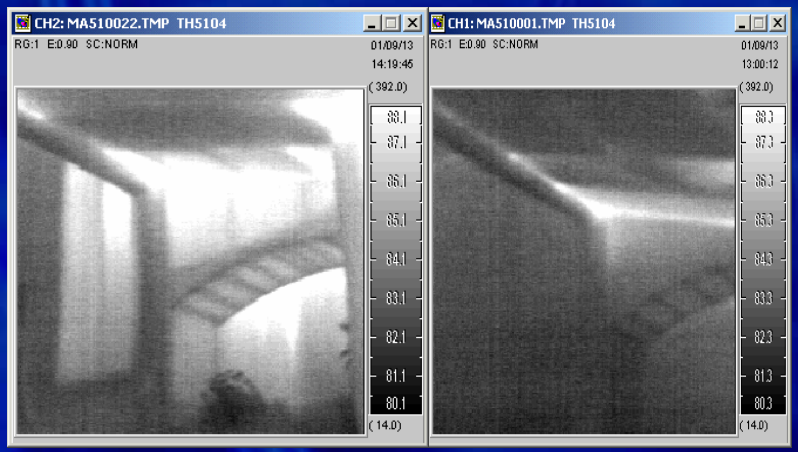
No air barrier

Air barrier and insulation aligned



No air barrier, suspended insulation

Air barrier and insulation aligned

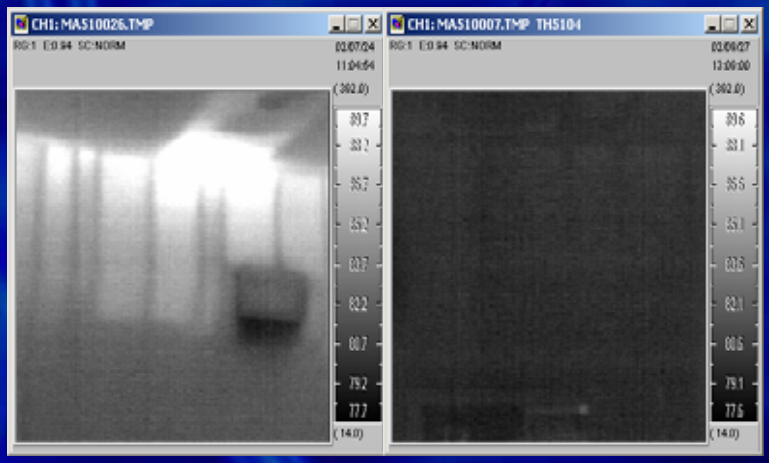


Weatherization example

24 homes with existing R-30

All we did was move the insulation!

Knee wall before **Knee wall after**



Insulation test – What is this?

A piece of insulation that is working!

Bottom Line: Results

Lower away!

An air conditioning unit is lowered by crane onto the roof of an apartment as part of a weatherproofing project for low-income housing in Avondale Feb. 21.

50 unit senior housing project

Project cost of $90,000

New AC units, duct sealing, pressure balancing and attic insulation.

Utility Data (50 units combined):
Work completed in April
Annual saving of $9,000 – Does not include gas

	1999	2000	2001	2002	2003
Jan	1580.9	1650.41	1717.51	1706.64	1576.79
Feb	1441.6	1511.78	1523.79	1485.37	1449.21
Mar	1686.7	1904.13	1680.86	1744.15	1758.57
Apr	2064.6	2702.18	2434.62	2245.56	1756.26
May	3559	4304.16	4379.49	3065.68	3037.52
Jun	5383.4	5472.49	5056.97	4016.33	3491.86
Jul	6484.9	5429.73	5247.87	3860.77	3745.05
Aug	6361.1	6566.62	6050.38	4609.58	4705.3
Sep	5260.1	4952.66	5186.72	3832.81	3838.1
Oct	3050.5	3471.33	3518.97	2644.71	3003.6
Nov	2152.2	1727.36	2135.01	1681.74	2092.98
Dec	1668.7	1727.41	1780.71	1628	1795.61
Total	40694	41420.26	40712.9	32521.34	32250.9

The Californian

- Project: *217 units Energy Retrofit (Fresno, CA)*
- Measures:
  - High Efficiency DHW Boiler System; Variable Speed Control System on Water Booster Pumps; HVAC System Tune-up; insulation; unit weatherization;lighting
- Cost: ~$160,000
- Savings: $29,500 /year
  - Reduced consumption: 24%
    Payback Period: 5-6 years

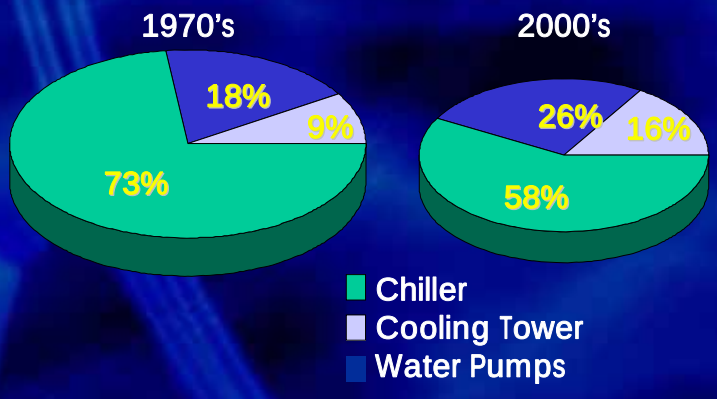
The Californian – Savings Detail

Measure	kBTU/yr.	% Total kBTU Savings	Savings	Payback	Actual Invoices
DHW Boiler System Replacement	1,595,918	81.3%	$ 14,922	7.87	$ 117,477
DHW Boiler System Replacement	314,296	16.0%	$ 12,528	1.38	$ 17,339
HVAC System Tune-up	52,437	2.7%	$ 2,090	8.89	$ 18,572
Total	1,962,651	100%	$ 29,539	5.19	$ 153,387

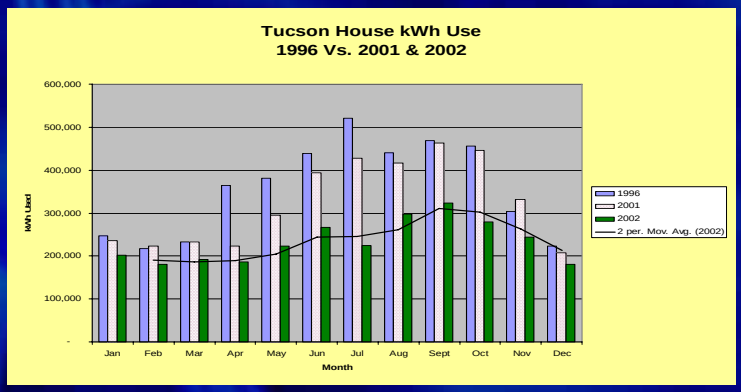
Tucson Town House

- **Project**: *200 units energy retrofit*
- **Conditions**: *High property energy bills, inadequate cooling*
- **Measures**: *Chiller replacement and lighting upgrades to units and common areas*
- **Costs**: *$194,000 (Lighting) $972,150 (Chiller)*
- **Savings**: *Over $100,000 annually*

Tucson House – Chiller Energy Consumption

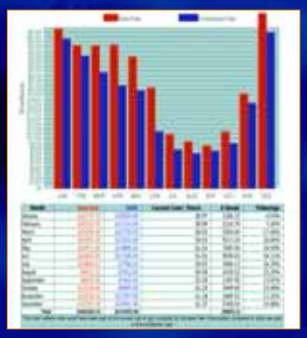


Tucson Housing – 1st Year Savings

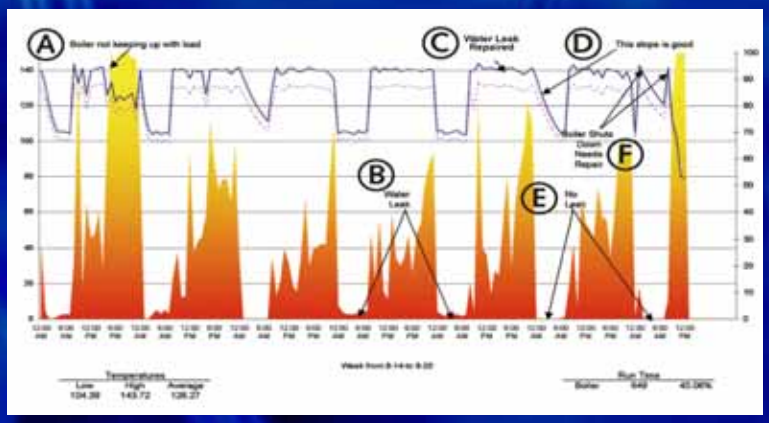


Angelus Plaza Apartments

- Project: *1,093 HUD-assisted multifamily (Los Angeles)*
- Conditions: High property energy bills,
- Measures: Domestic Hot Water upgrades and monitoring
- Costs: Energy Performance Contract (*Equity Thru Energy)*
- Savings:
  - 20% reduction to hot water consumption and costs
  - 49,674 therms
  - $50,700 annually



Angelus Plaza - Monitoring



Fresno Housing Authority –

Evaporative Cooler Portfolio Modernization

- Project: *317 units of public housing energy modernization (Fresno)*
- Condition: *High cooling costs, inadequate cooling, maintenance issues, customer complaints*
- Measures: *Replacement with high efficiency evaporative cooling equipment*
- Costs: ~$500,00 (Offset by ~$100,000 in utility rebates
- Benefits:
  - Reduced consumption
  - Increased cooling comfort
  - Fewer complaint/maintenance calls

Franco Center

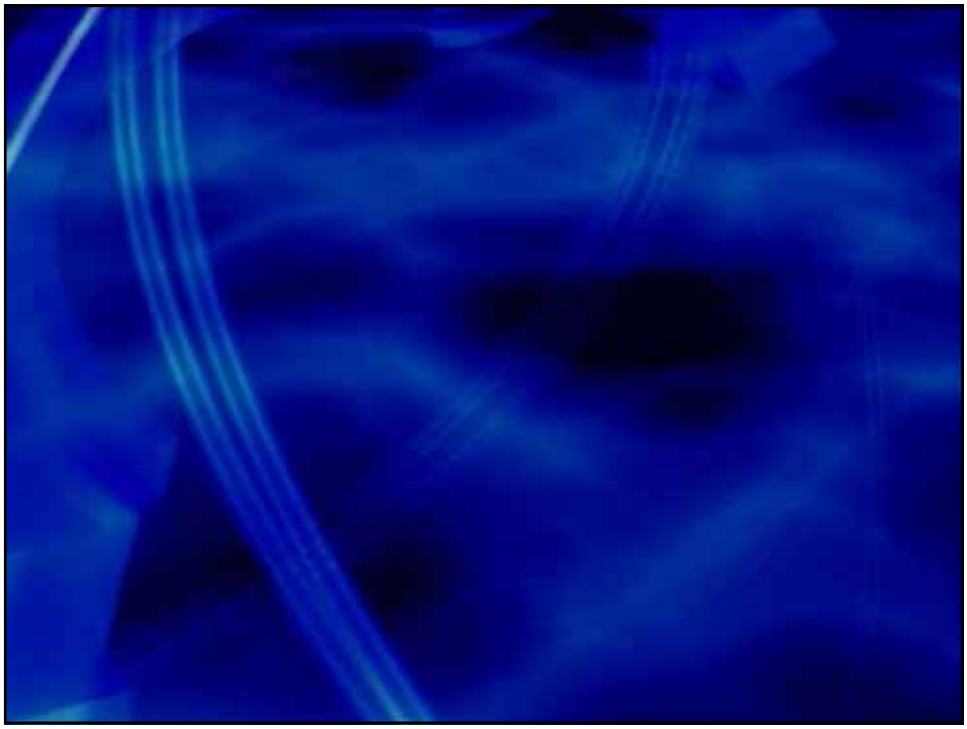
- Project: *110 HUD-assisted multifamily (Stockton, CA)*
- Conditions: *Boiler performance problems/ failures; inadequate cooling*
- Measures: *Energy Audit, ESCO investment assessment, Boiler and chiller replacement*
- Costs: *$1.8 million*
- Savings: *Unavailable*

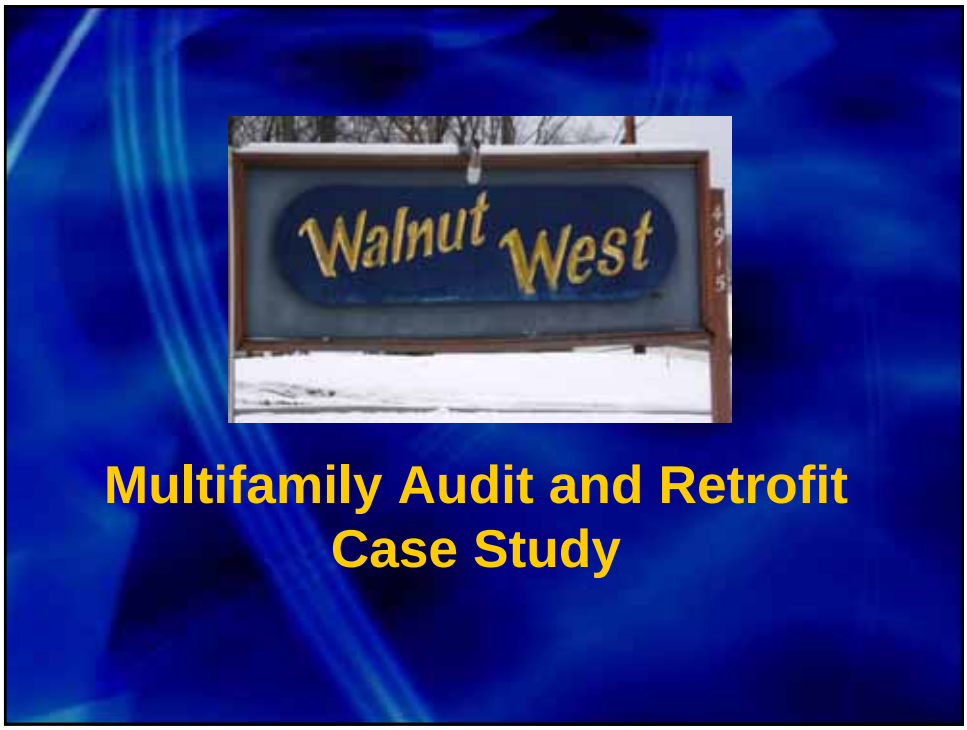
Rotary Plaza

- **Project: 181 units multifamily lighting retrofit (San Francisco, CA)**
- **Condition: Built: 1970; Excessive energy costs**
- **Measures: Energy audit; full lighting retrofit**
- **Savings:**
  - **Energy savings from lighting will be recycled to finance additional energy efficiency improvements**

Glenridge Apartments

- **Project:** *277 units multifamily lighting retrofit (San Francisco,CA)*
- **Condition:** *Built 1968. Master metered; high energy costs*
- **Measures:** *Facility energy audit; Lighting inventory; Full lighting retrofit*
- **Rebate:** *$12,000*





Multifamily Audit and Retrofit Case Study

Types of Audits

- Information audit
  - General guidance on work scope
  - Rough cost and savings estimates
- Installation or "investment" audit
  - Specific work scope
  - Detailed cost and savings info
  - Generally done with money on the table

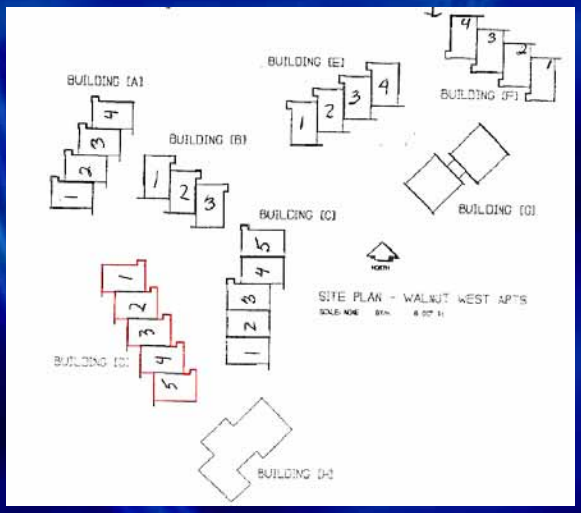
The Multifamily Investment Audit Process

1. Utility bill analysis
2. Site inspection with comprehensive visual and diagnostic investigation utilizing performance testing
3. Energy model calibrated development
4. Energy improvement measures and scenarios
5. Estimate costs
6. Financial analysis

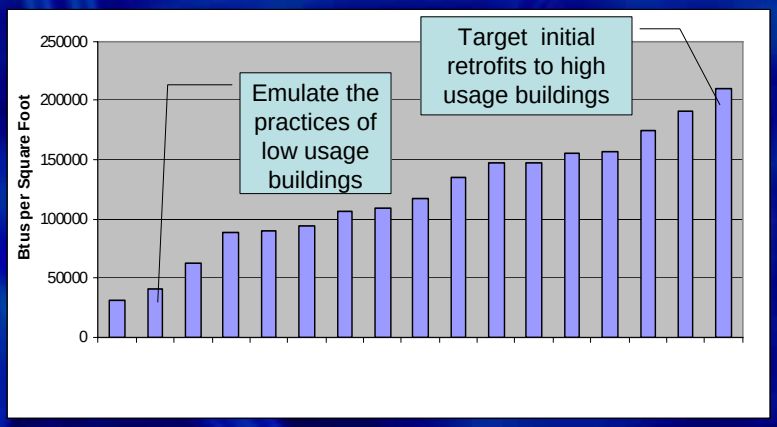
Walnut West Bldg Description

- Bldg description
  - 25 apt units in the 6 townhouse clusters
    - Individual gas furnaces and DHW tanks
  - 6 apt units in the 1 3-story apt building
    - Master heat and DHW from central boiler
  - 4 apt units in the old converted farmhouse
    - Master heat and DHW from central boiler

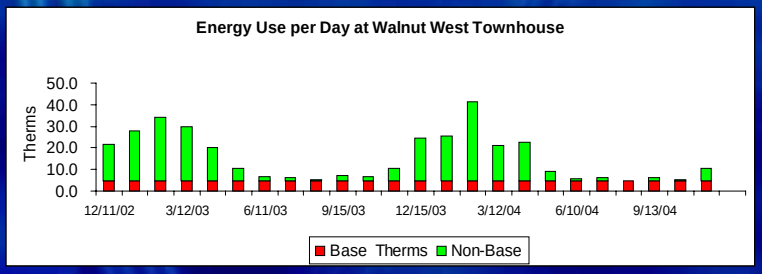
Walnut West Layout



Typical Energy Usage Intensity Benchmarking Data (NYC)



Building level billing analysis



- **Aggregation of data tenant and master accounts**
- **Mechanisms for addressing missing data**
  - **Sampling**
  - **Similar units**
  - **Time**

Comprehensive Visual Inspection

- Physical measurement of the building
- Occupant and operator interviews
- Observations of problems
  - Energy
  - Non-Energy
- Initial diagnosis
- Record probable solutions

People

- Occupant behaviors
  - Thermostat operation
  - Moisture production
  - Ventilation
  - Cleaning
  - Windows left open
  - Smoking
- Operator
  - Schedules
  - Problem reports
  - Maintenance issues

Performance Testing

- Combustion safety and efficiency
  - All gas appliances
- Air leakage testing with Blower doors
- Duct testing
- Infrared Imaging (combined with blower door)
- Moisture and IEQ (air and wood)
- Optional: Hobo meters

Combustion Safety and Efficiency

Air Leakage Testing

Duct Testing

Duct Hunting Season

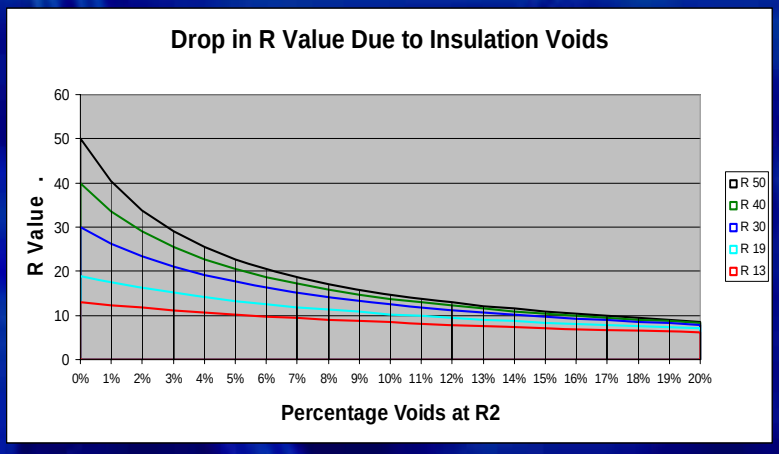
Bath Fan Testing

Infrared Imaging

- Used by itself and in combination with blower door
- Visual information on:
  - Insulation voids
  - Air flow
  - Moisture in materials
- Great sales tool!

Insulation Quality

Translate IR Images into R Value Impacts



IEQ – Indoor Environmental Quality

- Hazard control – Radon, Lead, VOC's, Dust
- Combustion
- Ventilation
- Smoking

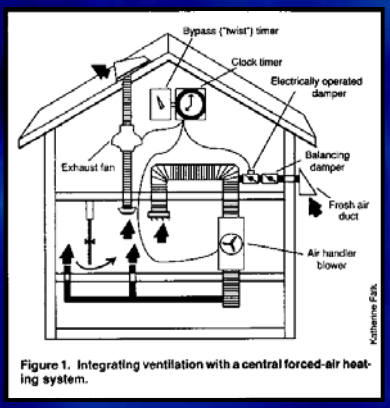


Figure 1. Integrating ventilation with a central forced-air heating system.

Moisture

Home Performance with Energy Star

- A whole-house approach to improving the energy efficiency of existing homes
- Differentiated local contractors
- Evaluate and implement performance-tested improvements
- Test out process = quality assurance

Energy Modeling with TREAT

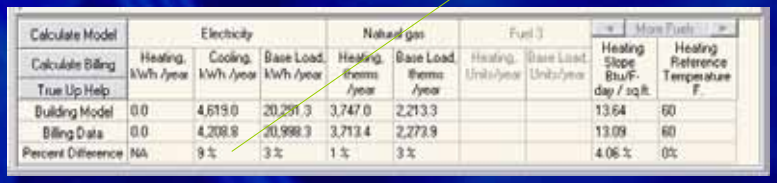
- Computer simulation of building energy use taking into account building characteristics, operations and weather for accurate prediction of savings
- TREAT
  - Verified hourly simulation
  - Integrated billing analysis
  - Scenario modeling
  - Savings tracking
  - Used by New York State to calculate savings in all retrofits of existing residential buildings

www.treatsoftware.com

Quality Assurance For Savings Predictions

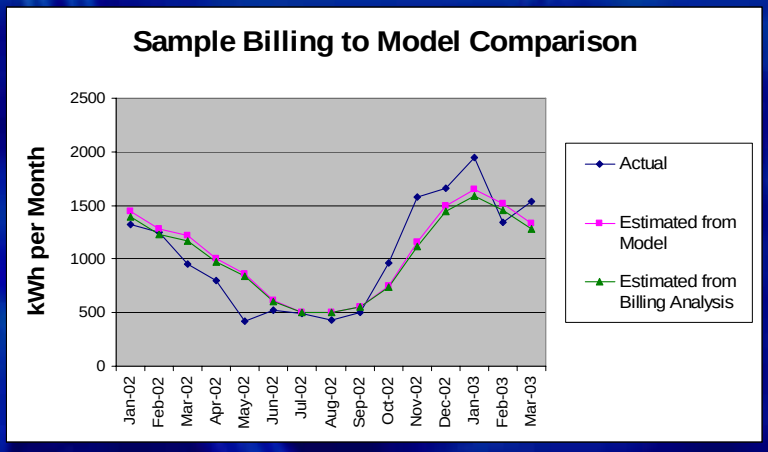
- **Model Calibration**
  - **Baseload**
  - **Temperature Settings**
  - **Exceptions (low bills = 55°F?)**

TREAT true-up screen compares the performance of the energy model to the actual bills

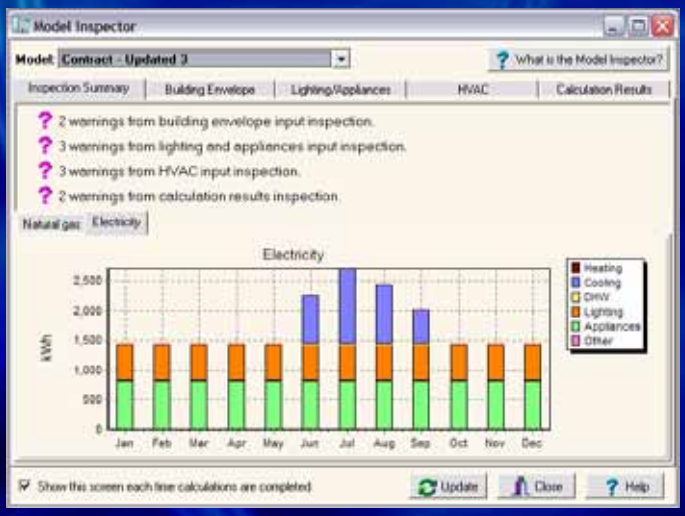


Calculate Model / Calculate Billing / True Up Help	Electricity			Natural gas		Fuel 3		More Fuels	
	Heating, kWh /year	Cooling, kWh /year	Base Load, kWh /year	Heating, therms /year	Base Load, therms /year	Heating, Units/year	Base Load, Units/year	Heating Slope Btu/F-day / sq.ft.	Heating Reference Temperature F.
Building Model	0.0	4,619.0	20,291.3	3,747.0	2,213.3			13.64	60
Billing Data	0.0	4,208.9	20,998.3	3,713.4	2,273.9			13.09	60
Percent Difference	NA	9 %	3 %	1 %	3 %			4.06 %	0%

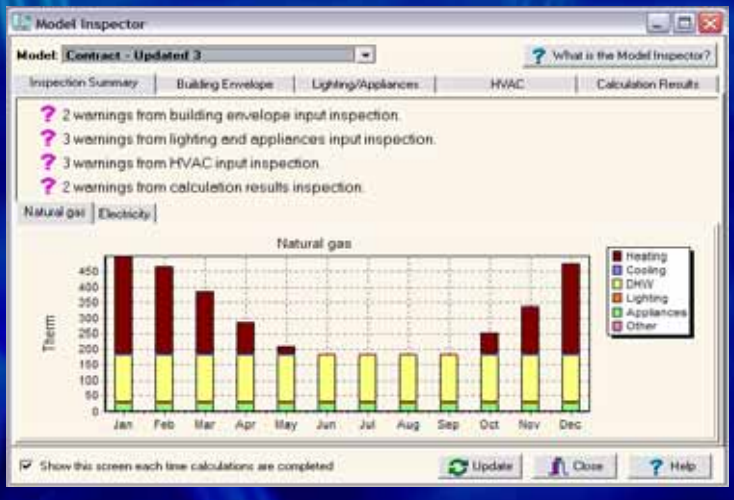
Calibration Accuracy



Electrical Energy End Uses



Gas End Uses



Improvement Analysis

Improvement Name	Cost $	Annual Usage MMBtu	Annual Savings MMBtu	Annual Usage $	Annual Savings $	Payback Years	SIR
Gas Dryer Flue - 4 Hardducted	768.00	681.02	0.00	11457	0	NA	NC
High-Flow Bath Fan	2032.00	685.25	-4.23	11506	-49	NA	NC
Install Low Flow Shower Head / Faucets	50.00	663.27	17.74	11237	220	0.23	43.77
Install Vented Range Hood	4744.00	681.02	0.00	11457	0	NA	NC
Insulate Crawl Rimjoist Sprayfoam	740.00	677.82	3.19	11418	39	19.09	2.05
Insulate Crawl Space	2684.00	668.88	12.14	11308	149	18.01	2.18
Insulate Roof RimJoist SprayFoam	3676.00	665.40	15.62	11260	197	18.64	2.10
Munchkin Indirect DHW Tanks	18000.00	632.64	48.38	10829	629	28.64	0.86
Replace Both Sldg Glass Doors	7395.00	668.03	12.99	11279	179	41.39	0.48
Replace Living Rm Fixed and Operable W	1200.00	677.02	4.00	11355	102	11.72	1.69
Replace Old Window Upstairs w/ Wall	1000.00	679.88	1.14	11430	28	36.19	0.55
Two-Stage Programmable Thermostats	200.00	637.73	43.29	11062	395	0.51	39.07
Vapor Barrier	1180.00	681.02	0.00	11457	0	NA	NC
Water Heater Setpoint Adjustment	1.00	680.67	0.35	11449	9	0.12	85.89

Bundling Improvements into Packages

Improvement Packages

Package Name	Cost $	Annual Usage MMBtu	Annual Savings MMBtu	Annual Usage $	Annual Savings $	Payback Years	Cash Flow $ / year	SIR
Audit	55573.00	397.32	283.70	6802	4655	11.94	-1784	1.93
Contract - SEER 8	32196.00	445.20	235.82	8353	3104	10.37	-627	2.61
Contract - Updated 3	37808.00	437.34	243.68	8008	3449	10.96	-932	2.36
DHW Tank Replacement - Munch	18000.00	632.64	48.38	10829	629	28.64	-1457	0.86
Furnace - Bryant, ECM, Duct Seal	18428.00	488.30	192.72	8886	2571	7.17	435	3.02
Lighting Improvements	1376.00	679.38	1.64	10971	486	2.83	327	3.53
Total Insulation	6410.00	635.52	45.50	10892	565	11.34	-178	2.46

Calculate Package

Calculate All Packages

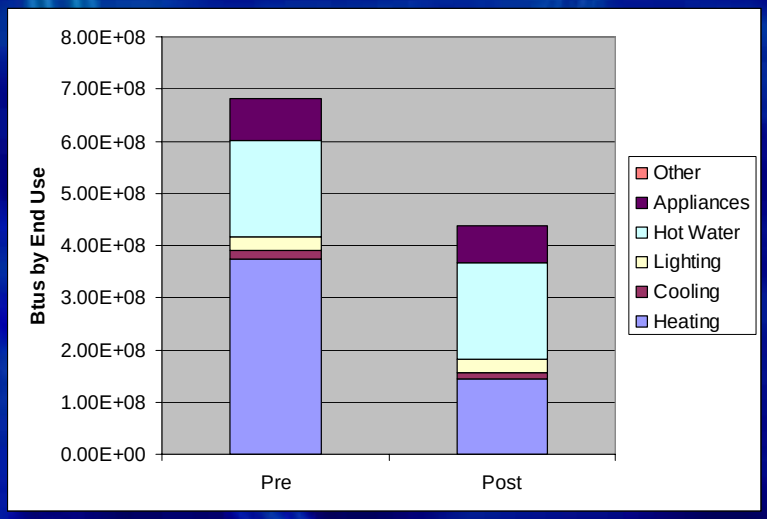
Edit Financial Information

Lifestyle Savings

Financial information used for cash flow and savings to investment ratio (SIR) analysis

Add Edit Copy Delete

Pre and Post Energy Use



Improvement Interactions

- Avoid predicting savings that are more than 100% of current energy use!!!
- Typical types of interactions
  - Lighting with heating and cooling
  - Insulation and heating
  - Windows and cooling
- Simulation modeling captures the impact of these interactions

Recommendations

Improve building air tightness

- Spot air sealing for penetrations through crawlspace ceiling and inside apartments where plumbing enters wall cavities
- Air sealing the crawl space
- Air sealing around window cases, caulking older windows

Air Sealing

- Cost: $17,000
- Annual Savings: $4,500
- Payback: 4.0 years
- Savings-Investment Ratio: 5.0

Sealing air leaks with spray foam and board materials

Weatherizing the AC Sleeve

Party Walls

Improve insulation

- Insulating the crawl space
- Insulating the band joist and rim joist below the insulated roof

Insulation

- Cost: $14,000
- Annual Savings: $2,200
- Payback: 6.2 years
- Savings-Investment Ratio: 5.9

Reduce fuel for heating and cooling and increase comfort by:

- Replacing old inefficient furnaces with high-efficiency condensing furnaces with new thermostats
- Install new high SEER air conditioning equipment
- Sealing leaky supply and return ductwork
- Installing larger opening return grills
- Install louvered grill in mechanical room door providing combustion air.
  (Only if existing furnaces remain)

Heating and Distribution System

- Cost: $120,000
- Annual Savings: $13,000
- Payback: 9.2 years
- Savings-Investment Ratio: 2.1

High efficiency gas furnace

- **Secondary heat exchanger**
- **94+% efficient**
- **ECM Motors!!!**

Duct Sealing

Thermostats

Programmable thermostats can save 5-15% annually versus a constant temperature setting

Cooling

- **Cost: $28,060**
- **Annual Savings: $1,345**
- **Payback: 20 years**
- **Savings-Investment Ratio: .95**

SEER Seasonal Energy Efficiency Ratio

- 1970s-era: 4.5-8.0
- Minimum allowed 200513.0
- Energy Star qualified (2004) 12.0
- Best commercially available 16-18

Sliding Glass Doors

- Replacing the old sliding glass doors with new ENERGY STAR rated models.
- Cost: $17,000
- Annual Savings: $1,000
- Payback: 17 years
- Savings-Investment Ratio: 1.2

Reduce fuel for domestic hot water by:

- Insulating any piping in unconditioned spaces
- Replacing old shower heads and faucets with low-flow models
- Cost: $440
- Annual Savings: $260
- Payback: 2.0 years
- Savings-Investment Ratio: 5.4

DHW Replaced On Failure

Reduce electric baseload consumption by:

- Replacing old refrigerators with ENERGY STAR rated models.
- Replacing incandescent fixtures with ENERGY STAR rated fluorescent fixtures.

Refrigerators

- Cost: $18,000
- Annual Savings: $1,470
- Payback: 12 years
- Savings-Investment Ratio: 1.6

ENERGY STAR refrigerators

- 50% less electricity than 10 year old models
- 40% less than pre-2001 standard
- 10% less than current standard
- Online lists

Lighting

- Cost: $8,500
- Annual Savings: $1,800
- Payback: 4.8 years
- Savings-Investment Ratio: 2.1

Lighting

Non- Energy Measures Control Moisture Levels by:

- Replacing damaged exterior window trim
- Installing a vapor barrier in the crawl space
- Replacing bathroom exhaust fans with new higher capacity whisper models on a timer.
- Hard ducting all clothes dryers and replacing the outside termination that is restricting exhaust flow.
- Replace re-circulating kitchen hoods with exhausting types

Moisture Problems

External Moisture Deterioration

Health & Safety Issue

Contracting

- Early feedback on installation
- “Testing out”

Test Out Finds Mistakes

About ENERGY STAR

- **What is ENERGY STAR**
  - **More than** 50 product **categories covered**
  - **Almost** 40 states, 500 utilities, and many other energy efficiency program sponsors **promoting ENERGY STAR at** over 21,000 partner storefronts
  - **More than** 2 billion **ENERGY STAR qualified products purchased in the US to date**

About ENERGY STAR

- **Why ENERGY STAR?**
  - Increasing demand
  - Supply constraints
  - Increasing energy prices

ENERGY STAR Qualified Products

- Benefits
  - Up to 50% more efficient
  - Quality and performance
  - Reduce air pollution
  - ROI through operating cost savings
- ENERGY STAR qualified appliances
  - Clothes washers
  - Dehumidifiers
  - Dishwashers
  - Refrigerators
  - Room Air Conditioners
- ENERGY STAR qualified lighting
  - Bulbs
  - Fixtures and Fans

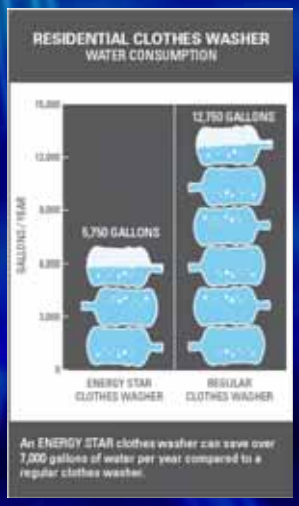
ENERGY STAR Qualified Clothes Washers

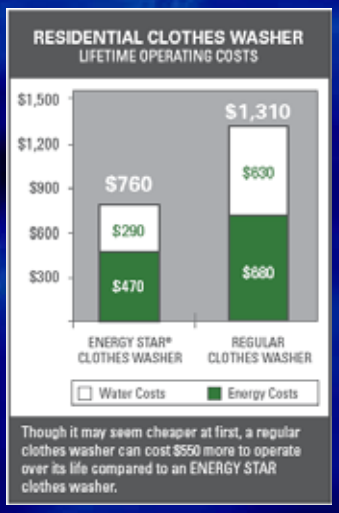
- About 40% more efficient than standard
- Benefits
  - Energy and water savings
  - More capacity
  - Clothes last longer
  - Higher spin speeds = less drying time

ENERGY STAR Qualified Clothes Washers

- Cost Effectiveness
  - Average life: 11 Years
  - Average cycles/year: 392
  - Time to recover initial investment: 5 years
  - Price ranges
    - ENERGY STAR: $550 - $1,520
    - Conventional: $240 - $770

ENERGY STAR Qualified Clothes Washers





ENERGY STAR Qualified Dehumidifiers

- **At least 10-20% more efficient**
  - **40-pint ENERGY STAR qualified dehumidifier can save ~$20 per year, or $200+ over the life of the unit.**

Condition without Dehumidification	Area (Sq. Feet)				
	500	1,000	1,500	2,000	2,500
Moderately Damp (space feels damp and has musty odor only in humid weather)	10	14	18	22	26
Very Damp (space always feels damp and has musty odor. Damp spots show on walls and floor.)	12	17	22	27	32
Wet (space feels and smells wet. Walls or floor sweat, or seepage is present.)	14	20	26	32	38
Extremely Wet (laundry drying, wet floor, high load conditions.)	16	23	30	37	44

ENERGY STAR Qualified Dishwashers

- At least 40% more efficient than standard
- Added benefits
  - Innovative designs
  - Soil sensors

ENERGY STAR Qualified Dishwashers

- Cost effectiveness
  - Average life: 11 years
  - Average cycles per year: 215
  - ENERGY STAR price premium: $30 – $60
  - Time to recover price premium: 2 – 6 years
  - Price ranges
    - ENERGY STAR: $170 - $1,750
    - Conventional: $160 - $450

ENERGY STAR Qualified Refrigerators

- ENERGY STAR qualified refrigerators/freezers are between 10 – 20% more efficient than standard
- Today's ENERGY STAR refrigerators use less energy than a 75-watt light bulb

ENERGY STAR Qualified Refrigerators

- Benefits
  - Quiet operation, Convenience and design
  - Freshness
- Cost effectiveness
  - Average life: 14 years
  - ENERGY STAR price premium: $30 – $100
  - Time to recover initial investment: 2 – 6 years
  - Price ranges (full size)
    - ENERGY STAR: $400 - $5,000
    - Conventional: $300 - $5,000
- Recycling can save

ENERGY STAR Qualified Room Air Conditioners

- At least 10% more efficient than standard
- Benefits
  - Added features
  - Quieter operation
- Cost effectiveness
  - Average product life expectancy: 10 years
  - Price ranges (approx)
    - ENERGY STAR: $130 - $850
    - Conventional: $80 - $1,000
  - ENERGY STAR price premium: $30 – $50
  - Time to recover price premium: 4 – 7 years

ENERGY STAR Qualified Room Air Conditioners

DETERMINE WHICH UNIT SIZE IS BEST FOR YOU.

- IF THE ROOM IS SQUARE OR RECTANGULAR, multiply the length of the area by the width.
- IF THE ROOM IS TRIANGULAR, multiply the length of the area by the width and divide by two.

Most rooms can be further divided into these basic shapes to determine the square footage:

If your room is other than square or rectangular, ask your sales associate to help you determine the square footage.

Using the square footage and the chart on the right, determine the correct cooling capacity.

AREA TO BE COOLED (sq. ft.)	CAPACITY NEEDED (btu/hour)
100 to 150	5,000
150 to 250	6,000
250 to 300	7,000
300 to 350	8,000
350 to 400	9,000
400 to 450	10,000
450 to 550	12,000
550 to 700	14,000
700 to 1,000	18,000
1,000 to 1,200	21,000
1,200 to 1,400	23,000
1,400 to 1,500	24,000
1,500 to 2,000	30,000

ENERGY STAR Qualified Lighting

- Lighting accounts for ~20% of an average home electric bill [1]
- An average home has ~45 bulbs in ~30 light fixtures [2]
- Home sizes are increasing[3]

ENERGY STAR Qualified Lighting

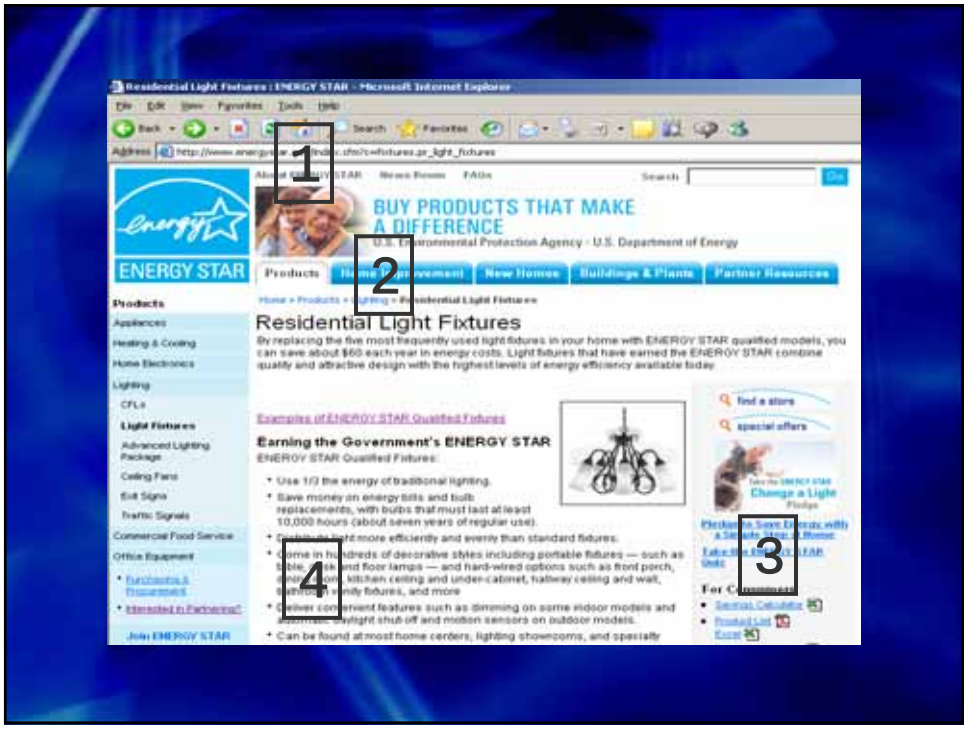
- ENERGY STAR qualified CFL bulbs
  - Use 75% less energy than incandescent bulbs
  - Last up to 10 times longer than incandescent bulbs
  - Save $30 or more in lifetime energy costs
  - Generate 70% less heat
  - Additional Requirements:
    - Instant-on
    - No humming
    - Color requirements
  - Available in many sizes and shapes

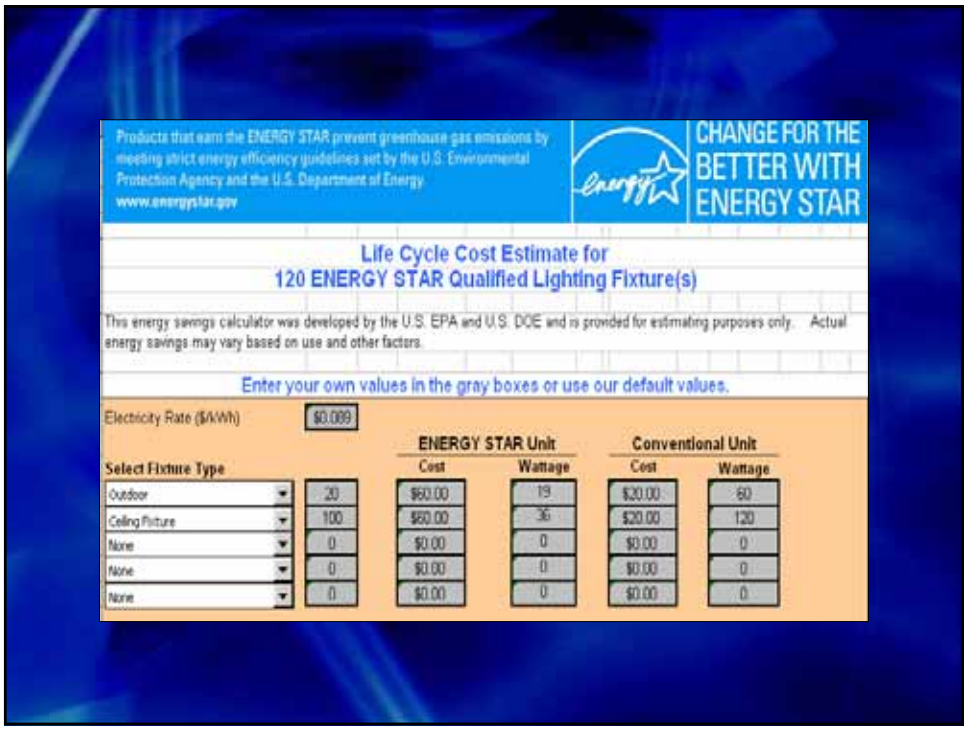
ENERGY STAR Qualified Lighting – Fixtures

- ENERGY STAR qualified residential light fixtures
  - 75% less energy
  - Bulbs last at least 7 yrs
  - Many decorative styles
  - 2-year warranty—2x industry standard

ENERGY STAR Qualified Lighting – Fixtures

- ENERGY STAR qualified ceiling fans and light kits
  - Fans are 15 – 20% more efficient
  - Fans with ENERGY STAR qualified light kits deliver 50% more savings


1
2
3
4
BUY PRODUCTS THAT MAKE A DIFFERENCE
ENERGY STAR
Residential Light Fixtures
Earning the Government's ENERGY STAR


Products that earn the ENERGY STAR prevent greenhouse gas emissions by meeting strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy.
www.energystar.gov
CHANGE FOR THE BETTER WITH ENERGY STAR
Life Cycle Cost Estimate for
120 ENERGY STAR Qualified Lighting Fixture(s)
This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.
Enter your own values in the gray boxes or use our default values.
Electricity Rate ($/kWh)
$0.089
Select Fixture Type
ENERGY STAR Unit
Conventional Unit
Cost
Wattage
Outdoor
20
$60.00
19
$20.00
60
Ceiling Fixture
100
$60.00
36
$20.00
120
None
0
$0.00
0
$0.00
0
None
0
$0.00
0
$0.00
0
None
0
$0.00
0
$0.00
0

ENERGY STAR Savings Calculator – Results

Annual and Life Cycle Costs and Savings for 120 Light Fixture(s)

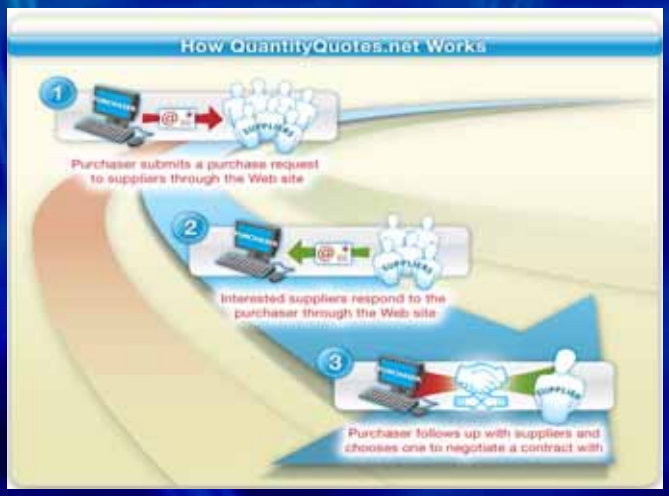
	120 ENERGY STAR Qualified Unit(s)	120 Conventional Unit(s)	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$861	$2,819	$1,958
Maintenance cost	$418	$1,124	$707
Total	**$1,279**	**$3,944**	**$2,665**
Life Cycle Costs*			
Life cycle operating cost (energy + maintenance)	$17,382	$53,594	$36,211
Purchase price for 120 unit(s)	$7,200	$2,400	-$4,800
Total	**$24,582**	**$55,994**	**$31,411**
		Simple payback of initial additional cost (years)†	**1.8**

ENERGY STAR Savings Calculator – Results

Summary of Benefits for 120 Light Fixture(s)

Initial cost difference	**$4,800**
Life cycle savings	**$36,211**
Net life cycle savings (life cycle savings - additional cost)	**$31,411**
Simple payback of additional cost (years)	**1.8**
Life cycle energy saved (kWh)	**438,000**
Life cycle air pollution reduction (lbs of CO_2)	**700,800**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**61.10**
Air pollution reduction equivalence (acres of forest)	**86.88**
Savings as a percent of retail price	**238%**

www.Quantity Quotes.net



Purchase Request Form for CFLs

This information will be sent to suppliers as part of your request.

Purchaser Location: Silver Spring, Maryland, 20910

1. Delivery City:

Delivery State:

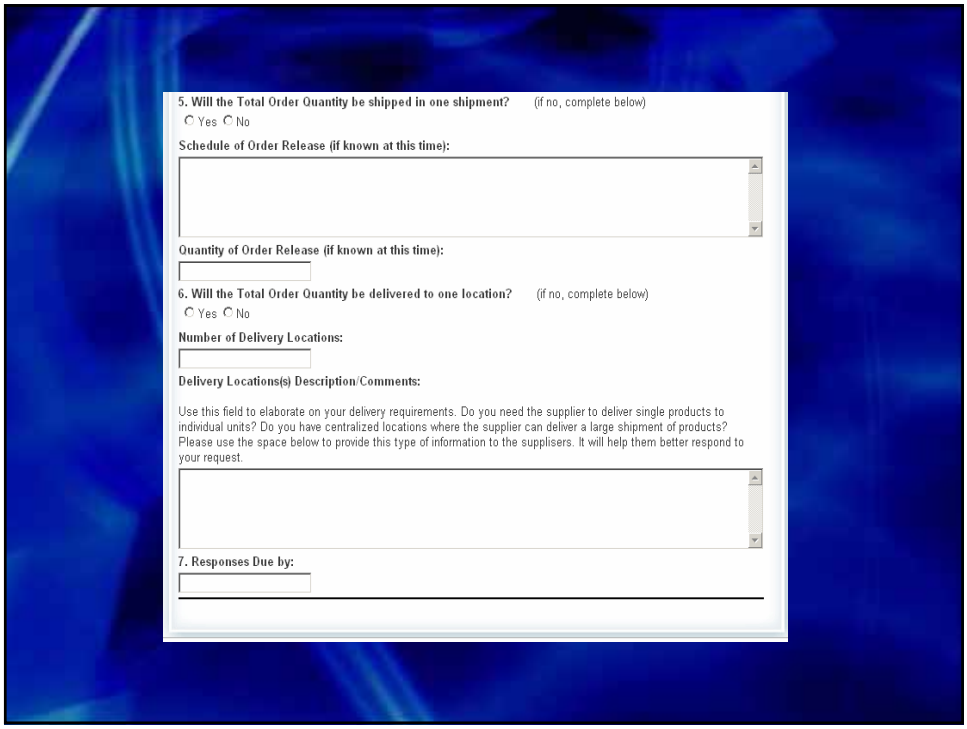
Delivery Zip Code:

2. Contract Duration

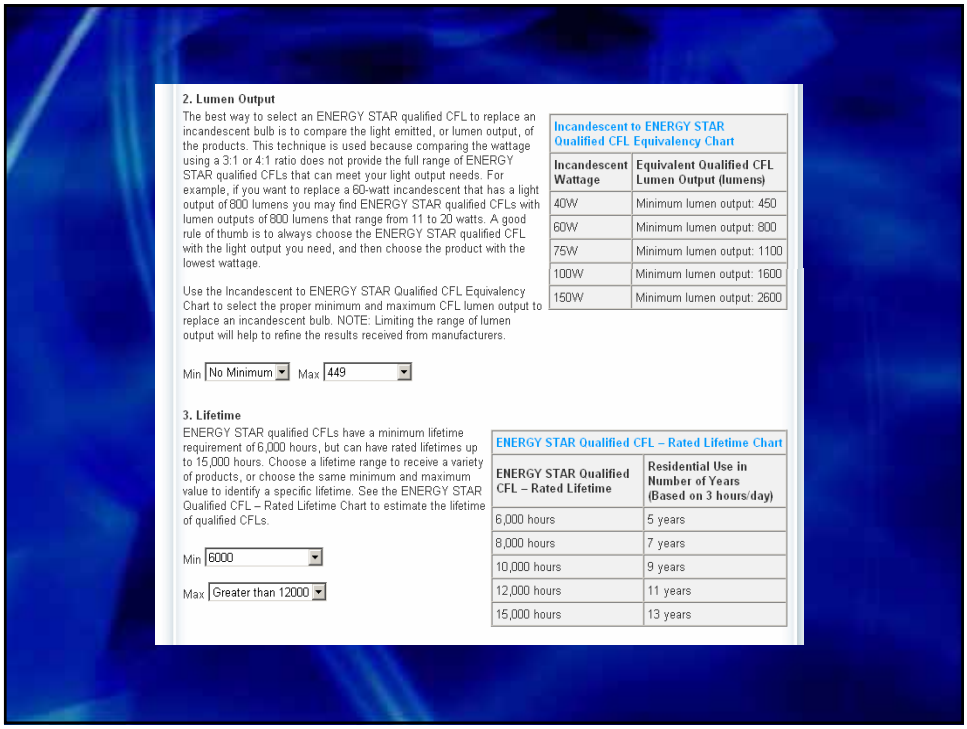
From: To:

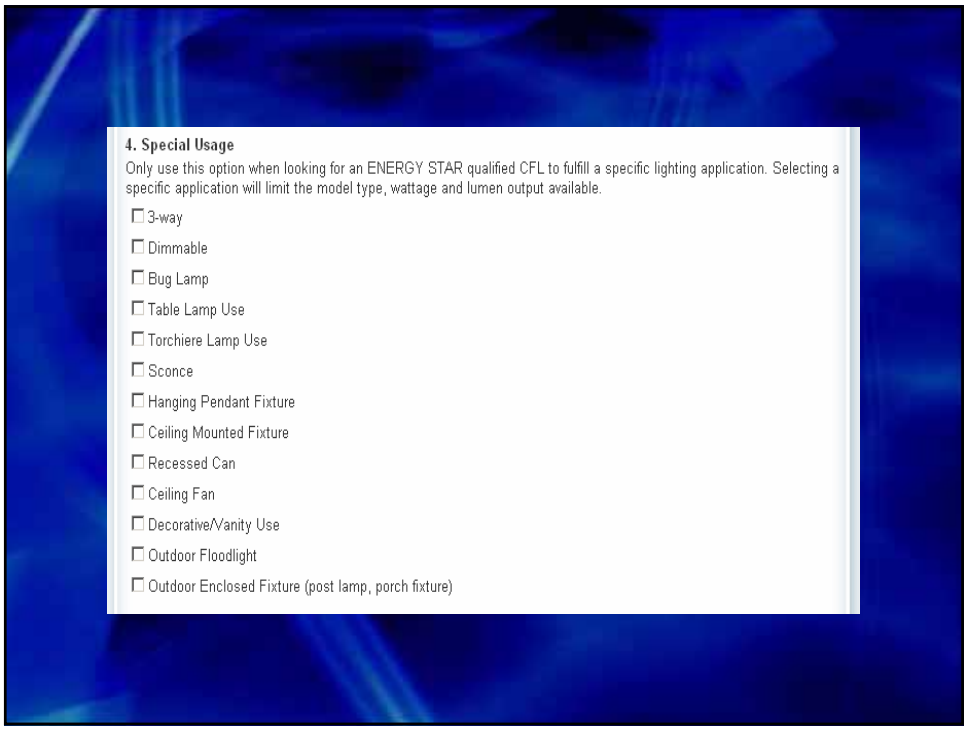
3. Project Description:

4. Total Order Quantity:


5. Will the Total Order Quantity be shipped in one shipment? (if no, complete below)
Yes No
Schedule of Order Release (if known at this time):
Quantity of Order Release (if known at this time):
6. Will the Total Order Quantity be delivered to one location? (if no, complete below)
Yes No
Number of Delivery Locations:
Delivery Locations(s) Description/Comments:
Use this field to elaborate on your delivery requirements. Do you need the supplier to deliver single products to individual units? Do you have centralized locations where the supplier can deliver a large shipment of products? Please use the space below to provide this type of information to the supplisers. It will help them better respond to your request.
7. Responses Due by:


1. * Model Type
Consider the possible lighting applications of the end-user when selecting an ENERGY STAR qualified CFL model type. Bare-spiral CFLs are most common and will fit most lighting applications. Bare-mini-spiral models are small enough to fit in most flush mounted ceiling fixtures and ceiling fans with light kits. Covered CFLs are better for specialty applications where the CFL is likely to be exposed. For instance, covered A-lines can be used in table lamps, hanging pendant lights, ceiling fans, or outdoor enclosed fixtures; covered globes are designed for use in bath bars or other decorative fixtures; covered reflectors are used in mostly recessed can fixtures. Make sure to review the manufacturer's information on the best application for the product you select.
Bare-mini-spiral
Bare-spiral
Bare-twin Tube
Bare-triple Tube
Bare-quad Tube
Bare-circline
Covered A-line
Covered Bullet
Covered Candle (medium base only)
Covered Globe
Covered Reflector
Covered Post


2. Lumen Output
The best way to select an ENERGY STAR qualified CFL to replace an incandescent bulb is to compare the light emitted, or lumen output, of the products. This technique is used because comparing the wattage using a 3:1 or 4:1 ratio does not provide the full range of ENERGY STAR qualified CFLs that can meet your light output needs. For example, if you want to replace a 60-watt incandescent that has a light output of 800 lumens you may find ENERGY STAR qualified CFLs with lumen outputs of 800 lumens that range from 11 to 20 watts. A good rule of thumb is to always choose the ENERGY STAR qualified CFL with the light output you need, and then choose the product with the lowest wattage.
Use the Incandescent to ENERGY STAR Qualified CFL Equivalency Chart to select the proper minimum and maximum CFL lumen output to replace an incandescent bulb. NOTE: Limiting the range of lumen output will help to refine the results received from manufacturers.
Incandescent to ENERGY STAR Qualified CFL Equivalency Chart
Incandescent Wattage
Equivalent Qualified CFL Lumen Output (lumens)
40W
Minimum lumen output: 450
60W
Minimum lumen output: 800
75W
Minimum lumen output: 1100
100W
Minimum lumen output: 1600
150W
Minimum lumen output: 2600
Min No Minimum
Max 449
3. Lifetime
ENERGY STAR qualified CFLs have a minimum lifetime requirement of 6,000 hours, but can have rated lifetimes up to 15,000 hours. Choose a lifetime range to receive a variety of products, or choose the same minimum and maximum value to identify a specific lifetime. See the ENERGY STAR Qualified CFL – Rated Lifetime Chart to estimate the lifetime of qualified CFLs.
Min 6000
Max Greater than 12000
ENERGY STAR Qualified CFL – Rated Lifetime Chart
ENERGY STAR Qualified CFL – Rated Lifetime
Residential Use in Number of Years (Based on 3 hours/day)
6,000 hours
5 years
8,000 hours
7 years
10,000 hours
9 years
12,000 hours
11 years
15,000 hours
13 years


4. Special Usage
Only use this option when looking for an ENERGY STAR qualified CFL to fulfill a specific lighting application. Selecting a specific application will limit the model type, wattage and lumen output available.
3-way
Dimmable
Bug Lamp
Table Lamp Use
Torchiere Lamp Use
Sconce
Hanging Pendant Fixture
Ceiling Mounted Fixture
Recessed Can
Ceiling Fan
Decorative/Vanity Use
Outdoor Floodlight
Outdoor Enclosed Fixture (post lamp, porch fixture)

5. Color Correlated Temperature (CCT)

Color Correlated Temperature is the perceived color of light. Many ENERGY STAR qualified CFLs have a color correlated temperature similar to soft white incandescent bulbs, 2700-3000K (Kelvin). ENERGY STAR qualified CFLs with a CCT above 3000K have a whiter or "cooler" light appearance, and a qualified CFL with a CCT outside 2700-3000K must label the CCT on the product packaging. Selecting a specific CCT will limit the number of products available. The CCT Chart to the right indicates lighting applications and light descriptions per Kelvin temperature.

- ☐ 2500 – 2700K
- ☐ 2700 - 3000K
- ☐ 3000 - 3500K
- ☐ 3500 - 4100K
- ☐ 4100 - 5000K
- ☐ 5000 - 6500K

CCT Chart

Kelvin Temperature	Lighting Applications	Light Description
2500 – 2700K	Homes	Warm White
2700 – 3000K	Homes, Restaurants	Soft White
3000 – 3500K	Homes, Restaurants, Public Reception Areas	White
3500 – 4100K	Homes, Libraries, Public Areas, Offices	Cool White
4100 – 5000K	Homes, Offices, Classrooms, Retailers	Cool White
5000 – 6500K	Medical Facilities, Jewelers	Daylight

Resident Education with ENERGY STAR

Change A Light Day is October 3, 2007

A challenge to every American to help change the world, one light – one energy-saving step – at a time.

HUD and Change A Light

- DOE, EPA and HUD work together
  - Engage government leaders
  - Invite participation by regional offices and affiliated organizations

HUD and Change A Light

- HUD's leadership in 2006
  - 3,500 Public Housing Authorities received information
  - 30 HUD regional and field offices signed up as pledge drivers
  - 85 HUD offices registered their activity online

Get Involved

- Plan kick-off events
- Do a lighting change out in your facility and promote the results
- Drive pledges

Get Involved

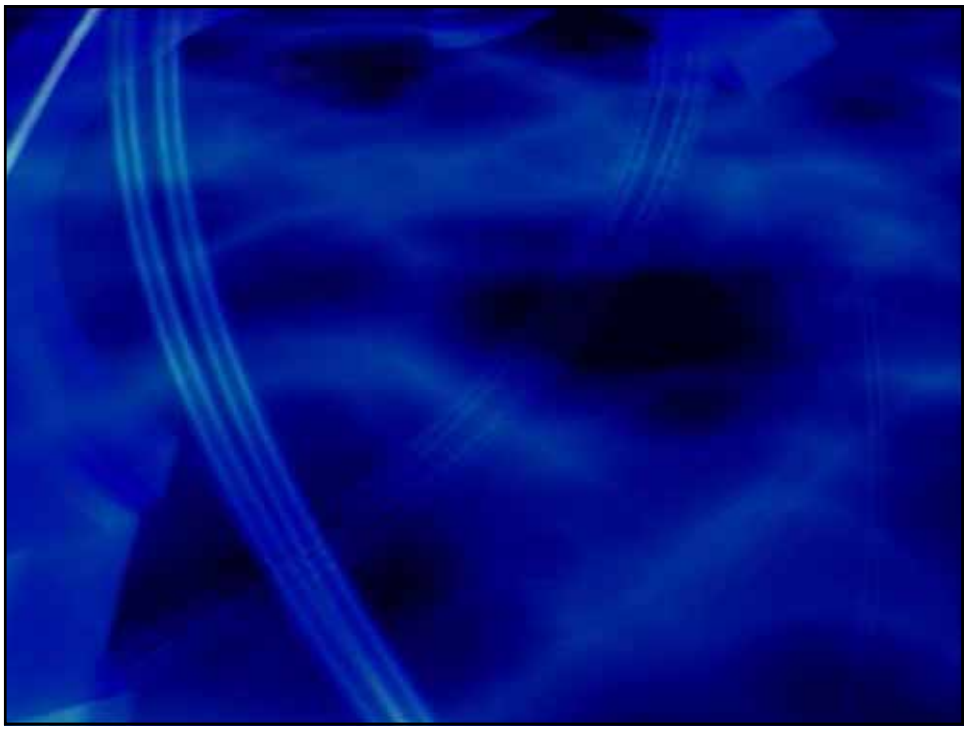
- Go to www.energystar.gov/joinCAL to
  - Access information and promotional templates/materials
  - Sign up as a new pledge driver or plan to reset goal
  - Register your ’07-’08 campaign activity this fall and view what others are doing

Selected Resources

- Online
  - www.hud.gov/energy
  - www.energystar.gov
    - www.energystar.gov/purchasing
    - www.energystar.gov/nationalcampaigns
    - www.energystar.gov/joinCAL
    - www.energystar.gov/training
  - www.quantityquotes.net

Selected Resources

- In person
  - Your HUD Regional Energy Coordinator
  - Your local utility
- For more information on ENERGY STAR
  - Hewan Tomlinson, US EPA
  - Tel: 202.343.9082
  - Email: tomlinson.hewan@epa.gov



Kalani Gardens – Lighting Replacement Study

	Conventional Lighting Usage *(KWh/Yr)*	Benchmark Cost	Energy Star Lighting Usage *(KWh/Yr)*	Energy Star Cost	Energy Savings *(KWh/Yr)*	Energy Savings *($)*
Kitchen	268	$52.26	57	$11.12	211	$41.15
Living Room	262	$51.09	57	$11.12	205	$39.98
Hallway	88	$17.16	19	$3.71	69	$13.46
Exterior	131	$25.55	28.5	$5.56	102.5	$19.99
Bathroom	131	$25.55	28	$5.46	103	$20.09
Bedroom	131	$25.55	28	$5.46	103	$20.09

SOURCE: University of Hawaii (UH) Center for Smart Building and Community Design, Sea Grant College Program

Kalani Gardens – Lighting Replacement Study

	Per Unit kWh Savings	Total kWh Savings	Per Unit Cost Savings	Total Cost Savings
2 Bedroom Units	896.5	78,892	$174.82	$15,384
3 Bedroom Units	999.5	30,985	$194.90	$6,042
119 Units	109,877 kWh		$21,426 /year	

SOURCE: University of Hawaii (UH) Center for Smart Building and Community Design, Sea Grant College Program

Exit Lamp Retrofit

- Property Details:
  - 200 unit multifamily; 6 buildings; 146,116 sq.ft
- Energy Measure:
  - Replace 74 incandescent lights with LED exit lamps
- Project Cost: $2,294
- Savings: $3,794
- Payback: > 1 year

SOURCE: ENERGY ACTION program

Full Lighting Retrofit

- Property Details:
  - EAH Inc, 130 unit multifamily; 1 building; 99,950 sq.ft
- Energy Measure:
  - Replace incandescent lights with CFLs
  - Upgrade fluorescent fixtures to T-8 and electronic ballasts
  - Use LED exit lamps
  - Replace mercury vapor lights w/ metal halide lights
- Project Cost: $11,169
- Savings: $ 8,928
- Payback: 1.3 years

SOURCE: ENERGY ACTION program

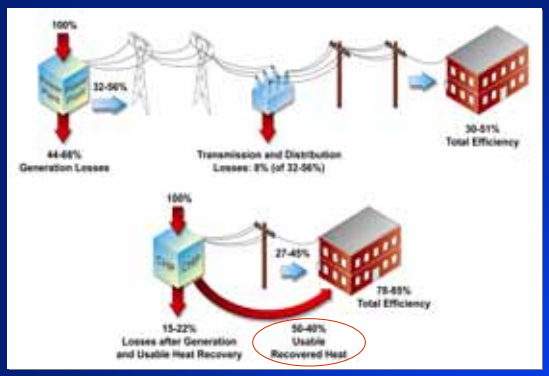
Appliance Upgrades

- Property Details:
  - Embassy Suites 74 unit multifamily
- Energy Measure:
  - Replace/decommission of 74 refrigerators
- Project Cost: $3,700 (added cost)
- Savings: $ 772
- Payback: 4.8 years (w/o rebate)
- Rebates: $7,400 (Refrigerators)
  $2,220 (Decommissioning)

What is "Combined Heat and Power (CHP)" or "cogeneration"?

CHP is a way to produce electricity in your own building and, at the same time, a way to use heat usually wasted when electricity is generated.

How CHP Saves Energy



Why Consider CHP?

- Lower operating cost: reduced electricity and/or fuel bills
- Avoid some cost of electric service
- Offset cost of HVAC system upgrades
- Increase reliability/avoid power outages
- Reduce emissions – satisfy new restrictions, generate salable credits
- Public relations – enhance “green” image

Why CHP for Multifamily?

- For space heating, can use hot water or steam
- Can run absorption cooling
- Can run desiccant dehumidifiers to reduce mold
- Can reduce demand during peak times
- Can be financed in various ways

How Housing Finance Agencies Support CHP

- Massachusetts HFA
  - Sees reduced energy costs as a means of maintaining affordability.
  - Financed the addition of CHP to 18 existing developments with over 5,000 apartments.
  - Supports CHP for new construction.
  - Utilities provide financial support.
  - Also use reserves; realizes 3-year payback.
  - Stresses the importance of the company.

Key Factors for CHP Attractiveness

- 80-100+ apartments in building
- Access to natural gas
- Master metered for electricity
- High percentage of hours with need for *both* power and thermal
- BTU cost of grid electricity significantly higher than cost of gas
- Installation cost competitive with conventional system.

CHP SYSTEMS

Include 2 or 3 basic pieces of equipment:

- **Electricity generator**
  - **Combustion / steam turbines**
  - **Reciprocating engines**
  - **Micro-turbines**
  - **Fuel cells**
- **Heat recovery / steam generator**
- **Thermally activated technologies (heating/cooling systems, dehumidifiers)**

CHP Equipment for Multifamily Buildings
Reciprocating Engines, Microturbines

Combined Heat and Power
Trenton, NJ—Trent Center East

- The East Building – 1965
- 225 units HUD senior housing
- (2) 70 kW package installed in 2003
- 50% electricity; all DHW
- $250,000 investment
- Shared savings 4-5 year payback

Combined Heat and Power
Danbury, CT—Wooster Manor

- 100 units PH built 1970's
- 60kW system installed 1998
- Provides 66% electricity, 50% space and all domestic hot water.
- Energy cost reduced by $40,000 annually
- $275,000 gas company loan

Combined Heat and Power
Cambridge, MA—808 Memorial

- 300 units built in 1975 with MassHousing financing
- 2004-75 kW cogen system installed in boiler room
- Provides 42% electricity, 33% heating and DHW
- $175,000 MassHsing loan
- Payback estimated 3.4 years

HUD Promotes CHP in Housing

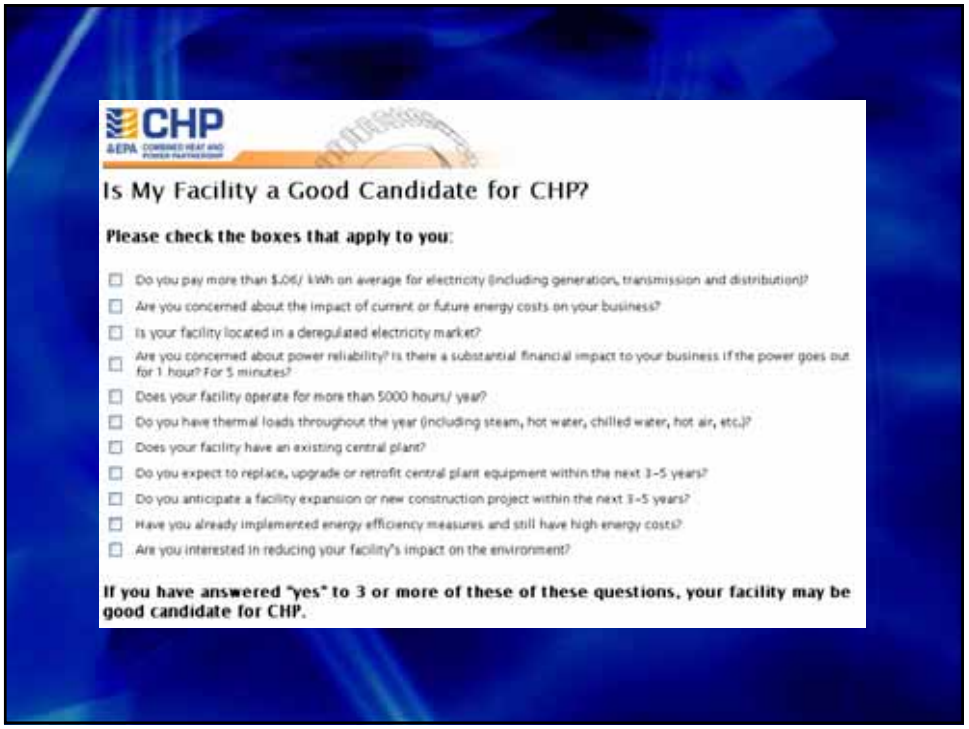
- Encouraging CHP use in multifamily public and assisted housing
- Posted guides for owners/managers:
  - "Q&A- What is CHP"
  - "How to do CHP feasibility screening."
- Working with DOE Regional CHP Application Centers to provide assistance to property owners

Q&A for Building Owners

- CHP basics
- Packaged CHP systems
- Building
- Residents
- Space
- Installation
- Utilities
- Load
- Fuels
- Electric rates
- Electric metering
- Economics
- Environment
- Service and Maintenance

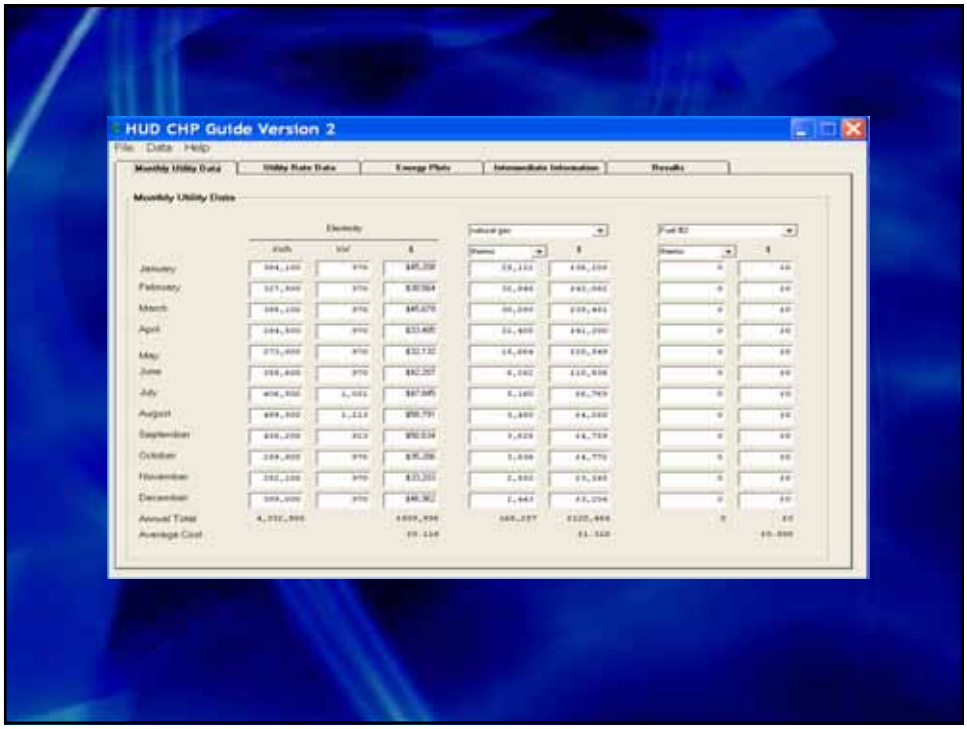
First steps . . .

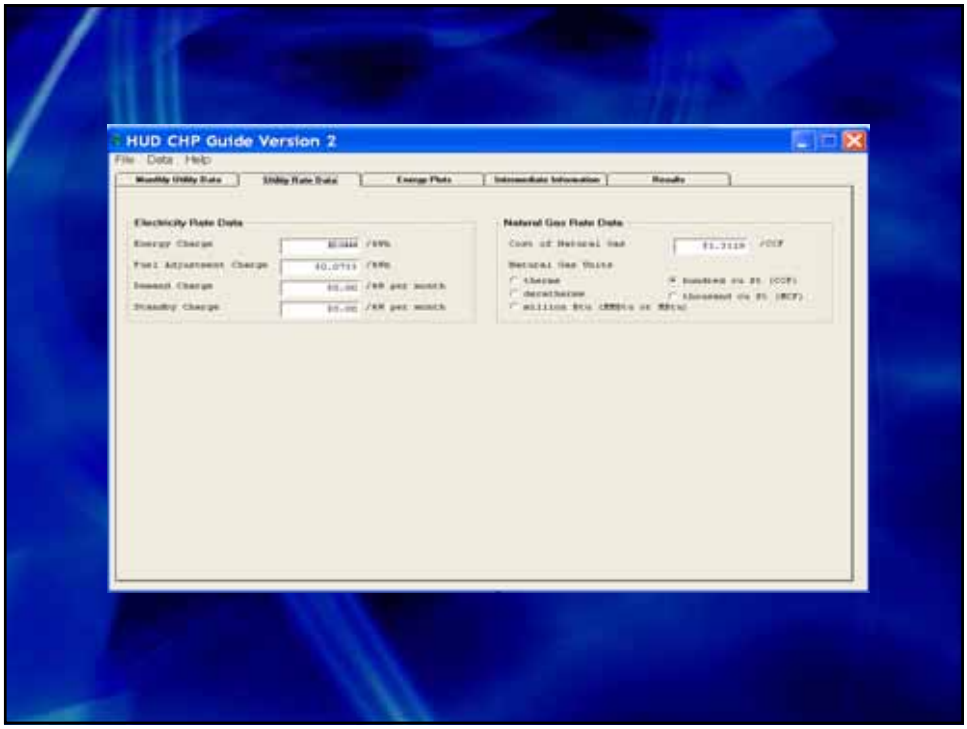
- For a quick preliminary view of potential: EPA has 11 Questions
- For a simple calculation of the payback potential for a building, try HUD CHP Feasibility Screening Software
- For sources of technical assistance, contact DOE Regional Application Centers

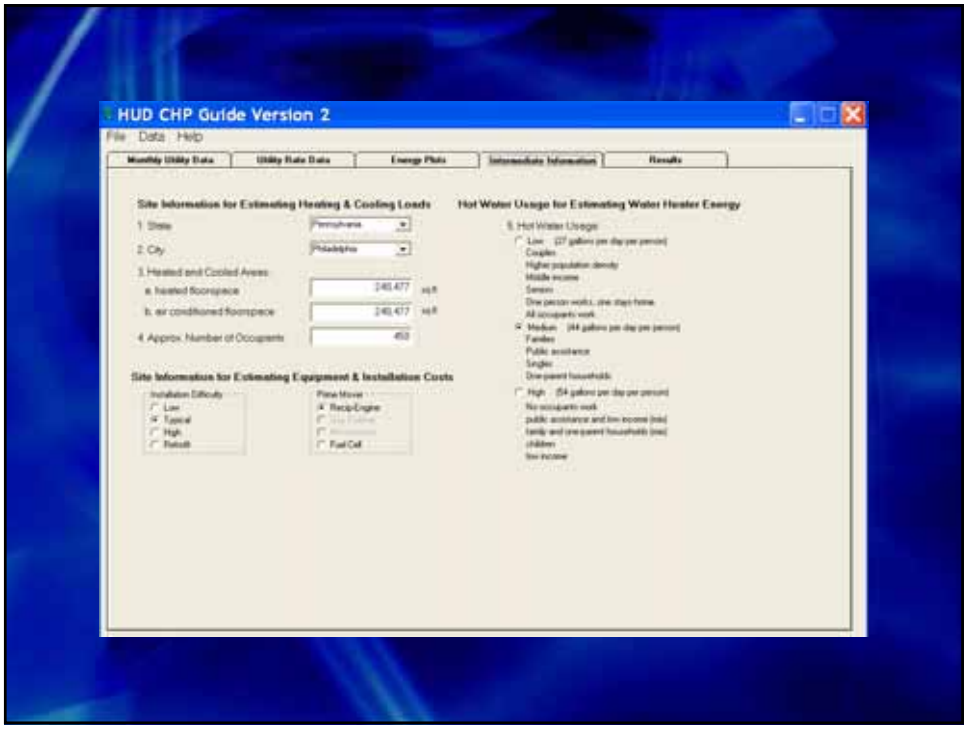


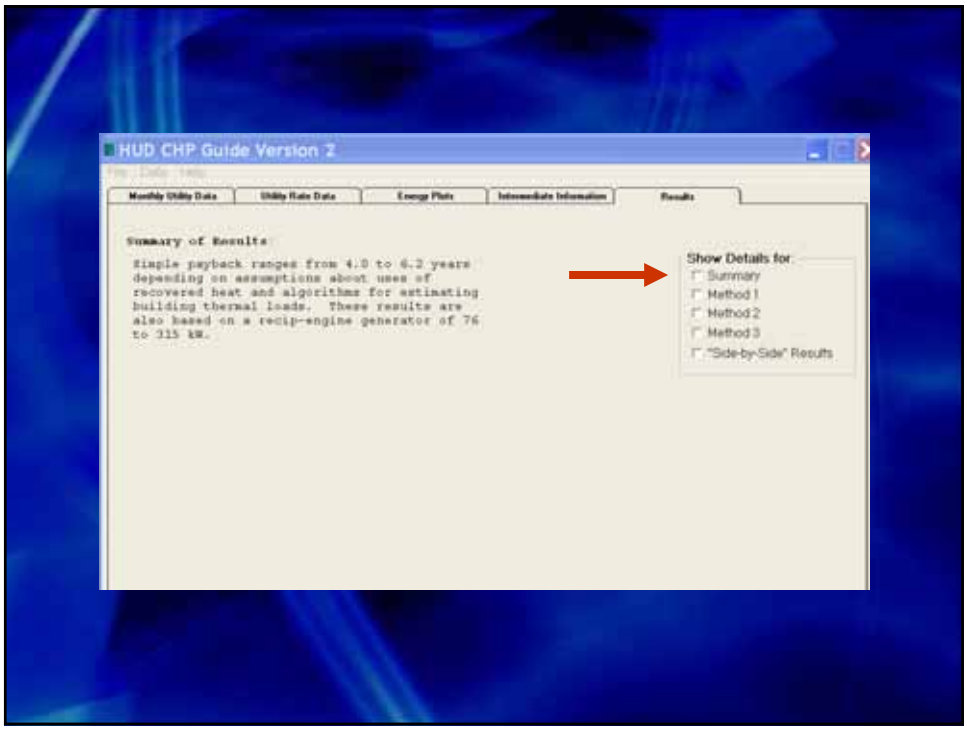
Data needed for preliminary CHP Feasibility Screening

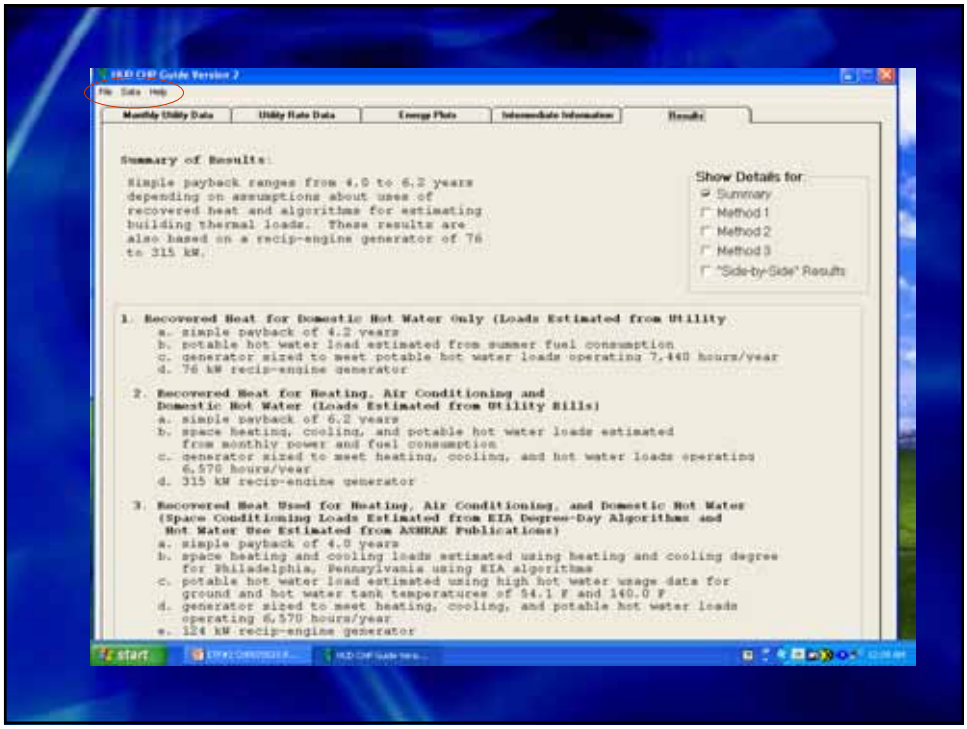
- Utility consumption (energy and demand)
- Utility rates
- Building area for heating and cooling
- Number of occupants
- Intermediate information


HUD CHP Guide Version 2
File Data Help
Monthly Utility Data
Utility Rate Data
Energy Plots
Intermediate Information
Results
Monthly Utility Data


HUD CHP Guide Version 2
File Data Help
Monthly Utility Data
Utility Rate Data
Energy Plots
Intermediate Information
Results
Electricity Rate Data
Natural Gas Rate Data


HUD CHP Guide Version 2
File Data Help
Monthly Utility Data
Utility Rate Data
Energy Plots
Intermediate Information
Results
Site Information for Estimating Heating & Cooling Loads
1. State
2. City
3. Heated and Cooled Areas:
a. heated floorspace
b. air conditioned floorspace
4. Approx. Number of Occupants
Hot Water Usage for Estimating Water Heater Energy
5. Hot Water Usage:
Site Information for Estimating Equipment & Installation Costs
Installation Difficulty
Low
Typical
High
Retrofit
Prime Mover
Recip Engine
Fuel Cell

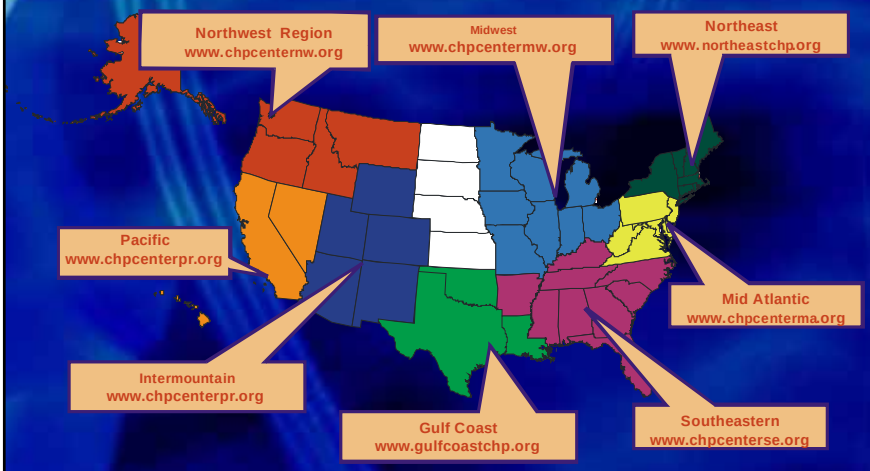

HUD CHP Guide Version 2
Monthly Utility Data
Utility Rate Data
Energy Plots
Intermediate Information
Results
Summary of Results
Simple payback ranges from 4.0 to 6.2 years depending on assumptions about uses of recovered heat and algorithms for estimating building thermal loads. These results are also based on a recip-engine generator of 76 to 315 kW.
Show Details for:
Summary
Method 1
Method 2
Method 3
"Side-by-Side" Results



What "Results" Mean

- Indicates whether a more detailed analysis would be worthwhile doing
- Encouraging results are a prelude to a more rigorous analysis by engineering professionals

Regional CHP Application Centers



Sources of Information

CHP Regional Application Centers RACs:
www.bchp.org/rac.html

DOE CHP Initiative: www.eren.doe.gov/der/chp

EPA CHP Partnership: www.epa.gov/chp

HUD CHP information:

CHP Guides and link to ORNL software:
www.hud.gov/offices/cpd/library/energy/index.cfm

Profile- www.hud.gov/offices/cpd/energyenviron/energy/library/hudchpDanburyCT.pdf

USCHPA www.uschpa.org

NYSERDA www.nyserda.org

robert.groberg@hud.gov