



Using Utility Bills As An Audit Tool

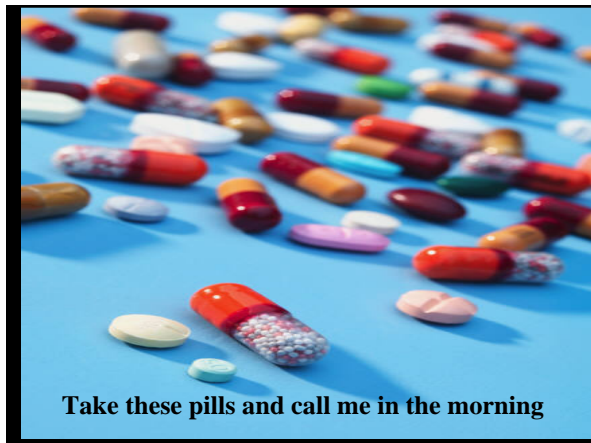
Charlie Gohman
Arizona Energy Office



Energy Efficiency Yesterday & Today

What if you don't feel well and go see a doctor.

You walk in his office and the first thing he says is...



Take these pills and call me in the morning

What is wrong with that approach

- No information to determine what is making you sick so...
 - Some pills may help
 - Some pills may do nothing
 - Some pills may make you worse
 - Some pills may combine to kill you

**This is how we use to do deal with homes!
(some still are)**

Old Approach

- Measures that are completed/installed on homes with no real understanding of impact on other areas.
 - Weatherization started (late 70s) with a list, use in every state!
- Limited testing/commissioning to determine problems/issues.
- Limited analysis on cost/benefit.

Today's Approach

- Gather complete data on the energy use characteristics of the home.
 - Need information on all the characteristic that can impact your decision making process.
- Complete information includes not only the physical characteristics of the house but also how a client uses energy.
- Lifestyle can have a huge impact on the effectiveness (reduced energy use) of our work.

Utility Bill Analysis

- Why should we look at utility bills, won't the energy audit tell us all we need to know about the savings potential?

Not in all cases, the audit is looking at the structure.

What about the people?

How You Can Use Utility Data

- As an auditing tool
- As a monitoring tool

Utility Bills as a Audit Tool

- Things you can discover by looking at utility bills.
 - Where a home is using energy
 - Isolate heating, cooling cost and base loads
 - Comparing these usages (benchmarking) to similar buildings with "average usage patterns". Isolate lifestyle.
 - Get a idea if there are any opportunities to cost effectively save energy.

What is Happening?

- Home with 23 year old HVAC, high duct leakage and other issues.
- Computer modeling tell us we will save a lot of money by adding a new HVAC and fix other issues.
- So we spend a large amount of funds to upgrade all the deficiencies.
- But the utility bill analysis shows little to no savings.

Why?

What is Happening?

- It wasn't the quality of the work.
- It wasn't the quality of the materials.

So what was it?

The occupants just didn't use any energy!
They were hot or cold and in the dark.

Pre WAP bills

12/11/2003	641	\$62.92	
11/8/2003	458	\$50.66	
10/8/2003	507	\$56.68	
9/10/2003	774	\$83.15	
8/11/2003	1001	\$102.36	
7/11/2003	1186	\$113.07	
6/12/2003	607	\$101.20	
5/12/2003	795	\$86.56	
4/14/2003	383	\$50.15	
3/14/2003	483	\$52.44	
2/12/2003	580	\$59.94	
1/10/2003	619	\$61.14	
			\$840 <u>total</u> utility cost
			Computer model- Over \$2000 cost.

Post WAP bills

12/9/2006	961	\$97.59
11/9/2006	679	\$74.12
10/10/2006	612	\$67.63
9/12/2006	748	\$90.65
8/10/2006	881	\$107.68
7/11/2006	926	\$113.37
6/12/2006	924	\$108.01
5/11/2006	951	\$108.08
4/13/2006	439	\$60.92
3/15/2006	473	\$54.29
2/14/2006	586	\$60.91
1/17/2006	722	\$72.91

Summer:
no change

Winter:
Increase due to
weather.

Why

- Look at the bills!
 - Over 70% of usage is base load (\$600 of \$840).
 - That leave only \$240 (computer model - \$1500) heating and cooling costs to capture saving from. Impossible to justify new HVAC system. Need saving of \$360 per year, more than is used.
- Why, client does not use the HVAC system very much and may have taken back (increased efficiency is off set by increased comfort) any savings.

Do We Walk Away?

- In Arizona's program, the decisions are based on the priority list or computer analysis. If the measures are allowed, we can do it.
- The final call is made by the local agency.
 - Health and safety issues due to lack of heat/cooling.
 - Changes in the occupants in the near future.
 - Condition of the house.

Auditing vs. Benchmarking

- Review of the two ways to look at a home.
 - Auditing (HERS is a good example)– Looking just at the structure.
 - Benchmarking – Looking at the utility cost (both the structure and occupants) and compare to similar structures.

HERS

- Rating: The Home Energy Rating System (HERS) provides a rating of a home's efficiency that is blind to occupants behavior.
 - Uses the same operation characteristics (thermostat setting, water use, internal loads...) in all homes, basically the same family is modeled for each home.
- The procedures are established by RESNET.

Benchmarking

- Benchmarking is the comparison of the utility cost/use of a home with some sort of baseline.
- Benchmarking includes the both the structure and the occupants.
 - High or low bill could be caused by either the structure or lifestyle.
- Benchmarking will provide more information on the opportunity (or lack of) to capture saving.

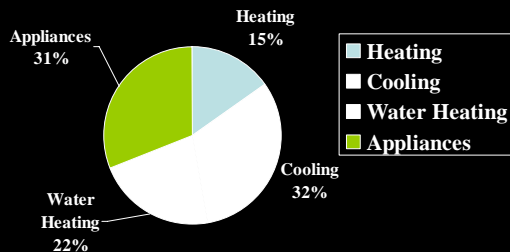
Benchmarking Plus an Audit

- Doing benchmarking in conjunction with a quality audit can provide information on where to focus your efforts.
 - Retrofit of inefficient structure
 - Education of home owner
 - On to the next job when there are limited opportunities.

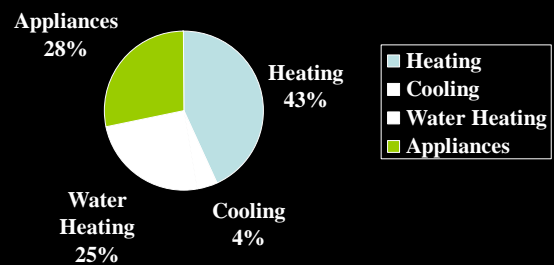
Using Utility Bills to Improve Results

- Average break out of heating, cooling & base.
- What do the different parts on a house contribute to the utility costs.
- Determining different uses (heating, cooling & base).
- Comparing the client bills to a benchmark.

Where Do We Use Energy Desert



Where Do We Use Energy Mountain



Establishing This Breakout

- Pick your base home, I used a code home.
- Run a computer simulation, I used REM/Design.
- Model will provide breakout.

How Much Does Each Building Component Contribute to Load?

- Desert:
 - Attic (R-30) – 10% to 15%
 - Wall (R-11) – 15% to 20%
 - Windows/doors (single/some shade) – 25% to 30%
 - Infiltration – 15% to 20%
 - Ducts – average leakage – 15% to...
 - Misc. – 10%

How Much Does Each Building Component Contribute to Load?

- Mountain:
 - Attic (R-30) – 15% to 20%
 - Wall (R-11) – 20% to 25%
 - Windows/doors (single/some shade) – 10% to 15%
 - Slab/crawl space – 15%
 - Infiltration – 15% to 20%
 - Ducts – average leakage – 15% to...
 - Mics – 10%

Why is This Information Important

- You can't save more than you use!!!!
 - Products claiming to save more than the component contributes to the bill.

For example: Attic contribute 10% of your H&C bill.
H&C is 45% of your total bill so
attic contribute 4.5% of the total bill.
How can a attic product save 30% of your total bill?

Again, Establish Your Base

- Pick your base home (code home)
- Run a computer model and look at the component consumption for each feature.

Isolating Heating, Cooling & Base Loads

- Look at those months when little if any heating or cooling is used, use the lowest two bills.
- Average these two bills.
- This gives you a good estimate of the base loads for a month.
- Multiply by 12 to get a years worth of base loads.

Base Loads

- Base loads are those things in a home that use energy year round. Everything other than heating and cooling.
 - Lighting
 - Refrigerator
 - Water heater
 - Cloths washing/dryer
 - Cooking
 - TV and others

Heating & Cooling VS. Base Loads

- | | | | |
|---------|-------|----------|-------|
| • Jan | \$90 | • July | \$170 |
| • Feb | \$75 | • August | \$165 |
| • March | \$50 | • Sept | \$150 |
| • April | \$75 | • Oct | \$90 |
| • May | \$100 | • Nov | \$60 |
| • June | \$155 | • Dec | \$75 |

March- \$50 & Nov - \$60
Average of \$55 per month base loads
\$660 yearly

Heating & Cooling VS. Base Loads

- | | | | |
|---------|-------|----------|-------|
| • Jan | \$90 | • July | \$170 |
| • Feb | \$75 | • August | \$165 |
| • March | \$50 | • Sept | \$150 |
| • April | \$75 | • Oct | \$90 |
| • May | \$100 | • Nov | \$60 |
| • June | \$155 | • Dec | \$75 |

Total bill of	\$1255
Minus the base of	<u>\$660</u>
Heating & cooling	\$585

Heating & Cooling VS. Base Loads

- Where are the majority of the costs, base load or heating and cooling.
- By isolating what is causing high bills, heating/cooling or base loads, you can focus your efforts in those areas.

Should you replace the HVAC or remove the 2 extra refrigerators.

Using This to Estimate Saving

- New AC will increase efficiency by 30%.
– 30% of what?
- Just the cooling load, you need to isolate the cooling load to give a good estimate.

You can get a feel for a component's impact by isolating its contribution to load.

Benchmarking Energy Intensity

- Compare the per sq. ft. utility cost to a benchmark.
- Basic benchmarks
 - New construction, guarantee home use about \$.25 per sq. ft. per year for heating and cooling. (about 35% less than average new home)
 - Water heating/gas - \$250 to \$300 (family of 4).
 - Base loads - \$500 to \$600 per year (family of 4).
- Use a computer model to generate some benchmarks.

Example benchmarks for existing homes

Heating and Cooling Costs - Phoenix

- Good-Fair insulation, shaded windows, good HVAC – Minimal savings opportunity
– \$.50 per sq. ft. per year
- Average – Some insulation in the attic, limited shading, fair HVAC with duct leakage & some room pressures. Good savings opportunity
– \$1.00 per sq. ft. per year
- Bad – uninsulated, no shading, poor HVAC with major duct leakage and pressure issues.
– \$1.75 per sq. ft. per year

Example

12/16/2005	603	\$64.61	\$849 total
11/18/2005	414	\$31.78	
10/19/2005	560	\$41.26	\$33 monthly base load
9/16/2005	962	\$99.59	\$396 yearly base load
8/16/2005	1484	\$125.23	\$453 heating and cooling
7/14/2005	1774	\$126.89	
6/14/2005	1382	\$103.85	Heating and cooling per sq ft. per year
5/13/2005	977	\$80.82	
4/18/2005	413	\$39.32	\$.37 – minimal saving potential
3/21/2005	154.3	\$35.68	
2/21/2005	394	\$40.78	
1/20/2005	497	\$59.25	

Example

12/10/2004	962	\$85.88	\$1578 total
11/10/2004	864	\$78.01	
10/8/2004	275	\$30.54	\$34 monthly base load
9/10/2004	233	\$127.07	\$408 yearly base load
8/10/2004	571	\$259.74	Heating and cooling of \$1170
7/13/2004	2614	\$321.93	
6/9/2004	2359	\$288.67	Heating and cooling per sq. ft.
5/11/2004	1773	\$112.24	\$.90 – Good savings potential
4/12/2004	1599	\$89.55	
3/11/2004	1359	\$37.82	
2/10/2004	897	\$60.52	
1/12/2004	848	\$86.59	

Access to Data

- What if you do not have easy access to all the utility data?

Ask the client questions?

What is your high bill?

What is your low bill?

This is better than nothing and in some cases will make the difference.
(what does a high bill of \$70 tell you)

Creating Benchmarks

- Define a number of homes (Good, bad, two story, crawl space...) based on what you have to deal with on a day to day basis.
 - May have good, average, bad for a number of house types, HVAC types.
 - Phoenix, main break out will be AC and Evap.
- Run for your various climates.

Utility Bill Analysis

- Looking at the utility bills before work compared to after work can provide information on the effectiveness of your work.
- The more years of data the better.
- Sophistication of analysis, how much time and how much money do you have. I have limited amounts of both so my analysis is fairly basic.

Example



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.

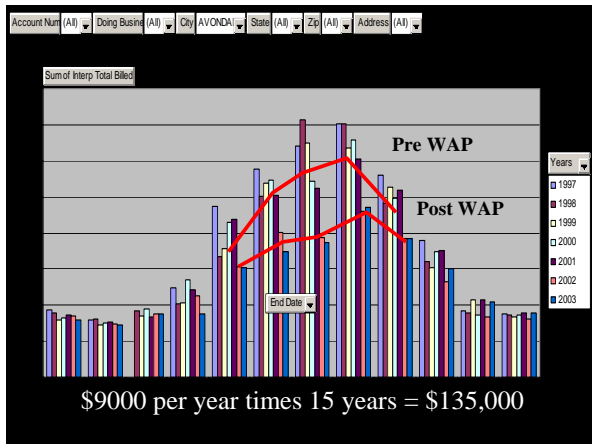
50 unit senior housing project

Project cost of \$90,000

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

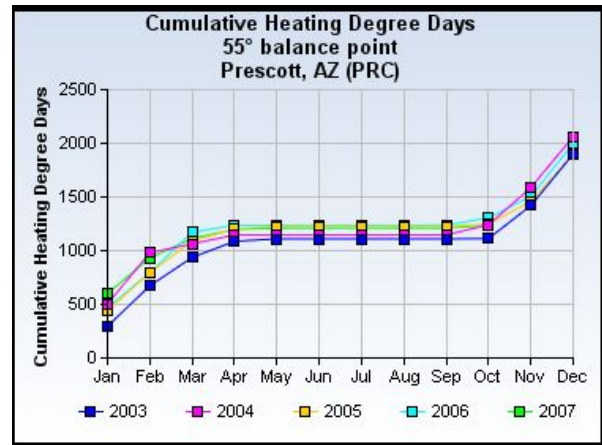
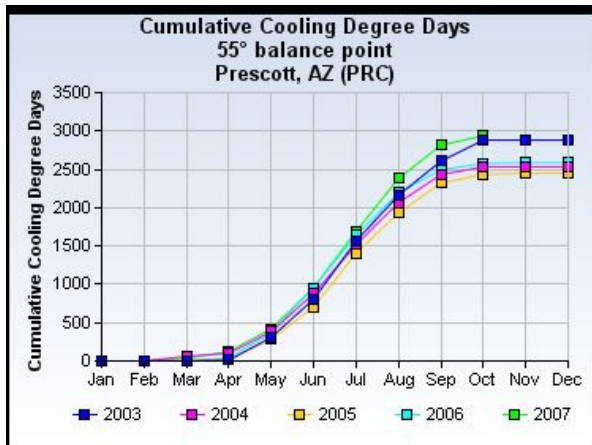
Utility Data (50 units combined): Work completed in April

	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



Weather Normalizing Data

- When comparing utility data from one year to the next, need to factor out differences in weather.
- www.weatherdatadepot.com – good site for Degree Day data.
- CDD is just ambient temperature, not absolute difference, solar load remains constant from year to year. **CDD differences is not an absolute!**



Weather

- I try to use a pre WAP year (I usually get 3/4 years of pre WAP data) where the HDD/CDD values are close to post WAP year.
- Again, this is more important with heating.

Other Issues

- Occupant changes (number of people increasing/decreasing)
- Other physical changes to the structure (appliances, additions...)
- Lack of data (new account, shut off...)

The more data, the easier it is to see the noise!
Too much noise, don't use!

Information

- To make quality decisions you need quality information.
 - About the structure
 - About the lifestyle
 - About your options