Streamlining Home Remodel Code Compliance Session

Home Energy Analysis Tools

Boulder County Green Building Conference

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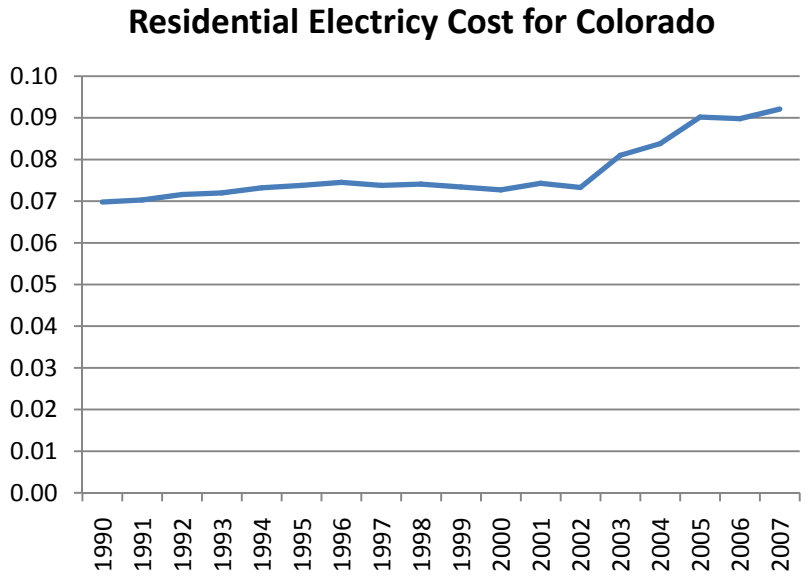
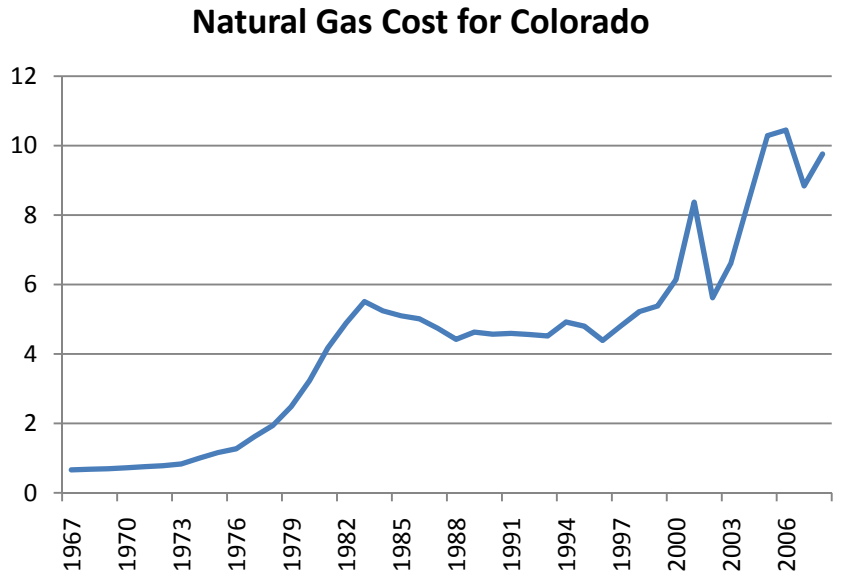
Typical Building Codes

- Current energy codes promote lousy construction
- Energy efficiency requirements based on cost/benefit from cheap energy prices.
- Durability and Indoor Air Quality issues not addressed adequately
- Good moisture management isn't addressed properly

Time for Better Building Codes

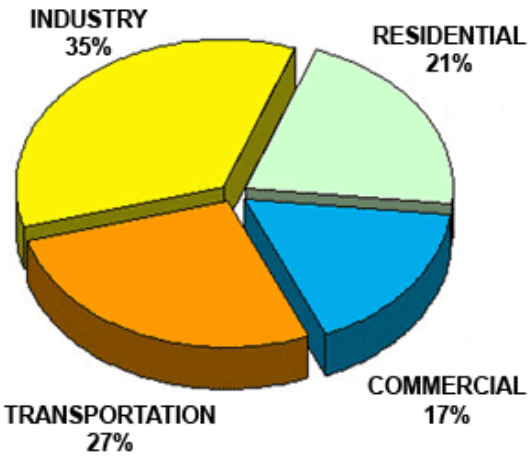
- **Energy prices in Europe have driven energy efficiency requirements to much higher levels.**
- **Recent energy cost trends and climate change necessitate drastic increases in energy efficiency**



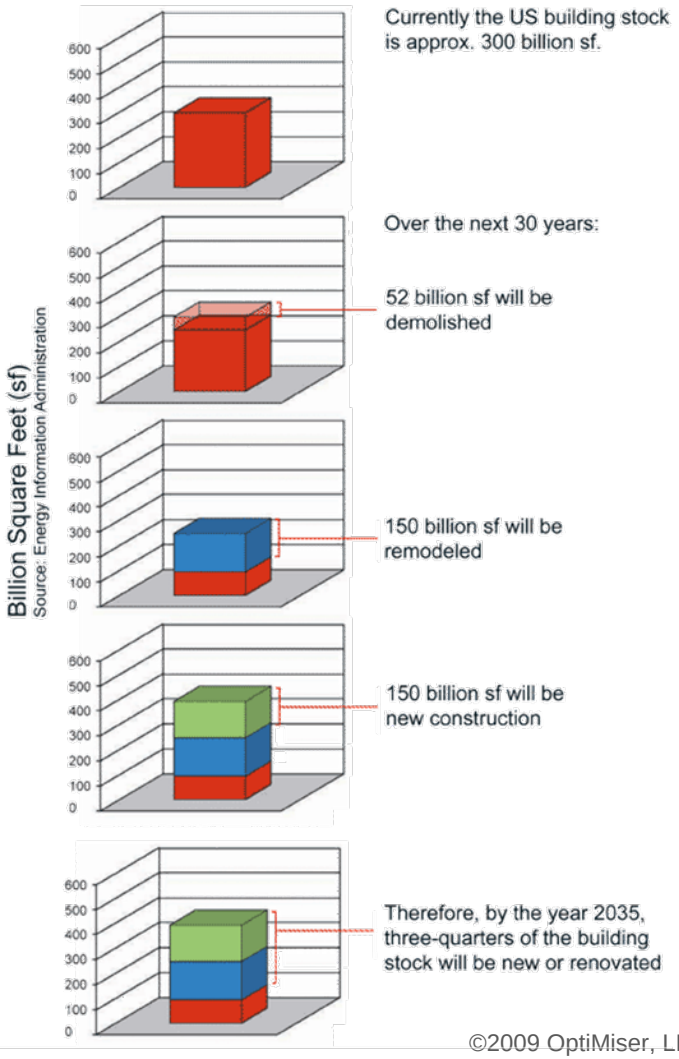


Existing Homes are Biggest Challenge

- **21% of US energy consumption is from existing residential buildings**
- **¾ of US building stock will be new or renovated by 2035**



Source: Architecture2030.org



Boulder's Building Codes

- Both the City of Boulder and Unincorporated Boulder County building codes for remodels require energy efficiency standards much higher than the current national standards
- Codes are more in line with current energy costs
- Both jurisdictions recommend or require the use of a HERS (Home Energy Rating System) rating
- A HERS rating is like a "miles-per gallon" rating on a home's predicted energy use
- HERS ratings are produced from an computer simulation in combination with performance testing of air and duct leakage

Boulder's Building Codes

- **HERS ratings in general must be performed on an entire home, and can't just be applied to an addition**
- **Both jurisdictions require HERS ratings on remodels/additions over a certain sq/ft threshold**
- **Otherwise, prescriptive energy efficiency improvements are required**

Boulder's Building Codes

- Boulder codes are some of the most stringent in the country
- By far more strict on energy efficiency requirements
- Codes also pay attention to water efficiency and waste management
- City of Boulder codes have an additional point system intended to improve things such as health and safety, indoor air quality, material use, occupant comfort, durability, and landscapes

Still Missing the Mark

- **Boulder codes for remodels and additions still do not directly reflect the most cost-effective improvements**
- **There are many ideas of what the generic "low-hanging fruit" of energy efficiency improvements are in an existing home**
- **However, all homes are unique both in their construction, the local weather, and in the way the occupants use the home**
- **What may be a cost-effective improvement in one home may not be very cost-effective in another**

Scenario 1

A home is occupied by a retired couple who like to wear sweaters and keep the thermostat at 66 in the winter. They wash dishes by hand, but one of them takes a hot bath every night because of a bad knee. The home has a cathedral ceiling with no attic. The furnace was just replaced, but the installer didn't explain the cost savings of a high efficiency unit, so the home has an 80% efficient unit that's brand new. The water heater is a 10 year old traditional gas unit at 56% efficiency. Air leakage isn't bad and the windows are in good shape. They have a 1960's refrigerator in the basement but a new one in the kitchen. The gas bill is $100/month year round.

Scenario 2

A home is occupied by a family of four. The kids always complain about their cold bedrooms (above the garage), so the parents keep the thermostat at 74 degrees and have to leave the window cracked in their bedroom at night. The furnace is 30 years old. The water heater has just been replaced with a 84% efficient tankless model. There is 4" of rockwool insulation in the attic and rockwool batts in the walls. They have a refrigerator from 1982. Most of the windows are ok, but there are some that don't close properly and are leaky. Almost all light fixtures are on dimmers or are low voltage. Summer gas bills are only $40/month, but winter bills are as high as $350.

Scenario 1 – Most Cost-Effective Upgrades

1) Recycle the refrigerator in the basement
2) Install compact fluorescent light bulbs
3) Install a programmable thermostat (and program it)
4) Replace the water heater with a tankless model

Scenario 2 – Most Cost-Effective Upgrades

1) Install a programmable thermostat (and program it)
2) Air seal and repair leaky windows
3) Blow cellulose in the attic
4) Drill and blow cellulose between the garage and the bedrooms above
5) Be prepared to install a high-efficiency furnace when this one breaks

Problems with HERS ratings on Existing Homes

- **A required HERS rating for one home may necessitate cost effective improvements while another may not**
- **In order to get to the required HERS score of 100, the home in Scenario 1 may have needed to additionally replace the new furnace or install PV on the roof (but the lot is completely shaded by 60 foot Cottonwoods)**
- **The home in Scenario 2 could reach the required HERS score of 100 by simply insulating the attic and garage ceiling**
- **Scenario 1 HERS requirements = not cost-effective**
- **Scenario 2 HERS requirements = cost-effective**

The Solution?

- **Only require energy efficiency improvements for existing homes that are cost-effective over the lifetime of the improvement**
- **Base improvement choices on % of total project budget**

The Tool?

Introducing OptiMiser!

- Optimiser starts with a website that allows the homeowner to enter their utility bills and some basic information about their home and behavior
- Optimiser makes initial recommendations for energy efficiency improvements based on these items
- The homeowner then schedules an audit with a qualified auditor
- The auditor gets a pre-populated OptiMiser file that is filled out in more detail during an audit

The Tool

- OptiMiser generates a custom report for the homeowner listing energy efficiency improvements in order of cost-effectiveness
- OptiMiser can also rank improvements based on the required budget for improvements. If you have $2000 to spend, it might recommend air sealing and some attic insulation. If you have $5000 to spend, it might include a furnace upgrade
- All recommended improvements will pay for themselves over their lifetime, or they will not be recommended (includes rising energy costs)
- Improvements are customized to how the occupants use the home

Financial Tools

- **OptiMiser can generate results from every improvement based on the following:**
  - **Payback (simple and modified)**
  - **CO2 Reduction**
  - **Upfront Cost**
  - **Initial Savings**
  - **Benefit/Cost Ratio**
  - **Present Value**
  - **Modified Internal Rate of Return**

Payback

Payback is simply the number of years it takes for the energy savings from an improvement to equal the upfront cost.

Simple Payback: Cost ÷ Savings = Payback (in years)

Modified Payback: This method incorporates an estimate of increasing energy prices, discount rates, and other factors to determine a more realistic value of the savings.

Modified Internal Rate of Return (MIRR)

The Modified Internal Rate of Return can be used to compare an investment in energy savings to a financial investment such as a savings account (without compounding interest) or the stock market.

If I invest $1000 in the stock market and get a 5% return for 30 years, the value would be $4,321.

If I invest $1000 in attic insulation, my savings after 30 years could be $6,073 which would equate to an interest rate of 6.2% if I were to invest in the stock market instead, and thus the MIRR is 6.2%.

Case Study

Typical Existing 2000 SqFt Home in Boulder

Improvement Cost	$ 8,312
Debt Ratio	80%
Loan Amount	$ 6,650
Basis	$ 1,662
Discount Rate	5%
Fuel Escalation Rate	3%
Mortgate Rate	5.25%
Tax Rate	30%
Initial Annual Fuel Savings	$ 698
Lifetime (Years)	30

Present Value of Savings	**$ 15,759**
Present Value incl. Tax Savings	**$ 18,222**
Cumulative Profit	**$ 8,212**
Savings-Investment Ratio (SIR)	**9.48**
Simple Payback (years)	**2.38**
Modified Payback (years)	**5**
Modified IRR	**10.6%**

Year	1	2	3	4	5	6	7	8	9	10	30	**Totals**
Utility Savings	719	741	763	786	809	833	858	884	911	938	1,694	34,204
Present Value of Utility Savings	685	672	659	646	634	622	610	598	587	576	392	15,759
Annual Additional Mortgage Payment	551	551	551	551	551	551	551	551	551	551	551	16,524
Interest Payment on Mortgage	434	427	421	414	406	398	390	382	373	363	15	8,212
Tax Savings at 30% Tax Rate	130	128	126	124	122	120	117	115	112	109	5	2,464
Maintenance Costs											700	1,800
Net Savings	298	318	338	359	380	402	425	448	472	496	448	18,344
PV of Net Savings	284	288	292	295	298	300	302	303	304	305	104	8,123
Cumulative PV of Net Savings	284	572	864	1,160	1,458	1,758	2,060	2,363	2,667	2,972	8,123	8,123

Case Study

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Discount Rate	5%
Fuel Escalation Rate	6%
Mortgate Rate	5.25%
Tax Rate	30%
Initial Annual Fuel Savings	$ 698
Lifetime (Years)	30

Present Value of Savings	**$ 24,336**
Present Value incl. Tax Savings	**$ 26,799**
Cumulative Profit	**$ 8,212**
Savings-Investment Ratio (SIR)	**14.64**
Simple Payback (years)	**2.38**
Modified Payback (years)	**4**
Modified IRR	**13.4%**

Year	1	2	3	4	5	6	7	8	9	10	30	**Totals**
Utility Savings	740	784	831	881	934	990	1,050	1,113	1,179	1,250	4,009	58,494
Present Value of Utility Savings	705	711	718	725	732	739	746	753	760	767	928	24,336
Annual Additional Mortgage Payment	551	551	551	551	551	551	551	551	551	551	551	16,524
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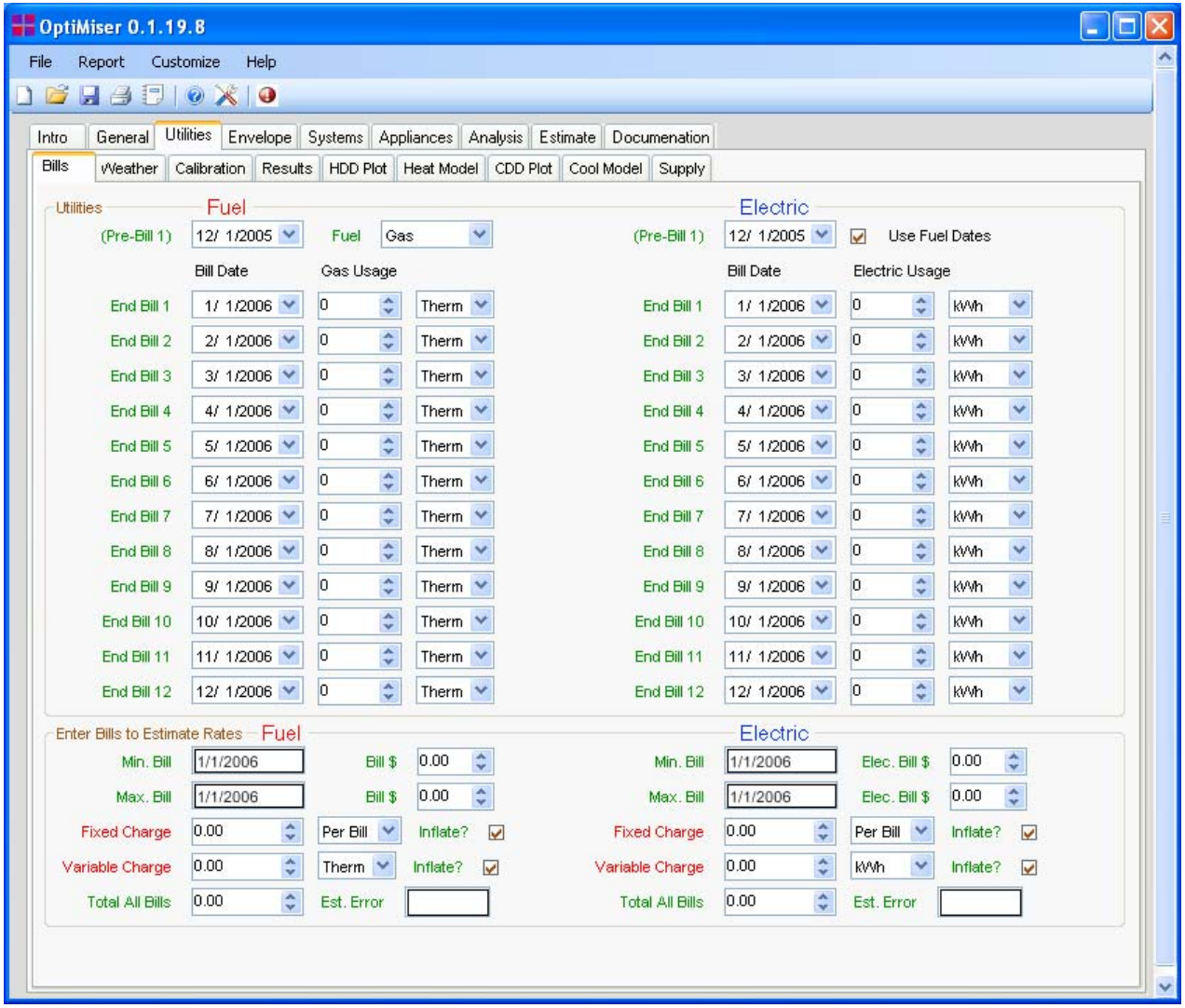
Tax Savings at 30% Tax Rate	130	128	126	124	122	120	117	115	112	109	5	2,464
Maintenance Costs											700	1,800
Net Savings	319	362	407	455	505	559	616	676	740	808	2,763	42,633
PV of Net Savings	304	328	351	374	396	417	438	458	477	496	639	16,701
Cumulative PV of Net Savings	304	632	983	1,357	1,753	2,170	2,608	3,066	3,543	4,039	16,701	16,701

Optimiser



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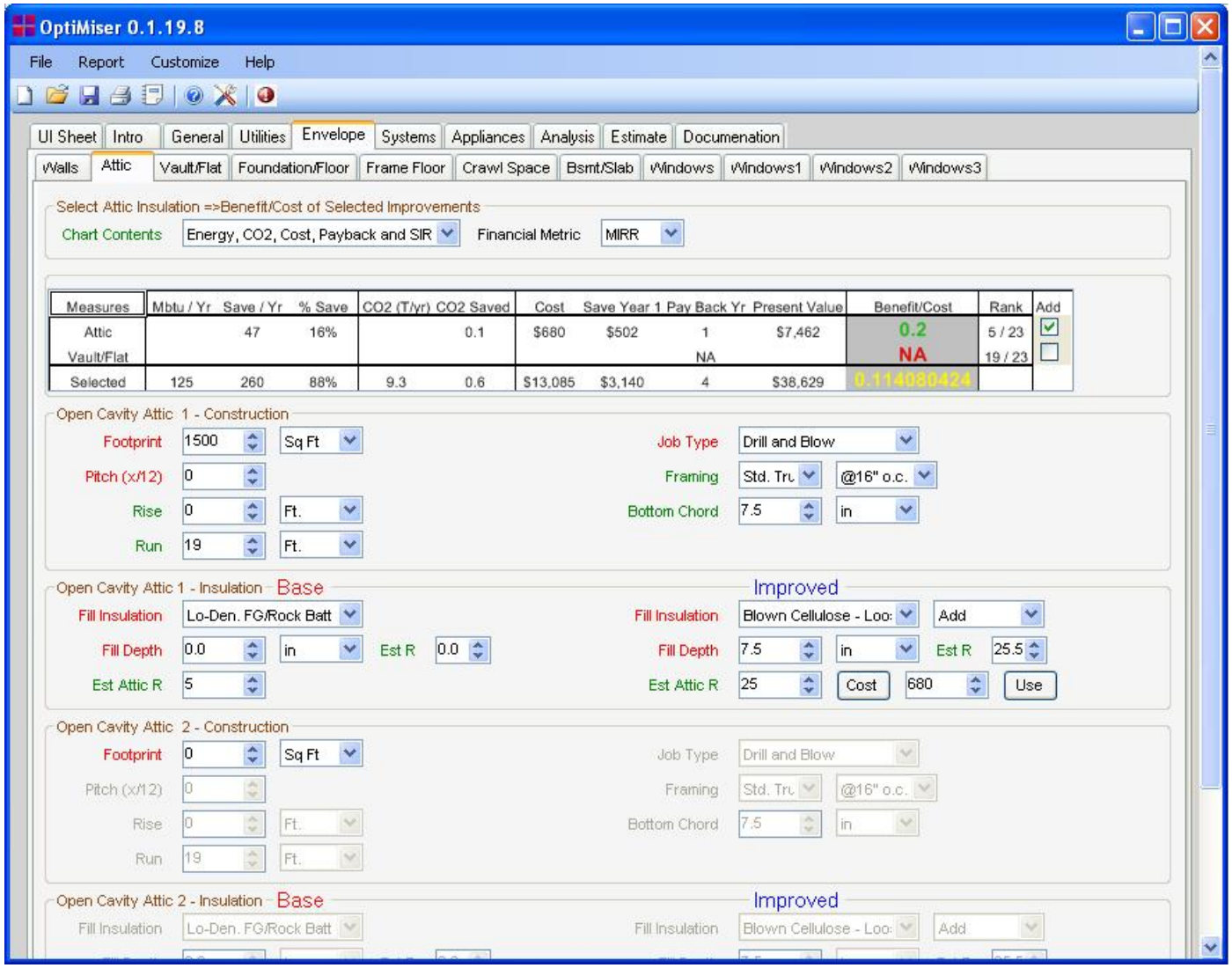

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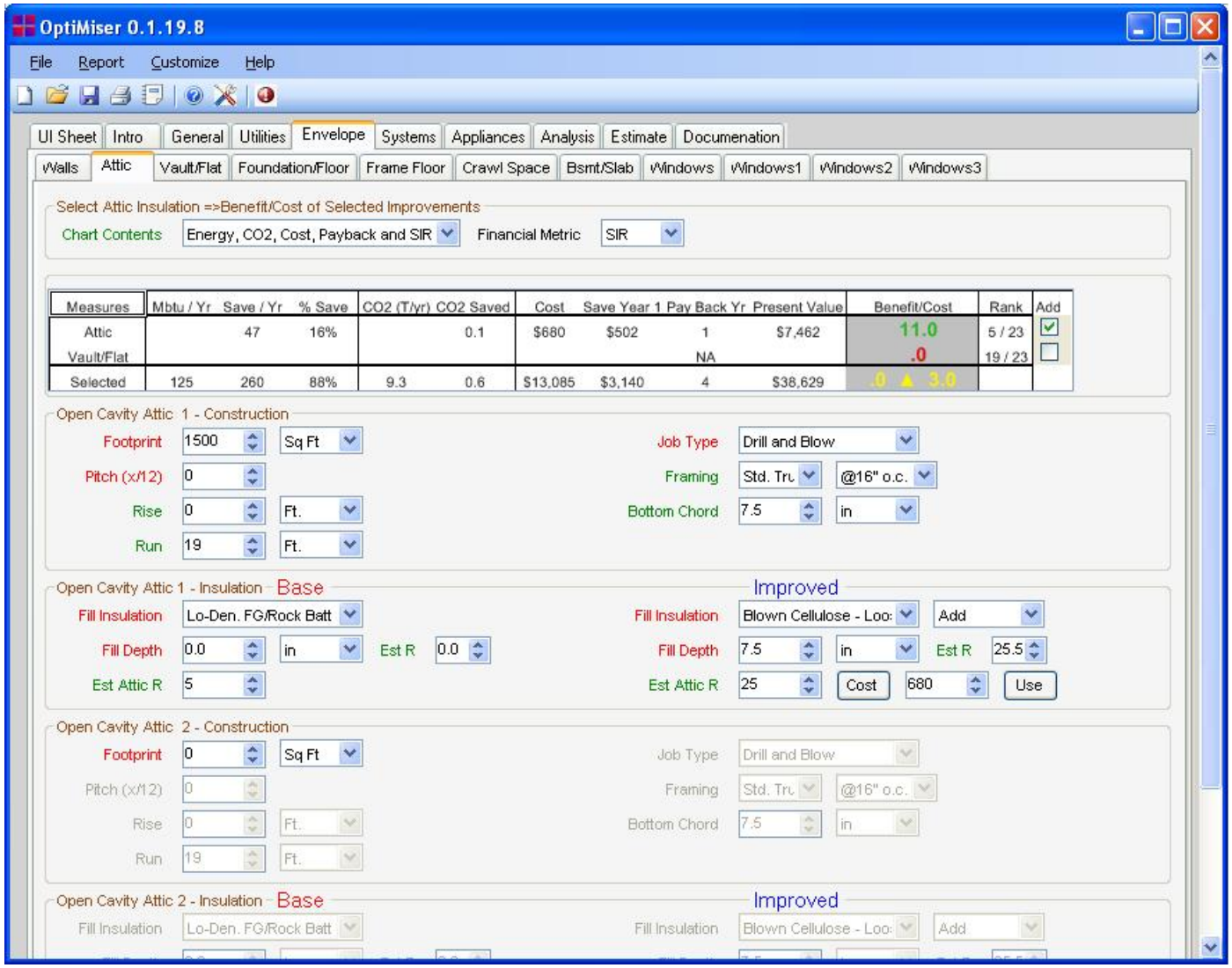

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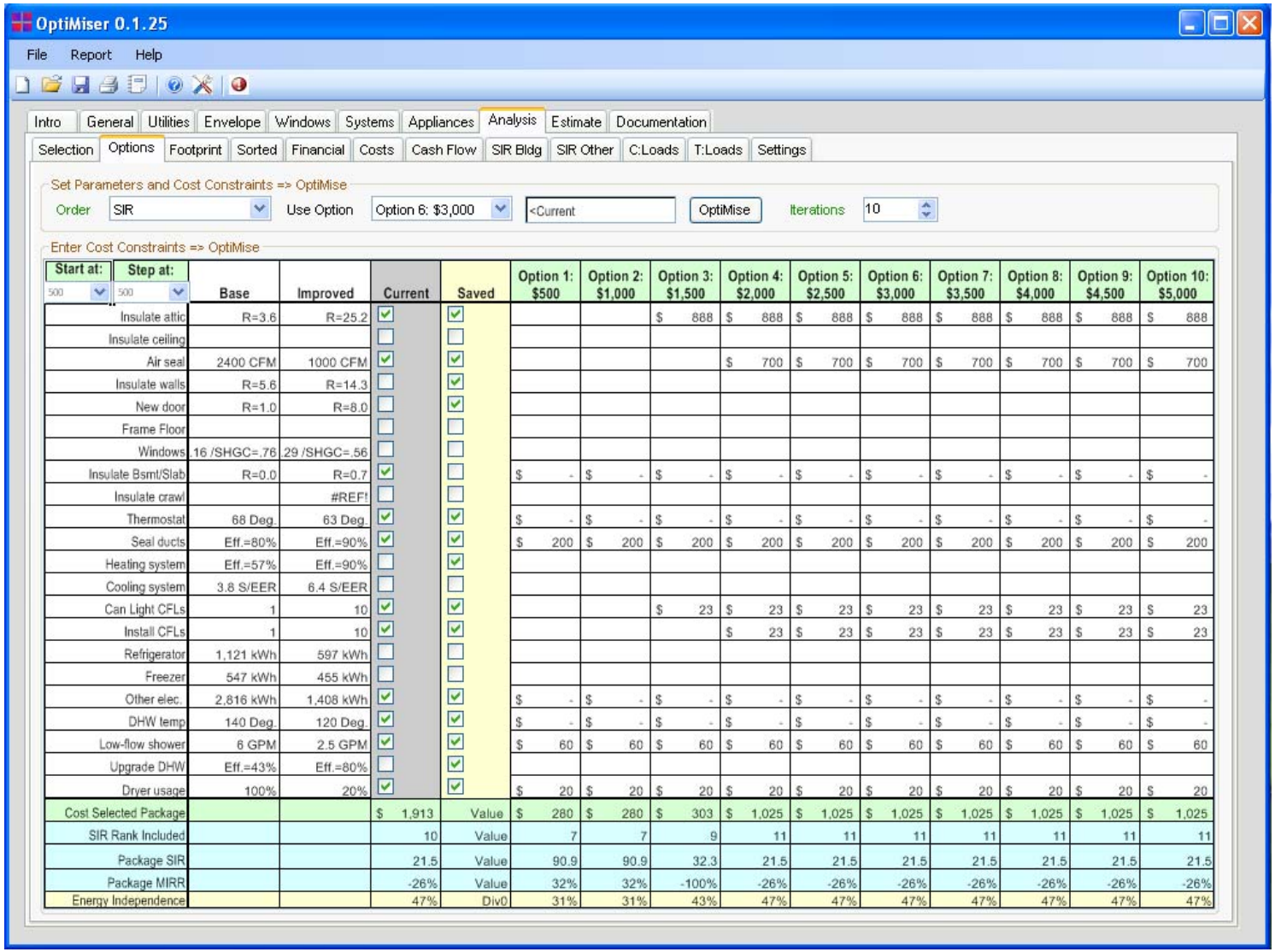

Start at: 500	Step at: 500	Base	Improved	Current	Saved	Option 1: $500	Option 2: $1,000	Option 3: $1,500	Option 4: $2,000	Option 5: $2,500	Option 6: $3,000	Option 7: $3,500	Option 8: $4,000	Option 9: $4,500	Option 10: $5,000
Insulate attic		R=3.6	R=25.2	☑	☑			$ 888	$ 888	$ 888	$ 888	$ 888	$ 888	$ 888	$ 888
Insulate ceiling				☐	☐										
Air seal		2400 CFM	1000 CFM	☑	☑				$ 700	$ 700	$ 700	$ 700	$ 700	$ 700	$ 700
Insulate walls		R=5.6	R=14.3	☐	☑										
New door		R=1.0	R=8.0	☐	☑										
Frame Floor				☐	☐										
Windows		16 /SHGC=.76	29 /SHGC=.56	☐	☐										
Insulate Bsmt/Slab		R=0.0	R=0.7	☑	☐	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Insulate crawl			#REF!	☐	☐										
Thermostat		68 Deg.	63 Deg.	☑	☑	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Seal ducts		Eff.=80%	Eff.=90%	☑	☑	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200	$ 200
Heating system		Eff.=57%	Eff.=90%	☐	☑										
Cooling system		3.8 S/EER	6.4 S/EER	☐	☐										
Can Light CFLs		1	10	☑	☑			$ 23	$ 23	$ 23	$ 23	$ 23	$ 23	$ 23	$ 23
Install CFLs		1	10	☑	☑				$ 23	$ 23	$ 23	$ 23	$ 23	$ 23	$ 23
Refrigerator		1,121 kWh	597 kWh	☐	☐										
Freezer		547 kWh	455 kWh	☐	☐										
Other elec.		2,816 kWh	1,408 kWh	☑	☑	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
DHW temp		140 Deg.	120 Deg.	☑	☑	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Low-flow shower		6 GPM	2.5 GPM	☑	☑	$ 60	$ 60	$ 60	$ 60	$ 60	$ 60	$ 60	$ 60	$ 60	$ 60
Upgrade DHW		Eff.=43%	Eff.=80%	☐	☑										
Dryer usage		100%	20%	☑	☑	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20
Cost Selected Package				$ 1,913	Value	$ 280	$ 280	$ 303	$ 1,025	$ 1,025	$ 1,025	$ 1,025	$ 1,025	$ 1,025	$ 1,025
SIR Rank Included				10	Value	7	7	9	11	11	11	11	11	11	11
Package SIR				21.5	Value	90.9	90.9	32.3	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Package MIRR				-26%	Value	32%	32%	-100%	-26%	-26%	-26%	-26%	-26%	-26%	-26%
Energy Independence				47%	Div0	31%	31%	43%	47%	47%	47%	47%	47%	47%	47%

When Can I Get It?

- **The Optimiser Auditor Tool is currently in beta testing and we plan to have it commercially available to auditors in Winter ’09**
- **We plan to have Optimiser Consumer Website available to homeowners for free in the Spring of 2010.**

Questions?

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