Economic Impact Analysis for O-11-65

Replacing the 2009 Albuquerque Energy Conservation Code with the 2009 New Mexico Energy Conservation Code

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CITY OF ALBUQUERQUE
CITY COUNCIL

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INTEROFFICE MEMORANDUM

TO: All City Councilors

FROM: Jon K. Zaman, Council Finance Officer
Stephanie Yara, Policy Analyst II

SUBJECT: Economic Impact Analysis for O-11-65 - Replacing the 2009 Albuquerque Energy Conservation Code with the 2009 New Mexico Energy Conservation Code.

DATE: December 16, 2011(revision 2)

EXECUTIVE SUMMARY

O-11-65 proposes to repeal the 2009 Albuquerque Energy Conservation Code (AECC) and adopt in its place the 2009 New Mexico Energy Conservation Code (NMECC).

The State adopted the 2009 NMECC (essentially the 2009 International Energy Conservation Code) on June 11, 2011 and provided a six-month phase-in period. The State is currently accepting plans drawn to either the 2006 NMECC or the 2009 NMECC, but after January 1, 2012, will only accept plans drawn to the 2009 NMECC.

O-11-65 will have little or no fiscal impact on the City, however, it does have economic impacts on the building industry, as well as energy conservation impacts.

The incremental costs associated with complying with the AECC rather than the NMECC range from $2,808 for a 1,560 sq. ft. 3-bedroom home to $81,146 for a 100,440 sq. ft. warehouse. Annual energy savings created by the AECC's greater energy efficiency requirements range from $191 for a 3-bedroom home up to $6,968 for a commercial warehouse. The following table shows construction costs and energy savings for five typical buildings types.

Building Type	Annual Energy Savings	Annual PIT Increase FHA	Annual PIT Increase Conv.	Implementation Cost Total	Implementation Cost per sq. ft.
3-bedroom home	$ 191	$ 199	$ 188	$ 2,808	$1.80
4-bedroom home	$ 296	$ 272	$ 257	$ 3,843	$1.50
24,450 sq. ft office bldg	$2,477	n/a	n/a	$42,820	$1.75
28,430 sq. ft. retail bldg	$1,715	n/a	n/a	$19,162	$0.67
100,440 sq. ft. warehouse	$6,968	n/a	n/a	$81,146	$0.81
*Retail bldg - alternate	$ 873	n/a	n/a	($8,698)	($0.31)
*Warehouse – alternate	$6,880	n/a	n/a	$167,942	$1.67

For residential buildings, the increases in cost result in increased mortgage costs and longer payback periods for improvements. Increased implementation mortgage costs range from $188/year to $272/year. While increases of that magnitude will likely not affect a buyer's ability to obtain financing, they do offset the energy cost savings to some extent (hence the longer payback periods).

Building Type	FHA First Time LCCA Payback	Conventional LCCA Payback
3-bedroom home	26.4 yrs	25.7 yrs
4-bedroom home	22.3 yrs	21.2 yrs

For commercial buildings, the increases in construction cost translate into higher lease rates, ranging from an increase of $0.22/sq.ft./year for office space to $0.09/sq.ft./year for retail space. These increases do not change Albuquerque's ranking when compared to regional city lease rates.

In terms of energy efficiency, the requirements of the AECC are more energy efficient than construction complying with the NMECC. The increased energy efficiency gained by building to AECC standards ranges from 5% to 19% depending on building type.

Type of Building	IECC Energy Use (million btu/yr)	AECC Energy Use (million btu/yr)	Energy Savings (million btu/yr)	AECC Increased Energy Efficiency
3-bedroom home	93.1	78.6	14.5	16%
4-bedroom home	147.9	120.4	27.5	19%
24,450 sf office bldg	1,090.8	964.7	126.1	12%
28,430 sf retail bldg	1,630.5	1,541.8	88.7	5%
100,440 sf warehouse	2,181.6	1,932.4	249.2	11%

BACKGROUND

On August 1, 2011, O-11-65 was introduced by Councilors Trudy Jones and Dan Lewis and was referred to the City Council's Land Use, Planning and Zoning (LUPZ) Committee. O-11-65 replaces the City of Albuquerque's 2009 AECC with the 2009 NMECC.

At the LUPZ Committee's September 14, 2011 Committee meeting, Councilor Isaac Benton requested that an Economic Impact Analysis (EIA) be prepared for the bill. This EIA is the result of that request.

F/S R-08-176 allows any Councilor to request an EIA on a bill before the Council that "impose[s] any obligation to take any action by an impacted community". F/S R-08-176 defines an Impacted Community as "Either: 1.) a person or category of business directly regulated by a proposed City Council action; or 2.) a person who will be impacted, more than incidentally, by a proposed City Council action."

Section 2(A) of F/S R-08-176 provides the requirements for the content of an Economic Impact Analysis:

> "*Economic Impact Analysis or EIA:* A written statement providing the information required for an FIA. In addition ***an EIA shall contain: the estimated costs imposed on the impacted community if the City Council takes action on a matter.*** The EIA shall be in a manner that provides an understanding of the effect on the impacted community. ***This cost may be estimated in any of a number of ways including but not limited to:***
>
> 1.) determining the size of the impacted community and estimating the impact on a representative sample;
>
> 2.) where specific numbers are not readily available, ***by a thorough explanation of the steps necessary for the impacted community to comply with the Council action;*** (emphasis added)
>
> ***3.) presenting the position of a representative(s) of the impacted community on the issue of cost. No EIA shall be prepared without an attempt by the Responsible Party to contact and receive input from some segment of the Impacted Community."*** (emphasis added)

In order to comply with the provisions of F/S R-08-176, Council staff solicited input from members of the Impacted Community and also contracted with Mechanical & Electrical Engineering, Inc. to perform energy savings and incremental cost of compliance modeling comparing the 2009 AECC to the NMECC.

SUMMARY OF O-11-65

The City regulates construction standards, in large part, by adopting technical codes. These technical codes are generally codes created by the State of New Mexico or the International Code Council. The City has adopted approximately 16 technical codes covering everything from electrical, to building with straw, to swimming pool and spa construction. These technical codes are updated periodically by the State or by the International Code Council. When a code is updated the City continues to use the old code until an ordinance is adopted, providing that the City will use the newer code. The City periodically reviews its technical codes and adopts the newer codes.

In June of this year the City Council adopted O-11-59. That ordinance adopted updated versions of many of the City's technical codes. O-11-65, now before the City Council, deals with one technical code that was not changed in June.

In 2007, the City adopted its own Energy Conservation Code rather than using the State's Energy Conservation Code. The City's Energy Conservation Code was amended in 2009. The City's Code is more restrictive than the State's. O-11-65 only deals with the Energy Conservation Code. The ordinance repeals the City's 2009 Energy Conservation Code and adopts in its place the 2009 New Mexico Energy Conservation Code.

The City also has a Uniform Administrative Code. The Uniform Administrative Code is a procedural document which generally establishes the procedures that the City uses in applying the technical codes. The Uniform Administrative Code is also amended by this legislation but only to make it clear that the City will now apply the New Mexico Energy Conservation Code and not the Albuquerque Energy Conservation Code.

STATUS OF 2009 NEW MEXICO ENERGY CONSERVATION CODE

On June 10, 2011, the State of New Mexico adopted 14.7.6, et seq. NMAC, the 2009 New Mexico Energy Conservation Code, which is essentially the 2009 International Energy Conservation Code. *See 14.7.6.8(A) NMAC.*

Per a memo from the Director of the New Mexico State Construction Industries Division (CID), the State provided a six-month phase-in period in which the CID would accept plans drawn to either the 2006 New Mexico Energy Conservation Code or the 2009 New Mexico Energy Conservation Code. After January 1, 2012, however, the CID will only accept plans drawn to the 2009 New Mexico Energy Conservation Code.

The New Mexico State Construction Industries Division has adopted additional amendments to the residential portion of the NM Energy Conservation Code. These amendments are also effective January 1, 2012, with no additional phase-in period.

The 2012 International Energy Conservation Code has already been published. It is substantially different than the 2009 International Energy Conservation Code. It is likely that the State will begin hearings to adopt the 2012 version early in 2013. Once adopted by the State, the 2012 International Energy Code will become the minimum standard for Albuquerque.

New Mexico Regulation and Licensing Department
CONSTRUCTION INDUSTRIES DIVISION
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505 S. Main St., Suite 150 • Las Cruces, NM 88004 • (505) 524-6320 • Fax (505) 524-6319
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Susana Martinez
GOVERNOR

J. Dee Dennis, Jr.
SUPERINTENDENT

Richard W. Tavelli
DIRECTOR

MEMO

TO: Members of the New Mexico Construction Industries Municipal and County Building Programs
FROM: Richard W. Tavelli, Director, CID
RE: Adoption of New Building Codes
DATE: June 30, 2011

Adoption of changes to the CID Rules, NMAC Chapters 5 – 10 listed below are effective as of January 28, 2011. From January 1, 2011 through July 1, 2011, CID will accept plans drawn to either the 2006 building codes or to the amended codes listed below. After July 1, 2011, CID will accept plans drawn to only the codes listed below.

At the June 10, 2011 Construction Industries Commission meeting, the Commission voted to repeal the 2009 New Mexico Energy Code and replace it with the National Base International Energy Conservation Code (IECC). CID will accept plans drawn to either the 2006 IECC or the 2009 IECC from July 1, 2011 to December 31, 2011. After January 1, 2012, CID will accept plans drawn to only the 2009 IECC.

Any ambiguity between the 2009 codes enforced as of 7-1-11 and the 2006 IECC that arise between 7-1-11 and 12-31-11 will be resolved on a case by case basis.

CID will inspect projects according to the requirements of the codes applicable to the project as it was permitted.

Chapter 5 – General Provisions
- 14. 5.1 - General Provisions
- 14.5.2 - Permits
- 14.5.3 – Inspections

Chapter 7- General Construction Building Codes
- 14.7.2 – 2009 New Mexico Commercial Building Code
- 14.7.3 – 2009 New Mexico Residential Building Code
- 14.7.4 – 2009 New Mexico Earthen Building Code
- 14.7.5 – 2009 New Mexico Non-Load Bearing Baled Straw
- 14.7.6 – 2006 New Mexico Energy Conservation Code until December 31, 2011

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Boards and Commissions Division
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Construction Industries Division
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Financial Institutions Division
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Manufactured Housing Division
(505) 476-4770

Securities Division
(505) 476-4580

Administrative Services Division
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14.7.6 - 2009 New Mexico Energy Conservation Code after January 1, 2011
14.7.7 – 2009 New Mexico Existing Building Code
14.7.8 – 2009 New Mexico Historic Earthen Buildings

Chapter 8 – Plumbing Codes
14.8.2 – 2009 New Mexico Plumbing Code

Chapter 9 – Mechanical Codes
14.9.2 – 2009 New Mexico Mechanical Code

Chapter 10 – Electrical Codes
14.10.4 – 2008 New Mexico Electrical Code until September 30, 2011
2011 New Mexico Electrical Code after October 1, 2011

If you have questions regarding the applicability of the codes, please contact Rudy Romero at 505-476-4598

FISCAL IMPACT ANALYSIS

There is little or no fiscal impact on the City regardless of whether the City adopts the 2009 New Mexico Energy Conservation Code or whether it retains the 2009 Albuquerque Energy Conservation Code. According to staff of the City's Planning Department, City staff has already been provided training on the provisions of the NMECC, and, of course, are very familiar with the provisions of the AECC.

Ironically, retaining the 2009 AECC will have a small fiscal impact on the City in the form of staff time to research and draft certain technical corrections to the AECC as adopted. These potential technical corrections are listed below. Planning Department staff points out that the personnel costs of researching and drafting these technical corrections will be approximately $1,545, which represents roughly 63 hours of staff time. As these costs represent staff time for currently filled positions, the cost of making these changes is really an opportunity cost related to other work being delayed or foregone, rather than actual additional costs to the City.

Technical Corrections required to AECC
(Source: Planning staff)

Volume I

1. Table 105.1 is a table of requirements for residential inspections. It should not be included in Volume I.
2. Table 105.1, under "Pipe Insulation" refers to Section 403.9.5. This Section does not exist.

Volume II

1. Section 101.6.4 refers to Section 101.7.3. This Section does not exist.
2. Section 105.3 refers to Section 105.3.2 and 105.3.3 which do not exist.
3. Table 105.1, under "Pipe Insulation" refers to Section 403.9.5. This Section does not exist.
4. Section 403.7 refers to Sections 403.8.1 through 403.8.3 for sizing heating and cooling systems. The Sections referred to are actually requirements for swimming pool, spas and hot tubs. References should be to Sections 403.7.1 through 403.7.3.
5. Section 403.8.6 refers to Sections 403.9.5.1 and 403.9.5.2. These Sections do not exist. The references should be to Sections 403.8.6.1 and 403.8.6.2.
6. Section 405.6, number two refers Section 403.8.1 for sizing of heating and cooling systems. Section 403.8.1 is for service water heating and does not apply to sizing of heating systems.
7. Some of the References in Chapter 7 to the International Residential Code are incorrect because they are references to the 2006 IRC and we have now adopted the 2009 IRC and there have been changes in those particular areas of that code.

ECONOMIC IMPACT ANALYSIS

As stated in F/S R-08-176 above, an EIA involves seeking input from the impacted community, outlining the *steps* necessary for compliance by that community, as well as calculating the *costs* involved in complying with the regulation. The following analysis and supplemental documents provide that information. Section 1 contains a report from M&E Engineering that shows energy savings, additional costs, simple payback, and life cycle cost analyses for five standard building products; Section 2 provides a description of the differences between the AECC and the NMECC for both residential as well as commercial construction; and Section 3 provides a summary of industry comments about the two codes followed by complete stakeholder comments.

In putting together the information used in this report, Council staff worked with the following representatives of the Impacted Community:

- Representatives of National Association of Industrial and Office Properties (NAIOP);
- Representatives of the NM Home Builders Association;
- Representatives of the New Mexico branch of the Associated General Contractors of America;
- Staff from the Planning Department; and
- The City Economist.

In addition, Council staff worked with individuals and organizations that represent the New Mexico energy conservation community, including:

- The Sierra Club;
- The Southwest Energy Efficiency Project;
- Energyenervation; and
- Mr. John Bucholz, editor of the 2009 Albuquerque Energy Conservation Code.

As shown in the M&E report contained in Section 1, the incremental costs associated with complying with the AECC rather than the IECC range from $2,808 for a 1,560 square foot 3-bedroom detached single family dwelling to $81,146 for a 100,440 square foot commercial warehouse. Annual energy created by the AECC's greater energy efficiency requirements range from $191 for the 3-bedroom house up to $6,968 for the commercial warehouse.

Residential Construction

For residential construction, the annual energy savings and incremental costs of construction are summarized below:

Building Type	Annual Energy Savings ($)	Implementation Cost ($) Total	Implementation Cost ($) per sq. ft.
3-bedroom Detached dwelling	$ 191	$2,808	$1.80
4-bedroom Detached dwelling	$ 296	$3,843	$1.50

Based on these figures, Council staff has calculated the increase in monthly and annual mortgage principal, interest and taxes (PIT) for two typical loan programs: the FHA First Time Homebuyer program with a 3.5% down payment and a Conventional Loan with a 10% down payment.

Please see attached spreadsheet for details. The incremental increases in mortgage payments are summarized below:

Building Type	Increased PIT FHA First Time Home Buyer Program		Increased PIT Conventional Loan Program	
	Monthly	**Annual**	**Monthly**	**Annual**
3-bedroom Detached dwelling	$16.58	$199	$15.67	$188
4-bedroom Detached dwelling	$22.67	$272	$21.42	$257

Council staff contacted Yolanda Olguin, a Branch Sales Manager with Wells Fargo Home Mortgage, in order to determine the effect these types of increases might have on the ability of a buyer to afford a mortgage. Her response was that cost increases of the magnitude shown in the M&E's report would not, in and of themselves, negatively affect a homebuyer's ability to obtain financing. Here's an excerpt of her response:

> *"An increase of $4,000 - $5,000 in home cost would not necessarily disqualify a homebuyer for a mortgage. Qualification is not only based on the borrower's gross income, but also on the down payment amount and the borrower's credit score. Of these three factors, the credit score requirement is the most restrictive. If a borrower does not qualify based on income, they may qualify with the income of a cosigner. If a borrower's down payment is not large enough for a conventional loan, the lender can choose from a variety of other loan programs (such as FHA programs) that require no or low down payment amounts, or provide down payment assistance. However, if a borrower is disqualified due to a low credit score, the only option for the lender is to provide credit counseling to the potential borrower to help raise their credit score and re-evaluate qualification at a later date.*
>
> *Based on the current mortgage interest rate of 4.25%, an increase of $4,000 in the cost of the home would result in an increase of about $20 to the monthly mortgage payment, or about $240 per year. That increase would be offset by any energy savings the increased costs provided."*

Increased mortgage PIT, however, does have a negative affect on payback period for the implementation cost of the AECC. In the case of the 3 bedroom dwelling, the simple payback period based on implementation cost and energy cost savings alone is equal to $2,808/$191, or 14.7 years. However, since increased mortgage PIT costs under the FHA First-Time Homebuyers Program are greater than the energy cost savings, the payback period is lengthened; in this case, beyond the 30-year term of the mortgage. For the other three cases, the payback periods are lengthened, but not beyond the 30-year term. Simple payback periods taking into account the increased mortgage costs would be calculated based on the following formula:

Simple Payback Period = 30 years + [(30 yrs)(Incremental Mortgage Costs – Savings)/Savings)]

The following table shows simple payback periods adjusted for increased mortgage costs.

Building Type	FHA First Time Simple Payback	Conventional Simple Payback
3-bedroom Detached dwelling	30+$240/$191 = 31.3 yrs	30+(-$90)/$191 = 29.5 yrs
4-bedroom Detached dwelling	30+(-$720)/296 = 27.6 yrs	30+(-$1,170)/296 = 26 yrs

Similarly, for a Life Cycle Cost Analysis (adjusting for inflation and increasing energy costs) taking into consideration increased mortgage costs, the payback periods are...

Building Type	FHA First Time LCCA Payback	Conventional LCCA Payback
3-bedroom Detached dwelling	26.4 yrs	25.7 yrs
4-bedroom Detached dwelling	22.3 yrs	21.2 yrs

Effect of increase in construction costs on mortgage payments

Loan Program: FHA First Time Homebuyer, 3.5% downpayment, 2.25% mortgage insurance premium

Scenario	Years	Interest Rate	Home Value	Down Payment 3.5%	Mortgage Insurance 2.25%	Loan Amount	Monthly Payment	Annual Payment	Property Tax[2]	Total Annual PIT	Total PIT increase
Base- Median Home Price 3bd [3]	30	4.02%	$205,482	$7,192	$4,623	$202,913	$971	$11,653	$2,877	$14,530	
3bd Detached w/AECC implementation costs $2,808	30	4.02%	$208,290	$7,290	$4,687	$205,686	$984	$11,812	$2,916	$14,728	$199
Base- Median Home Price 4bd [3]	30	4.02%	$357,800	$12,523	$8,051	$353,328	$1,691	$20,291	$5,009	$25,300	
4bd Detached w/AECC implementation costs $3,843	30	4.02%	$361,643	$12,658	$8,137	$357,122	$1,709	$20,509	$5,063	$25,572	$272

Loan Program: Conventional, 10% downpayment [4], 2.25% mortgage insurance premium

Scenario	Years	Interest Rate	Home Value	Down Payment 10%	Mortgage Insurance 2.25%	Loan Amount	Monthly Payment	Annual Payment	Property Tax[2]	Total Annual PIT	Total PIT increase
Base- Median Home Price 3bd [3]	30	4.02%	$205,482	$20,548	$4,623	$189,557	$907	$10,886	$2,877	$13,763	
3bd Detached w/AECC implementation costs $2,808	30	4.02%	$208,290	$20,829	$4,687	$192,148	$920	$11,035	$2,916	$13,951	$188
Base- Median Home Price 4bd [3]	30	4.02%	$357,800	$35,780	$8,051	$330,071	$1,580	$18,955	$5,009	$23,965	
4bd Detached w/AECC implementation costs $3,843	30	4.02%	$361,643	$36,164	$8,137	$333,616	$1,597	$19,159	$5,063	$24,222	$257

[1] Average US mortgage rate per PR Web article "Homes.org Releases Mortgage Rates Update- Thanksgiving Week Impacts" 11/29/11 = 4.02%

[2] Property Tax = 42 mils of 1/3 home value

[3] Median home price per www.trulia.com and homes.trovit.com
3 bedroom $205,482
4 bedroom $357,800

[4] Required Conventional loan down payments range from 5%-20%

Commercial Construction

For commercial construction, the annual energy savings and incremental costs of construction are summarized below:

Building Type	Annual Energy Savings ($)	Implementation Cost ($) Total	per sq. ft.
24,450 sq. ft 2-story office building	$2,477	$42,820	$1.75
28,430 sq. ft. Retail building	$1,715	$19,162	$0.67
100,440 sq. ft. Industrial/Warehouse	$6,968	$81,146	$0.81
*Retail bldg - alternate	$ 873	($8,698)	($0.31)
*Warehouse – alternate	$6,880	$167,942	$1.67

Because there are such a wide variety of methods of financing commercial construction, this analysis will focus instead on the effect of AECC implementation costs on Albuquerque's relative regional lease rates for Office, Retail, and Industrial/Warehouse properties. Based on information provided by CBRE, the increased per square foot construction costs listed above translate into increases in lease rates of $0.22 per sq.ft./year for Office, $0.09/sq.ft./year for Retail, $0.10 per sq. ft./year for Industrial/Warehouse, and $0.21 per sq.ft./year for the Warehouse Alternate. There would be a decrease in the lease rate of $0.04 per sq. ft./year for the Retail Alternate case. Albuquerque's regional rankings for the five modeled commercial products are shown below.

Current Regional Office Lease Rates

Albuquerque	**15.63**
Dallas/Ft. Worth	17.53
Salt Lake City	19.23
Tucson	19.26
San Antonio	19.46
Denver	19.64
Phoenix	20.98
Austin	24.93

Regional Office Lease Rates with AECC

Albuquerque	**15.85**
Dallas/Ft. Worth	17.53
Salt Lake City	19.23
Tucson	19.26
San Antonio	19.46
Denver	19.64
Phoenix	20.98
Austin	24.93

Current Regional Retail Lease Rates

Albuquerque	**14.00**
Dallas/Ft. Worth	14.09
Phoenix	15.95
Tucson	15.95
Denver	16.20

Regional Retail Lease Rates with AECC

Albuquerque	**14.09**
Dallas/Ft. Worth	14.09
Phoenix	15.95
Tucson	15.95
Denver	16.20

Current Regional Industrial/Warehouse Lease Rates

El Paso	3.40
Dallas/Ft. Worth	3.73
Salt Lake City	4.08
San Antonio	4.24
Denver	5.92
Tucson	6.25
Phoenix	6.60
Albuquerque	**6.85**
Austin	7.08

Regional Industrial/Warehouse Lease Rates with AECC

El Paso	3.40
Dallas/Ft. Worth	3.73
Salt Lake City	4.08
San Antonio	4.24
Denver	5.92
Tucson	6.25
Phoenix	6.60
Albuquerque	**6.95**
Austin	7.08

Current Regional Retail Lease Rates- Alternate

Albuquerque	**14.00**
Dallas/Ft. Worth	14.09
Phoenix	15.95
Tucson	15.95
Denver	16.20

Regional Retail Lease Rates with AECC-Alternate

Albuquerque	**13.96**
Dallas/Ft. Worth	14.09
Phoenix	15.95
Tucson	15.95
Denver	16.20

Current Regional Industrial/Warehouse Lease Rates -Alternate

El Paso	3.40
Dallas/Ft. Worth	3.73
Salt Lake City	4.08
San Antonio	4.24
Denver	5.92
Tucson	6.25
Phoenix	6.60
Albuquerque	**6.85**
Austin	7.08

Regional Industrial/Warehouse Lease Rates with AECC -Alternate

El Paso	3.40
Dallas/Ft. Worth	3.73
Salt Lake City	4.08
San Antonio	4.24
Denver	5.92
Tucson	6.25
Phoenix	6.60
Albuquerque	**7.06**
Austin	7.08

Energy Savings

The M&E report contained in Section 1 shows that construction that complies with the provisions of the AECC is more energy efficient than construction complying with the IECC across the board. The increased energy efficiency gained by building to AECC standards ranges from 5% to 19% depending on building type.

Type of Building	IECC Energy Use (million btu/yr)	AECC Energy Use (million btu/yr)	Energy Savings (million btu/yr)	AECC Increased Energy Efficiency
3-bedroom Detached dwelling	93.1	78.6	14.5	16%
4-bedroom Detached dwelling	147.9	120.4	27.5	19%
24,450 sq. ft 2-story office bldg	1,090.8	964.7	126.1	12%
28,430 sq. ft. Retail building	1,630.5	1,541.8	88.7	5%
100,440 sq. ft. Indust./Warehouse	2,181.6	1,932.4	249.2	11%

In addition to energy savings, there is literature that suggests that energy savings also contribute to regional energy and environmental conservation efforts. For example, the report entitled *Clean Energy Solutions, Energy Efficiency and Renewable Energy in New Mexico*, by Zugel & Heavner, states that "a typical coal-fired power plant consumes 0.49 gallons of water per kWh through evaporation loss". For the types of buildings modeled in the M & E study, that translates into the following regional water savings:

IRS Depreciable Life

Building	(A) Annual Energy Savings in kWh	(B) Annual Water Savings in gallons (A x 0.49gal)	(C) Depreciable Service Life - IRS [1]	(D) Service Life Water Savings gallons (B x C)
Three BR Home	1,611	789	27.5	21,708
Four BR Home	1,231	603	27.5	16,588
Office Building	29,711	14,558	39	567,777
Retail Building	20,105	9,851	39	384,207
Warehouse	117,128	57,393	39	2,238,316

1 IRS Publication 946 (2010) "How to Depreciate Property", MACRS General Depreciation System
Residential Rental 27.5 years, Nonresidential Real 39 years

Industry Expected Life

Building	(A) Annual Energy Savings in kWh	(B) Annual Water Savings in gallons (A x 0.49gal)	(C) Expected Service Life [2]	(D) Service Life Water Savings gallons (B x C)
Office Building	29,711	14,558	73.4	1,068,586
Retail Building	20,105	9,851	73.4	723,096
Warehouse	117,128	57,393	73.4	4,212,626

2 Average expected service life, non-residential buildings "Survey On Actual Service Lives for North American Buildings"
http://www.softwoodlumber.org/pdfs/SurveyonActualServiceLives.pdf

no industry data found for residential buildings

SECTION 1

COST AND ENERGY SAVINGS COMPARISON - 2009 ALBUQUERQUE ENERGY CONSERVATION CODE VS. 2009 INTERNATIONAL ENERGY CONSERVATION CODE

PREPARED BY

MECHANICAL & ELECTRICAL ENGINEERING, INC.

Energy Conservation Code Comparison

Prepared for
City of Albuquerque

November 2011

MECHANICAL & ELECTRICAL ENGINEERING, INC.

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I. Introduction

M&E Engineering was placed under contract by the City of Albuquerque to provide energy modeling of two residences and three commercial buildings to assist the City of Albuquerque evaluate the energy conservation and economic impact of eliminating the 2009 Albuquerque Energy Conservation Code - Volumes I and II (2009 ABQ ECC) and enforcing the 2009 IECC. For this project *energy modeling* means developing a computer model of the energy using characteristics of the building and then imposing a year's worth of climate data to develop a good estimate of the annual energy consumption of the building with and without the 2009 Albuquerque Energy Code requirements.

The City of Albuquerque arranged for architects and builders to provide construction documents for the five buildings and requested a comparison of the annual energy consumption of the buildings under the criteria of the 2009 Albuquerque Energy Conservation Code and of the 2009 International Energy Conservation Code (2009 IECC). The 2009 ABQ ECC was put into effect in December 2009 and the 2009 IECC adopted by the State of New Mexico to be in effect in 2011. In addition, M&E Engineering was asked to determine the incremental increase in construction cost associated with the requirements of the 2009 Albuquerque Energy Conservation Code. With energy savings and implementation cost information an economic analysis is presented.

As our country and state continue to achieve reduced energy use, Energy Codes will continue to change, getting increasingly more stringent and changing more frequently. The 2009 ABQ ECC adopts and amends the 2006 International Energy Conservation Code. There are a few instances where the recently adopted 2009 IECC is more stringent than the 2009 ABQ ECC. When this occurs, the more stringent requirement is identified and used in the analysis.

This report will provide a brief description of each building, a description of each building component change (code requirement) used to reduce energy, and a summary of the energy savings with estimates of the increased construction cost.

II. Summary and Results - Amended

The table below illustrates the energy conservation and economic impact of the effects of implementation of the 2009 ABQ ECC on two residences and three commercial buildings. Continuation of the 2009 ABQ ECC code reduces energy use and cost more than the 2009 IECC.

Amendment note: The analysis was amended for two buildings, the Retail and the Warehouse (noted as Alternate). In this analysis the comparison was made between the 2009 IECC and the 2009 ABQ ECC as it is currently written and adopted. A few requirements of the 2009 ABQ ECC are not as stringent as the requirements of the 2009 IECC.

In the original analysis when a requirement of the 2009 ABQ ECC was less stringent than the State adopted 2009 IECC, the requirement was changed to equal that of the State adoption.

Building	Energy Savings (in Dollars)	Implementation Cost ($)		Simple Payback	LCCA **
		Total	per sq. ft.		
Three Bedroom Detached Dwelling	$ 191	$2,808	$1.80	14.7 years	11.0 years
Four Bedroom Detached Dwelling	$ 296	$3,843	$1.50	13.0 years	9.6 years
Office Building	$2,477	$42,820	$1.75	17.3 years	12.3 years
Retail Building	$1,715	$19,162	$0.67	11.2 years	8.5 years
Warehouse	$6,968	$81,146	$0.81	11.6 years	7.1 years
Retail Building Alternate	$873	-$8,698	-$0.31	N/A	N/A
Warehouse Alternate	$6,880	$167,942	$1.67	24.4 years	14.6 years

* Warehouse does not have cooling
** LCCA Life Cycle Cost Analysis, See Section IV. Methodology

A more detailed Table presenting Btu savings can be found in Appendix A.

Details of the analysis are presented in the following pages. Be aware that these results are specific to each of the five buildings and are a snapshot of possible energy reductions in these specific buildings based on measurable and assumed conditions about the home. For example, a measurable condition has a calculation based on a quantity of material and changes in its thermal characteristics. Other calculations are assumptions of how the occupants would operate the building - that is how many hours the lights would be used, etc. In reality, the occupants of one dwelling may be at home most of the day and in another, the occupants may be at work all day. One building may have different hours of operation than another. Different usage will strongly affect the actual energy use of a dwelling or building.

III. Background

The City of Albuquerque provided construction plans of the following five buildings which were designed before the adoption of either the 2009 IECC or the 2009 AECC. The information from these documents was used to establish the components, i.e., wall and window areas.

Three Bedroom Single Family Detached Dwelling
Four Bedroom Single Family Detached Dwelling
Office Building
Retail Building
Warehouse

The baseline use for these buildings was determined by applying the 2009 IECC design criteria to the building components. The alternate use was determined by applying the 2009 ABQ ECC criteria. To manage the building components and the design criteria based on the two codes, a table was completed, one for residential and one for commercial.

2009 IECC	Design criteria per the requirements of the 2009 International Energy Conservation Code. This information was used to calculate the Baseline energy.
2009 ABQ ECC	Design criteria per the requirements of the 2009 Albuquerque Energy Conservation Code. This information was used to calculate the estimated energy use of the dwelling or building when the requirements of the City of Albuquerque Energy Conservation Code are applied.

A. Building Components - Residential

The two codes, the 2009 IECC and the 2009 ABQ ECC, contain different design requirements for some components of a dwelling. The following list presents the building components with 2009 IECC requirements as compared to the more stringent 2009 ABQ ECC design requirements.

The columns to the right indicate which components were applicable to each dwelling and the marginal cost increase. N/A notes a design component which did not occur in the building. Component assumptions and comments follow the table.

R1 = 3 bedroom, single level residence.
R2 = 4 bedroom, two-story residence

	Building Component	2009 IECC requirements	2009 ABQ ECC requirements	R1	R2
1	Wall insulation - above grade	R = 13	R= 21 R = 13 plus R=7.5	$2,173	$2,997
2	Floor insulation - above grade	R=19 (U=0.047)	R= 21 (U=0.046)	n/a	$170
3	Roof - solar reflectance	No requirement	Low slope 0.65, Steep slope 0.25	$0	$0
4	Glazing - orientation specifics and U-factor	U=0.35	N,E,W low e type glazing, U=0.35	$160	$218
5	Ventilation or Air Exchange Rate	7 ACH 50	6 ACH 50	$250	$250
6	Mechanical Exhaust (laundry and bathrooms)	No requirement	criteria in code plus use of occupancy sensors	$138	$138
7	Mechanical water piping	R=3 Heat trap not required	R=4 on 2 in. or less pipe diameter and R=6 on >2 in. Heat trap required	$87	$70
8	Water conservation	No requirements	shower 2.5 gpm faucet 2.2 gpm	$0	$0
9	Light Fixtures	50% high efficiency	Prescribed % of Energy Star rated fixtures	$0	$0
10	Skylights	U=0.60	U=0.45	n/a	n/a
11	Testing	See Assumptions	See Assumptions	$0	$0

R-value The thermal resistance value of a material.
U =1/R
gpm Gallons per minute, a water flow rate
ACH air changes per hour

Component Assumptions

Assumptions were made in order to calculate the difference in energy use of the 2009 IECC compliant dwelling and the energy use after implementation of the 2009 ABQ ECC. These assumptions were also the basis of preparing the incremental cost to implement the 2009 ABQ ECC requirements. The following notes describe the assumptions.

1. Wall insulation: Sheathing with an R value of 7.5 was added to the 2 x 4 frame wall containing batt insulation with an R value of 13, and in the dwelling designed with 2 x 6 frame walls, R-19 insulation was in the cavity with sheathing of R=2.

2. Floor insulation - above grade: Flooring insulation was changed from R-19 to R-21

3. Roof Reflectance: Roofing was changed to have Energy Star qualified reflective roof coverings. Roofing with a reflective coating does not appear to have a incremental cost increase, and only presents energy savings when the dwelling has refrigerated air conditioning. It may cause an increase in energy use during the heating season.

4. Glazing: Low e glazing was provided on the North, East and West sides of the building.

5. Air Exchange Rate: The infiltration rate was changed from 7 ACH to 6 ACH based on improved door and window seals.

6. Mechanical Exhaust rate: Occupancy sensor installed to reduce fan use.

7. Mechanical (domestic) water piping: Piping was installed under slab or floor. Vertical piping in walls was all less than 2 inches in diameter and would fit in 2x4 or 2x6 frame wall. Heat trap installation included in this calculation.

8. Water conservation: Since most fixtures available in NM have low gpm, baseline assumed shower heads at 3 gpm, faucet at 2.2 gpm. Savings shown only as reduced hot water use at shower. Depending on the supplier, lower gpm fixtures can be purchased for the same price as higher gpm fixtures.

9. Light fixtures: Design documents showed a fixture layout without fixture specification. The 2009 IECC requires 50% of the fixtures to be high efficiency and the 2009 ABQ ECC schedules percentages by room usage. Depending on how the fixtures are selected to meet the 50% requirement of the 2009 IECC, the energy savings and the fixture costs could meet the requirements of the 2009 ABQ IECC, so no costs were added to meet the 2009 ABQ ECC criteria. (Energy star fixtures replacement rates = 50% in high use rooms, 25% medium use rooms, 100% storage, 50% exterior. Energy Star fixtures use 25% of standard bulb, or 15 watts for a 6 watt bulb.)

10. Skylight: Single dome skylights were changed to double dome. None applied to these residences.

11. The 2009 IECC and the 2009 ABQ ECC require testing of duct and building envelope leakage. The 2009 ABQ ECC has additional inspection requirements for the thermal envelope. Since the testing requirements for the codes are the same, and the inspections are to verify other code items, no changes were made in the modeling to show energy savings or losses and no marginal cost difference is associated with the testing.

B. Building Components - Commercial Buildings

The two codes, the 2009 IECC and the 2009 ABQ ECC, contain different design requirements for some components of a building. The following list presents the building components with 2009 IECC requirements as compared to the more stringent 2009 ABQ ECC design requirements.

Not all components apply to all buildings. The columns to the right indicate which components were applicable to each building and the marginal cost increase. N/A notes a design component which did not occur in the building. A brief description of each component and each building follows the table. All requirements for the 2009 IECC are for Climate Zone 4 - Non Marine.

B1 = office building
B2 = retail
B3 = warehouse

	Building Component	**2009 IECC**	**2009 ABQ ECC**	**B1**	**B2**	**B3**
1A	Roof - insulation entirely above deck	R-20 ci U-0.048	R-25 ci (U-0.039)[1]	$4518	$9,875	$36,096
1B	Roof - metal	R-13 + R-13 U-0.055	R-13 + R-19	n/a	n/a	n/a
1C	Roof - solar reflectance	NR	Low slope 0.65 Steep slope 0.25	$0	$0	$0
2A	Wall - Mass	R-9.5 ci U-0.104	R-12.5 ci (U-0.08)[1]	n/a	$4,236	$17,665
2B	Wall - Metal building	R-19 U-0.084	R-13, R-13	n/a	n/a	n/a
2C	Wall - Metal framed	R-13 + R-7.5 ci U-0.064	R-19 + R-5 ci (U-0.055)[1]	$11,664	n/a	n/a
2D	Wall - Wood framed Other	R-13 U-0.0.89	R-21, or R-13 + R-7.5 ci	n/a	n/a	n/a
3A	Slab - Unheated	NR F-0.73	R-10 for 24" (F-0.54)[1]	$1,951	$2,934	$5,514
3B	Slab - Heated	R-15 for 24" F-0.048	R-10 for 24" + R-5 under slab	n/a	n/a	n/a
4A	Glazing	U-0.5 SHGC 0.4 PF NR	U-0.42 SHGC 0.38 PF 0.5 for S, E, W	$14,387	$1,992	$3,673

4B	Sky Lights [3]	U-0.6 SHGC 0.4	U-0.6 [2] SHGC 0.39	n/a	n/a	$890
5	Doors	U-0.7	U-0.5	$19	$50	$1,112
6A	Mechanical System. B1	Heat Pump 12 EER Cooling 4.2 COP Heating	Heat Pump 12 EER Cooling 4.2 COP Heating	$0	n/a	n/a
6B	Mechanical System. B2	AC Air Cooled <65MBH 11.1 EER	AC Air Cooled <65MBH 11.1 EER [2]	n/a	$0	n/a
6C	Mechanical System B2	AC Air Cooled 135-240 MBH 10.8 EER	AC Air Cooled 135-240 MBH 10.8 EER [2]	n/a	$0	n/a
6D	Mechanical Systems B3	Unit Heater 80% AFUE	Unit Heater 80% AFUE	n/a	n/a	$0
7A	Lighting B1	Office LPD 1.0 W/sf	Office LPD 0.9 W/sf with 15% OS reduction	$9,982	n/a	n/a
7B	Lighting B2	Retail LPD 1.5 W/sf	Retail LPD 1.3 W/sf	n/a	$0	n/a
7C	Lighting B3	Warehouse LPD 0.8 W/sf with 15% OS reduction	Warehouse LPD 0.6 W/sf with 50% System reduction	n/a	n/a	$16,196
8	Domestic HW Pipe Insulation	R-3.7	R-4	$299	$76	n/a
9	Testing and Inspections	See Assumptions	See Assumptions	$0	$0	$0

R-value The thermal resistance value of a material.
U-factor The thermal conductance of a material, 1/R.
ci Continuous insulation
F-factor The thermal conductance of a slab perimeter.
NR No Requirement.
SHGC Solar Heat Gain Coefficient
PF Projection Factor, required size of glazing shading related to height of window.
EER Energy Efficiency Ratio
COP Coefficient of Performance
MBH 1000 Btu/hr
AFUE Annual Fuel Utilization Efficiency
LPD Lighting Power Density
OS Occupancy Sensor

Notes

1 The 2009 ABQ ECC does not provide an equivalent U-factor or F-factor for the specified R-value. This factor is the value used in the modeling program and is equivalent to the 2009 ABQ ECC requirement.

2 The requirement specified by the 2009 ABQ ECC is less strict than the requirement specified by the 2009 IECC. Since the building must meet or exceed all requirements for the State of New Mexico, the 2009 IECC requirement is used for the 2009 ABQ ECC modeling.

3 The 2009 IECC requires the total sky light area to be less than 3% of the total roof area. The 2009 ABQ ECC requires warehouses to have a total sky light area between 5% and 7% of the total roof area. Since the building must meet or exceed all requirements for the State of New Mexico, the 2009 IECC requirement is used for the 2009 ABQ ECC modeling.

Component Assumptions

Assumptions were made in order to calculate the difference in energy use of the 2009 IECC building and the energy use of the 2009 ABQ ECC building. These assumptions were also the basis of preparing the marginal cost to implement the 2009 ABQ ECC requirements. The following notes describe the assumptions.

1, 2, 3.

Insulation requirements for the 2009 IECC are from Tables 502.1.2, 502.2(1), and 502.2(2). Insulation requirements for the 2009 ABQ ECC are from Tables 502.2(1), and 502.2(2).

- 1A. Refer to Note 1 for additional information.
- 1B. Requirements were not used in modeling so no assumptions were necessary.
- 1C. The reflectance used for the 2009 IECC is 0.1 since no requirement is specified. All roofs are low slope.
- 2A. Refer to Note 1 for additional information.
- 2B. Requirements were not used in modeling so no assumptions were necessary.
- 2C. Refer to Note 1 for additional information.
- 2D. Requirements were not used in modeling so no assumptions were necessary.
- 3A. Refer to Note 1 for additional information.
- 3B. Requirements were not used in modeling so no assumptions were necessary.

4. Glazing and Sky light requirements for the 2009 IECC and 2009 ABQ ECC are from Tables 502.3.
   - 4A. The 2009 IECC does not require any shading (Projection Factor) for glazing. The windows were modeled with the provided shading as shown on the building construction documents. The shading sizes were revised to comply with the 2009 ABQ ECC projection factor of 0.5 for all South, East, and West facing windows.
   - 4B. Refer to Note 2 and 3 for additional information.

5. Door requirements for the 2009 IECC and the 2009 ABQ ECC are from Table 502.2(1).

6. Mechanical System requirements for the 2009 IECC and the 2009 ABQ ECC are from Tables 503.2.3(1-7).
   6A. No changes were made in mechanical efficiencies.
   6B. Refer to Note 2 for additional information.
   6C. Refer to Note 2 for additional information.
   6D. No changes were made in mechanical efficiencies

7. Lighting requirements for the 2009 IECC and the 2009 ABQ ECC are form Table 505.5.2.
   7A. The whole office building is modeled with uniform lighting power density throughout. The 2009 ABQ ECC requires an occupancy sensor use reduction (ASHRAE 90.1 Appendix G allows 15% reduction). A lighting power density of 0.765 W/sf was used for modeling the 2009 ABQ ECC.
   7B. The retail building is modeled with the specified lighting power density and an additional lighting allowance for specific product space areas. The effective lighting power density for the 2009 IECC is 2.005 W/sf. The effective lighting power density for the 2009 ABQ ECC is 1.92 W/sf.
   7C. The ware house is modeled with the specified lighting power density with a reduction in use. The 2009 IECC requires an occupancy sensor use reduction (ASHRAE 90.1 Appendix G allows 15% reduction). A lighting power density of 0.68 W/sf was used for modeling the 2009 IECC. The 2009 ABQ ECC requires a lighting use reduction with use of sky lights (50% use reduction from Section 502.3.3 exception 6). A lighting power density of 0.3 W/sf is used for modeling the 2009 ABQ ECC.

8. Domestic piping insulation requirements for the 2009 IECC are to install 1 inch of insulation with a conductance of 0.27 Btu/in-hr-sf-F. The 2009 ABQ ECC requires R-4 insulation for pipes smaller than 2 inches in diameter. Building B1 has automatic recirculating controls, 275 feet of hot water piping, and operates 12 hrs/day, 5 days a week. Building B2 has no automatic recirculating, 70 feet of hot water piping, and operates 9 hrs/day, 7 days a week.

9. The 2009 IECC and the 2009 ABQ ECC require testing of duct and building envelope leakage. The 2009 ABQ ECC has additional inspection requirements for the thermal envelope, air leakage, HVAC systems, service water heating systems, heated swimming pools, and electrical lighting to ensure compliance with the code. Since the testing requirements for the codes are the same, and the inspections are to verify other code items, no changes were made in the modeling to show energy savings or losses.

Building Descriptions

B1 - the office building is a 24,450 sf, 2 story open office space building with a front lobby and restroom area on both floors, a back of house mechanical and storage area, two stair wells, and one elevator. It has extensive shading on the exterior glazing. The mechanical system is a water source heat pump system with boilers and closed circuit cooling tower and common primary and secondary water circulating pumps.

B2 - the retail building is a big box, 28,430 sf, high bay retail area with a 2 story office section with stairs, restrooms, break room, and storage, back of house receiving area with dock and small storage space. There is shading for front glazing only. The mechanical system is multiple, packaged gas fired DX RTUs, each with economizer section.

B3 - the warehouse is a 100,440 sf, high bay open space office/warehouse. The front has multiple curtain wall entries and the back multiple cargo docking areas. There are multiple skylights throughout building, but no restrooms or service water use. There is shading on the front entry. The mechanical system consists of gas-fired unit heaters and there is no cooling system.

IV. Methodology

A. Energy Modeling

Using the plans provided with components set to comply with the 2009 IECC requirements, M&E Engineering calculated an estimated energy use baseline for each building. This baseline energy use was calculated using *REM/Design* for the dwellings and *Trane Trace* for the buildings; both are energy modeling programs. An energy modeling program is a computerized simulation of a building's energy use which is based on detailed information about the building, its building components, and weather data.

By changing the building components to meet the 2009 ABQ ECC requirements, M&E estimated a revised energy use for each building as tho it were built per the requirements of the 2009 ABA ECC. The difference in the results - energy use baseline less revised energy use - *produces* the savings (or energy use avoidance).

Summary pages presenting the results from the modeling program are included under Appendix B.

> Note: An analysis of this type (energy modeling of a defined building) is specific to the defined building and the conclusions are based on a study of modifications to the building components. The cost of the modification is also specific to the defined building. The reader should resist the temptation to extrapolate or apply the results to other buildings as they do not constitute an average or a typical occurrence.

The range of payback results for a specific project reinforces why one is discouraged from the temptation to extrapolate (reference Energy Modeling section) the specific results from one dwelling to other dwellings. The payback of a project is affected by many variables, including but not limited to :

1. One story or two story configuration.
2. Wall construction, masonry, stud, etc.
3. Window orientation
4. Heating system type
5. Cooling system type
6. Occupant habits, however, for the purpose of this study, all dwellings were occupied by families with the same habits of light use, heating system hours on, etc.

If the exact same building were constructed with a different orientation, for example rotated 90 degrees so that the South facing windows were now East facing, the energy savings results for each changed condition would be different. On the other hand, they would likely be within a nominal range, so one can obtain a sense of which projects result in more cost effective energy reduction.

This information also suggests that there are diminishing returns to some energy conservation ideas. Adding more wall insulation, for example, will increase construction costs but may not significantly save more energy.

B. Cost Estimates and Payback

Cost data has been provided as a incremental difference. The construction costs shown indicate the construction cost difference between the dwelling/building with and without the application of the required code changes. The incremental cost difference for each component was calculated based upon those costs.

Cost estimates were prepared based on *Means Construction Costs,* 2010. This information was supplemented with cost and installation experience obtained from contractors and vendors.

Payback values are given using two methods.

Simple payback: Simple payback is calculated by dividing the incremental construction cost by the first year's energy savings. This number tells you the number of years of savings it takes to pay for the cost of construction.

LCCA: Life Cycle Cost Analysis (LCCA) also results in the number of years of savings it takes to pay for the cost of construction but it takes into consideration the variables over time of the escalation in fuel and power rates, rates of inflation, and cost of money. LCCA is considered to be a more accurate economic evaluation.

Rates used:

- General Inflation 3.525%
- Power escalation 3.022%
- Gas escalation 3.540%

Sources: U.S. Bureau of Labor Statistics
General Rate of Inflation
http://www.rateinflation.com/inflation-rate/usa-inflation-rate.php

Calculator for natural gas and electricity
http://metricmash.com/inflation.aspx?code=SEHF02

Appendix A

Results

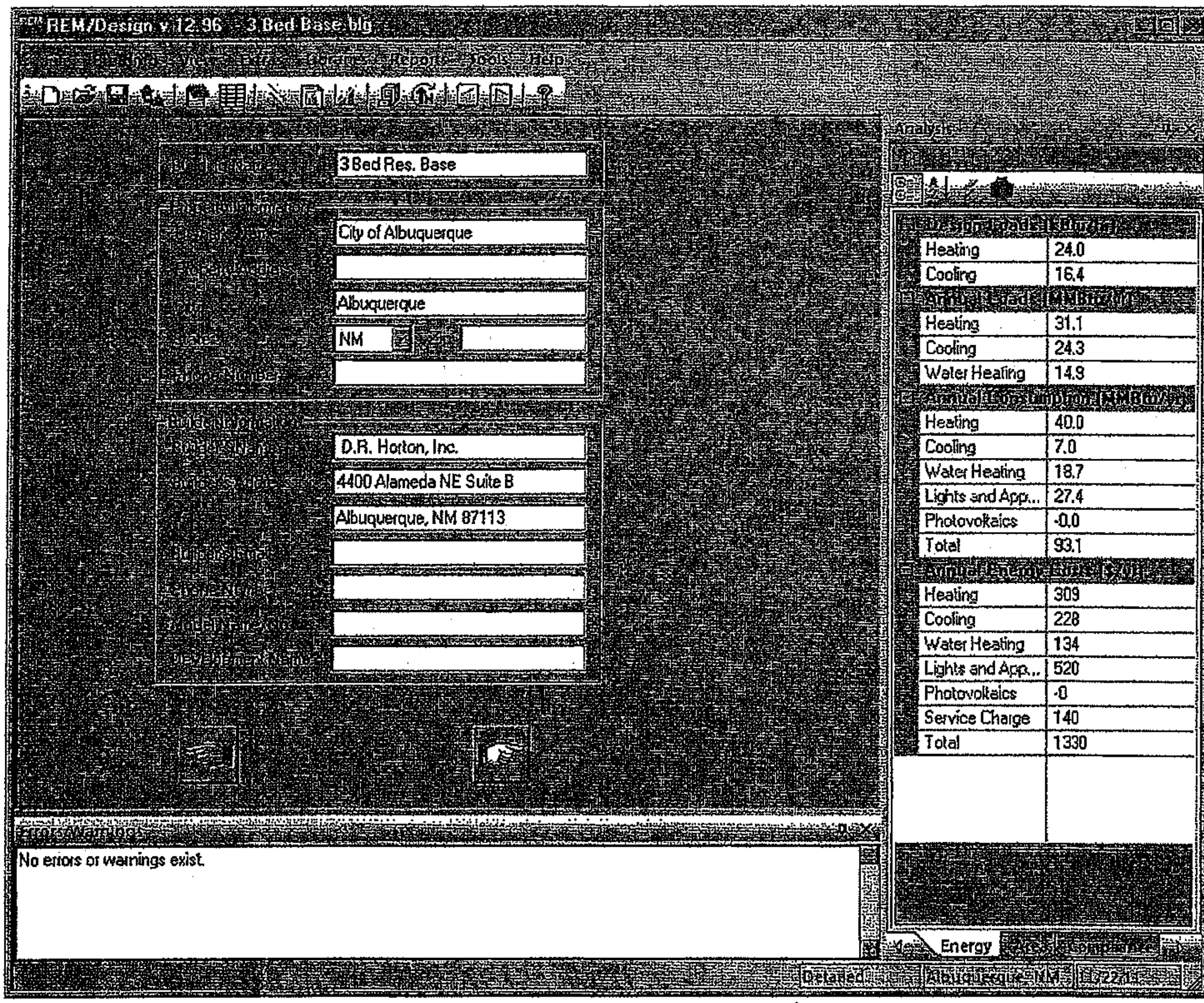
	Energy Use with 2009 IECC requirements in place		Energy Use with 2009 ABQ ECC requirements in place		Savings		Economic Impact	
	Energy million Btu/yr	Cost $/yr	Energy million Btu/yr	Cost $/yr	Energy million Btu/yr	$/yr	Cost $	PB LCCA (years)
Three Bedroom Dwelling	93.1	$1,330	78.6	$1139	14.5 16%	$191 14%	$2,808	14.7 PB 11.0 LCCA
Four Bedroom Dwelling	147.9	$1,992	120.4	$1,696	27.5 19%	$296 15%	$3,843	13.0 PB 9.6 LCCA
Office Building	1,090.8	$22,257	964.7	$19,780	126.1 12%	$2,477 11%	$42,820	17.3 PB 12.3 LCCA
Retail	1,630.5	$34,180	1,541.8	$32,465	88.7 5%	$1,715 5%	$19,162	11.2 PB 8.5 LCCA
Warehouse	2,181.6	$34,272	1,932.4	$27,304	249.2 11%	$6,968 20%	$81,146	11.6 PB 7.1 LCCA

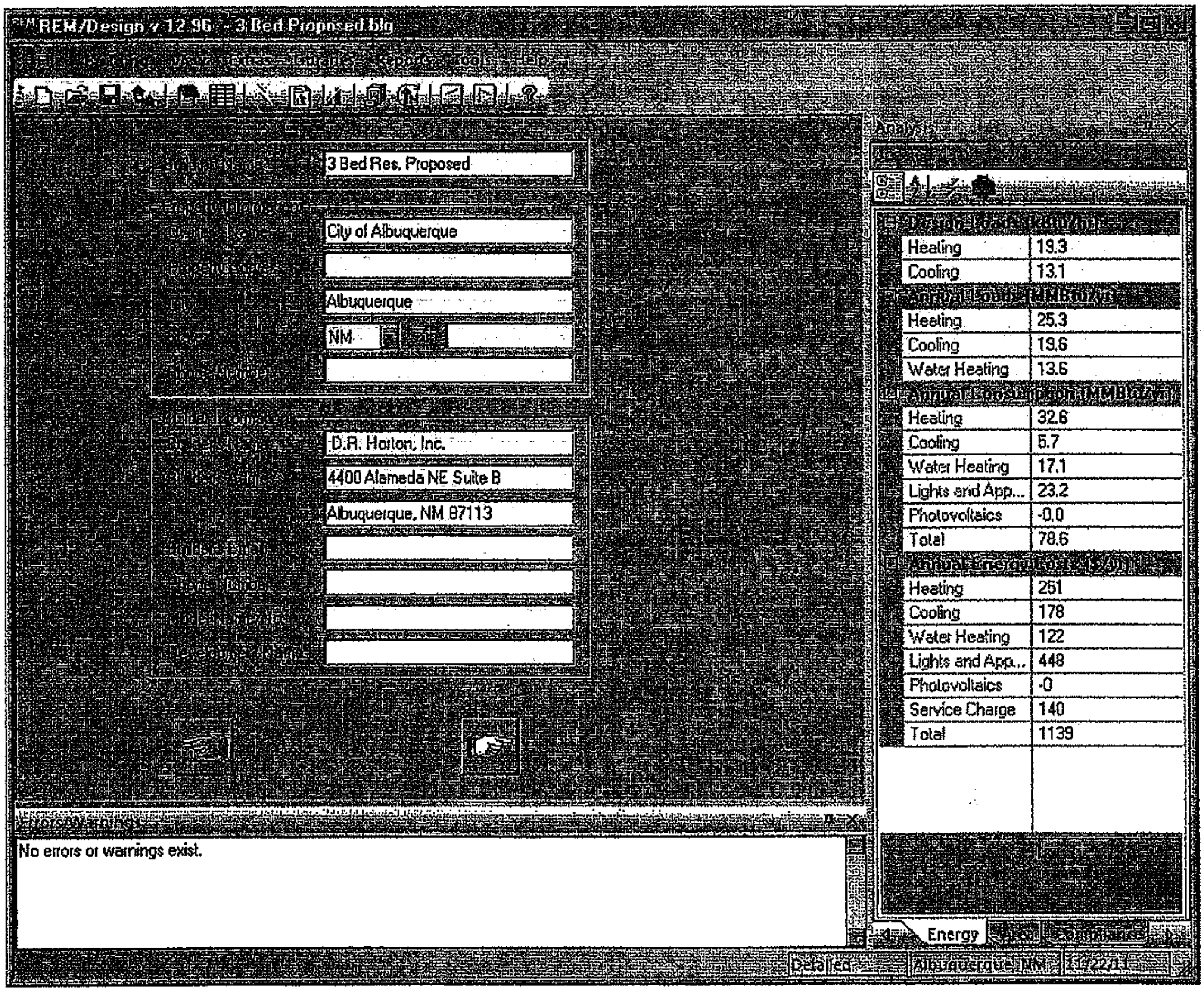
PB Simple Payback, See Section IV. Methodology
LCCA Life Cycle Cost Analysis, See Section IV. Methodology

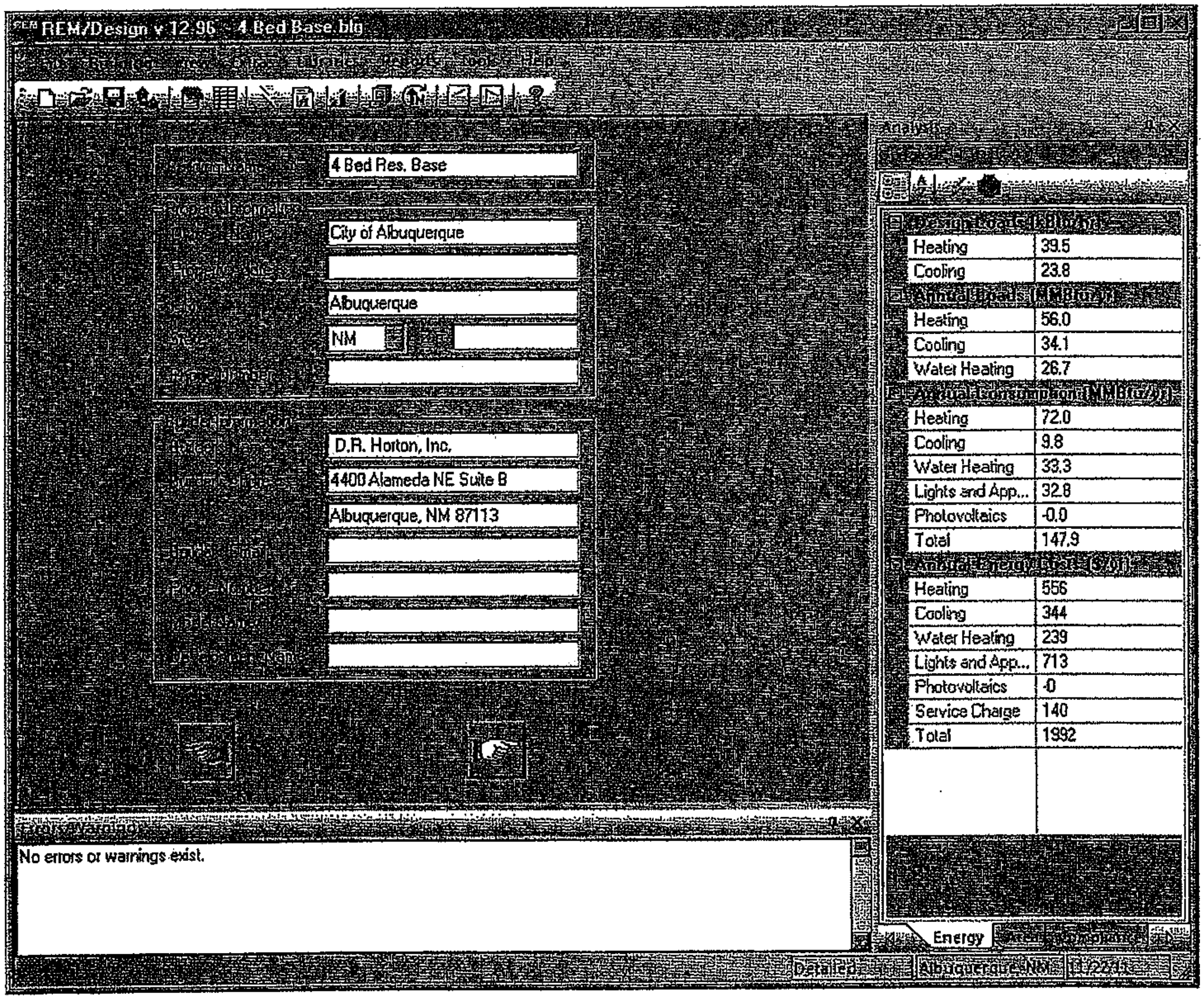
Btu British thermal unit. A measurement of energy which allows electricity (kWh) and gas (therms) units to be combined.

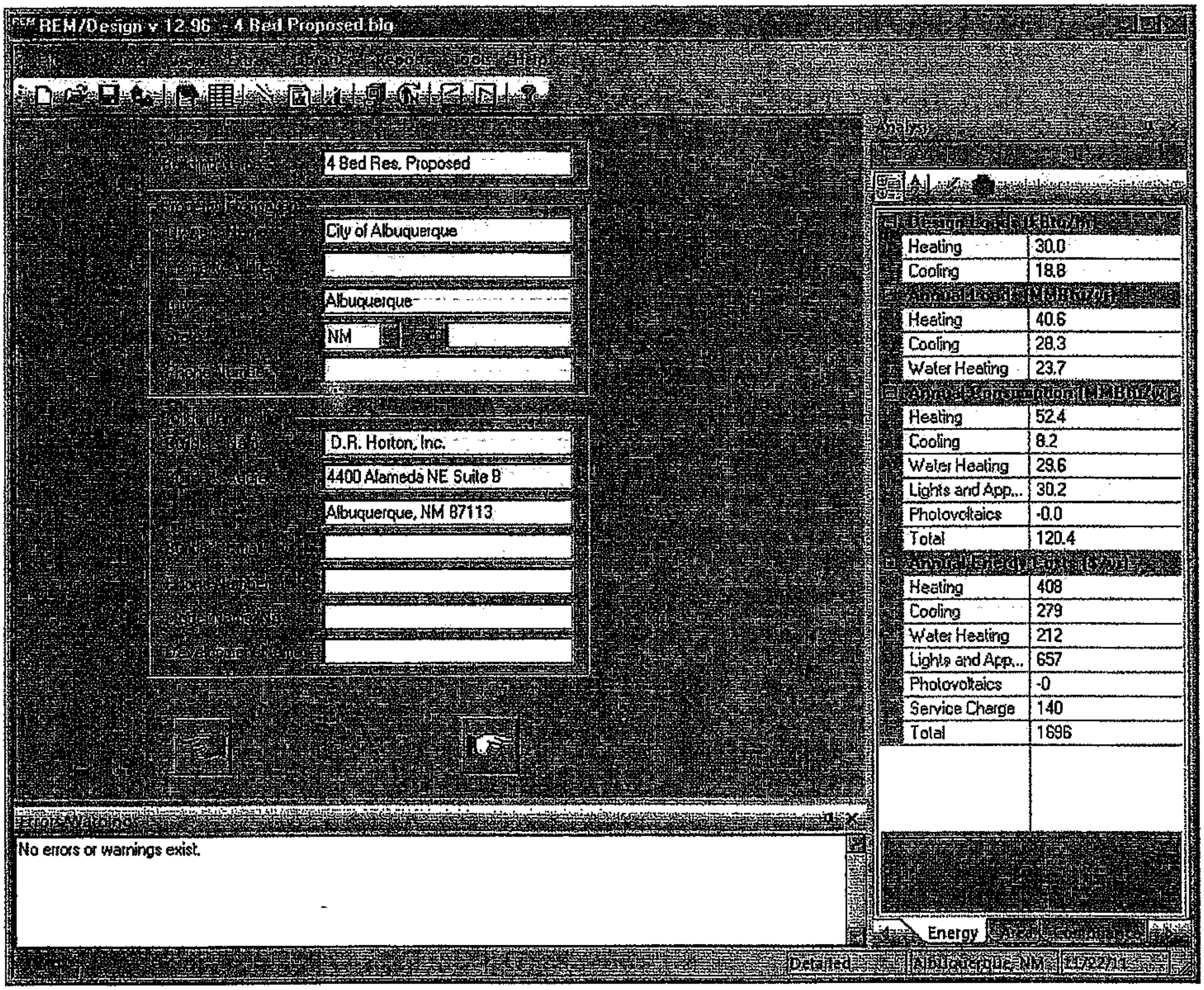
Appendix B

The following pages present the summary pages from REM/Design and Trane Trace. In each program, the base building represents the building meeting the requirements of the 2009 International Energy Conservation Code (2009 IECC) and the proposed building represents the building meeting the requirements of the 2009 Albuquerque Energy Conservation Code (2009 ABQ ECC).


REM/Design v 12.96 - 3 Bed Base.blg
3 Bed Res. Base
City of Albuquerque
Albuquerque
NM
D.R. Horton, Inc.
4400 Alameda NE Suite B
Albuquerque, NM 87113
No errors or warnings exist.
Heating 24.0
Cooling 16.4
Heating 31.1
Cooling 24.3
Water Heating 14.9
Heating 40.0
Cooling 7.0
Water Heating 18.7
Lights and App... 27.4
Photovoltaics -0.0
Total 93.1
Heating 309
Cooling 228
Water Heating 134
Lights and App... 520
Photovoltaics -0
Service Charge 140
Total 1330
Energy
Detailed
Albuquerque, NM


REM/Design v 12.96 - 3 Bed Proposed.blg
3 Bed Res. Proposed
City of Albuquerque
Albuquerque
NM
D.R. Horton, Inc.
4400 Alameda NE Suite B
Albuquerque, NM 87113
Heating 19.3
Cooling 13.1
Heating 25.3
Cooling 19.6
Water Heating 13.6
Heating 32.6
Cooling 5.7
Water Heating 17.1
Lights and App... 23.2
Photovoltaics -0.0
Total 78.6
Heating 251
Cooling 178
Water Heating 122
Lights and App... 448
Photovoltaics -0
Service Charge 140
Total 1139
No errors or warnings exist.
Energy
Detailed
Albuquerque, NM


REM/Design v 12.96 - 4 Bed Base.blg
4 Bed Res. Base
City of Albuquerque
Albuquerque
NM
D.R. Horton, Inc.
4400 Alameda NE Suite B
Albuquerque, NM 87113
Heating 39.5
Cooling 23.8
Heating 56.0
Cooling 34.1
Water Heating 26.7
Heating 72.0
Cooling 9.8
Water Heating 33.3
Lights and App... 32.8
Photovoltaics -0.0
Total 147.9
Heating 556
Cooling 344
Water Heating 239
Lights and App... 713
Photovoltaics -0
Service Charge 140
Total 1992
No errors or warnings exist.
Energy
Detailed
Albuquerque, NM


REM/Design v 12.96 - 4 Bed Proposed.blg
4 Bed Res. Proposed
City of Albuquerque
Albuquerque
NM
D.R. Horton, Inc.
4400 Alameda NE Suite B
Albuquerque, NM 87113
No errors or warnings exist.
Heating 30.0
Cooling 18.8
Heating 40.6
Cooling 28.3
Water Heating 23.7
Heating 52.4
Cooling 8.2
Water Heating 29.6
Lights and App... 30.2
Photovoltaics -0.0
Total 120.4
Heating 408
Cooling 279
Water Heating 212
Lights and App... 657
Photovoltaics -0
Service Charge 140
Total 1696
Energy
Detailed

Energy Cost Budget / PRM Summary

By M&E Engineering Inc

Project Name: Journal Center Tract 5		Date: November 23, 2011
City: Albuquerque NM	Weather Data: Albuquerque, New Mexico	

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-1 25k sf Office Base			Alt-2 25k sf Office Proposed		
		Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh	Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh
Lighting - Conditioned	Electricity	215.3	20	83	164.7	77	64
Space Heating	Electricity	55.1	5	53	48.1	87	47
	Gas	195.7	18	794	171.4	88	706
Space Cooling	Electricity	80.5	7	88	62.4	78	70
Pumps	Electricity	183.7	17	58	184.3	100	58
Heat Rejection	Electricity	7.4	1	5	5.9	80	5
Fans - Conditioned	Electricity	157.4	14	56	132.6	84	47
Receptacles - Conditioned	Electricity	190.8	17	60	190.8	100	60
Stand-alone Base Utilities	Gas	4.9	0	1	4.5	93	1
Total Building Consumption		1,090.8			964.8		

		* Alt-1 25k sf Office Base	Alt-2 25k sf Office Proposed
Total	**Number of hours heating load not met**	175	215
	Number of hours cooling load not met	19	35

	* Alt-1 25k sf Office Base		Alt-2 25k sf Office Proposed	
	Energy 10^6 Btu/yr	Cost/yr $/yr	Energy 10^6 Btu/yr	Cost/yr $/yr
Electricity	890.2	19,794	788.8	17,595
Gas	200.6	2,464	175.9	2,185
Total	1,091	22,257	965	19,780

Energy Cost Budget / PRM Summary

By M&E Engineering Inc

Project Name: 11117 Retail	Date: November 23, 2011
City: Albuquerque NM	Weather Data: Albuquerque, New Mexico

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-1 Retail BBB Base			Alt-2 Retail BBB Proposed Full		
		Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh	Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh
Lighting - Conditioned	Electricity	896.9	55	195	858.8	96	186
Space Heating	Gas	178.2	11	1,500	158.2	89	1,434
Space Cooling	Electricity	204.5	13	166	187.6	92	148
Heat Rejection	Electricity	41.5	3	31	38.4	92	28
Fans - Conditioned	Electricity	185.5	11	36	175.0	94	34
Receptacles - Conditioned	Electricity	122.6	8	46	122.6	100	46
Stand-alone Base Utilities	Gas	1.3	0	0	1.2	93	0
Total Building Consumption		1,630.5			1,541.8		

		* Alt-1 Retail BBB Base	Alt-2 Retail BBB Proposed Full
Total	Number of hours heating load not met	143	93
	Number of hours cooling load not met	0	0

	* Alt-1 Retail BBB Base		Alt-2 Retail BBB Proposed Full	
	Energy 10^6 Btu/yr	Cost/yr $/yr	Energy 10^6 Btu/yr	Cost/yr $/yr
Electricity	1,451.0	31,954	1,382.4	30,466
Gas	179.5	2,225	159.4	1,999
Total	1,630	34,180	1,642	32,465

Energy Cost Budget / PRM Summary

By M&E Engineering Inc

Project Name: Office Warehouse	Date: November 23, 2011
City: Albuquerque NM	Weather Data: Albuquerque, New Mexico

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-1 11117 Warehouse Base			Alt-2 11117 Warehouse Propose		
		Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh	Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh
Lighting - Conditioned	Electricity	707.7	32	233	312.2	44	103
Space Heating	Gas	1,320.9	61	2,137	1,471.4	111	1,981
Fans - Conditioned	Electricity	48.9	2	15	44.7	91	14
Receptacles - Conditioned	Electricity	104.1	5	34	104.1	100	34
Total Building Consumption		2,181.6			1,932.4		

		* Alt-1 11117 Warehouse Base	Alt-2 11117 Warehouse Propose
Total	**Number of hours heating load not met**	219	212
	Number of hours cooling load not met	0	0

	* Alt-1 11117 Warehouse Base		Alt-2 11117 Warehouse Propose	
	Energy 10^6 Btu/yr	Cost/yr $/yr	Energy 10^6 Btu/yr	Cost/yr $/yr
Electricity	860.7	19,154	461.0	10,485
Gas	1,320.9	15,118	1,471.4	16,819
Total	2,182	34,272	1,932	27,304

Appendix C

Resources

Construction Documents:

Three Bedroom Single Family Detached Dwelling
D.R. Horton, Inc., 6/19/2006

Four Bedroom Single Family Detached Dwelling
D.R. Horton, Inc., 11/19/2010

Office — Journal Center Tract 5, Office Building B
Dekker Perich Sabatini, 1/27/2006

Retail — Bed Bath & Beyond TI
Dekker Perich Sabatini, 2/1/2007

Warehouse — The Industrial Center at La Estancia, Building 1A Office / Warehouse Shell, Claudio Vigil Architects, 7/26/2005

Cost Estimating Resources
- Plumbing Cost Data, RS Means
- Electrical Cost Data, RS Means
- Mechanical Cost Data, RS Means
- Square Foot Costs, RS Means
- Construction Cost Data, RS Means
- Architect's Square Foot Costs, McGraw Hill Construction
- Green Building Square Foot Costbook, McGraw Hill Construction

Simulation software: Trane Trace® 700, version 6.2.7 for commercial buildings
REM/Design 12.97, 1985-2011 for dwellings

Energy Simulation - Mathematical model constructed to represent each possible energy flow path and their interactions associated with building systems and construction.

Utility Rates: Rates are PNM and NM Gas Co. residential rates.
Gas 0.716$/Therm with $9.59 monthly customer charge
Electric 0.0906237 $/kWh up to 450 kWh
0.1373455 $/kWh (summer) or 0.1185101 $/kWh (winter) next 450 kWh
$5.00 monthly customer charge

Commercial Rates
PNM Electric Small Power
NM Gas Co Small Volume

SECTION 2

SIDE BY SIDE COMPARISON OF THE 2009 ALBUQUERQUE ENERGY CONSERVATION CODE & 2009 INTERNATIONAL ENERGY CONSERVATION CODE (SOURCE: PLANNING DEPARTMENT)

Residential	2009 Interim Albuquerque Energy Conservation Code	2009 International Energy Conservation Code	
Ceilings	R-38	R-38	
Wood frame wall r-value	R-21or R-13+7.5cl	R-13	
Mass wall R-value	R-5	R-10 if more than half of insulation is on the interior R-5 if on the exterior	
Skylight SHGC	0.4	None	
North, east or west facing glazed fenestrations	Low-e glass	None	
Frame Wall U Factor	0.051	0.082	
Building envelope leakage test	Shall not exceed 6 air changes per hour of building enclosure area at 50 Pa. Exception: not required for additions less than 500 sq. ft. in area, alterations, renovations or repairs	Shall be less than 7 air changes per hour at 50 Pa. or building tightness and insulation installation required by Table 402.4.2 must be field verified	
Heating and Cooling Equipment Sizing	Use ACCA Manual S and Manual J	Use ACCA Manual S and Manual J	
Sizing of Ducts	Use ACCA Manual D	Use ACCA Manual D	
Insulation of Ducts	Supply and return min. R-8 Ducts in floor trusses R-6	Supply ducts in attics min. R-8 All others min. R-6	
Duct Leakage Test	For each newly installed system, air leakage rate from ducts to ourdoors is not to exceed 4 CFM at 25 Pascals per 100 sq. ft. of conditioned floor space or 6% of total air flow rate in the HVAC system.	Post construction test: Leakage to outdoors less than or equal to 8 CFM per 100 sq. ft. of conditioned floor area or a total leakage less than or equal to 12 CFM per 100 sq. ft. of conditioned floor area when tested at a pressure differential of 1 in. w.g. (25 Pa) across the entire system	Rough in test: Total Leakage shall be less than or equal to 6 CFM per 100 sq. ft. of conditioned floor area when tested at a pressure differential of 1 in. w.g. (25 Pa) across the roughed on system. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 4 CFM per 100 sq. ft. of conditioned floor area
Hot Water Recirculating Line Insulation	R-4	R-2	
Mechanical system piping	R-4 for 2" or less R-6 for over 2"	R-3	
Hot Water Circulating System	Shall be arranged to turn off automatically or manually	Same	
Showers	Maximum flow rate at pressure of 80 lbs per sq in 2.5 gal per min	None	These are covered in the plumbing codes
Faucets	Maximum flow rate at pressure of 60 lbs per sq in 2.2 gal per min	None	
Lighting Fixtures	Energy Star Labeled Fixtures: 50% fixtures - high use rooms; 25% fixtures - medium use rooms; 100% fixtures - utility rooms, closets, pantries, laundry rooms, sheds, garages, and unfinished basements; 50% fixtures - outdoor lighting excluding landscape lighting	50% of lamps in permanently installed lighting fixtures have to be high-efficacy	
Bathroom and Laundry Fans Controls	Must have an occupancy sensor or automatic timer switch	None	
Fans	Must be energy star labeled	None	
Swimming Pool Energy Source	Primary must be solar	None	
Pool Heaters	On-Off switch ahead of T-stat	On-Off switch ahead of T-stat, no continuously burning pilot lights, and time clock	
Pool Motor	Time clock required	Time switches with exceptions	
Pool Covers	If heated to more than 90 degrees must be equipped with a cover equivalent to R-12	All pools shall have vapor retardant pool cover. Over 90 degrees cover equivalent to R-12. Except pools deriving 60% of energy from solar or site recovered energy	
Spas & hot tubs	If heated to more than 90 degrees exterior must be insulated R-12 minimum	None	
Roof Reflectance	.65 for low slope .25 for steep slope Energy Star Qualified	None	

Commercial	2009 Interim Albuquerque Energy Conservation Code	2009 International Energy Conservation Code
Roof		
Insulation entirely above deck	R-25 ci	R-20 ci
Metal building with R-5 thermal blocks	R-13 + R-19 *	R-13 + R-13 for all groups except R-19 for group R *
Attic and other	R-38	R-38
Single rafter	R-38 + R-5 ci	None
Walls		
Mass	R-12.5 ci	R-11.4 ci for group R R-9.5 ci for all others
Metal building	R-13 + R-13 ***	R-19
Metal framed	R-19 + R-5 ci **	R-13 + R-7.5 ci **
Wood framed and other	R-21 or R-13 + R-7.5 ci	R-13 + R-3.8 ci for group R R-13 for all others
Walls below grade	R-13 or R-10 ci	R-7.5 ci for group R none for all others
Floors		
Mass	R-12.5 ci	R-10.4 ci for group R R-10 ci for all others
Metal framed	R-30	R-30
Wood framed and other	R-30	R-30
Slabs		
Unheated	R-10 for 24"	R-10 for 24" for group R none for all others
Heated	R-10 for 24" + R-5 ci under slab	R-15 for 24" below
Opaque doors		
Swinging	U-0.50	U-0.70
Roll up or sliding	U-0.50	U-0.50
* Sag & bag installation	** ci is continuous insulation applied to the exterior of the wall or roof	*** The first layer of insulation is installed continuously perpendicular to the girts, and is compressed as the metal skin is attached to the girts. The second layer is installed within the framing cavity

Commercial	2009 Interim Albuquerque Energy Conservation Code	2009 International Energy Conservation Code
Fenestrations		
Framing materials other than metal with or without metal reinforcement or cladding	Maximum U-factor 0.30	Maximum U-factor 0.40
Metal framing with or without thermal break		
Curtain wall/storefront	Maximum U-factor 0.42	Maximum U-factor 0.50
Entrance door	Maximum U-factor 0.75	Maximum U-factor 0.85
All others	Maximum U-factor 0.42	Maximum U-factor 0.55
Solar Heat Gain Coefficient SHGC		
All frame types	Maximum SHGC 0.38	none
SHGC: PF < 0.25	All frame types/ S,E,W orientations Maximum PF 0.5	0.40
SHGC: 0.25 ≤ PF ≥ 0.5		None
SHGC: PF ≥ 0.5		None
Skylights		
Warehouse and factory skylights	Maximum U-factor 0.69 Maximum SHGC 0.39 [2] Minimum visible light transmittance (VLT) 0.59 [2]	Maximum U-factor 0.60 Maximum SHGC 0.40
All others	Maximum U-factor 0.69 [1] Maximum SHGC 0.34 [1]	Maximum U-factor 0.60 Maximum SHGC 0.40
	[1] Maximum area (percentage of gross roof) 3%	
	[2] Area (percentage of gross roof) 5% min. 7% max.	
Reflectance of interior surfaces	There are 10 exceptions	
Ceilings & ducts and/or exposed structure	80%	None
Ceilings - other	70%	None
Light wells - ducts and or structure exposed	80%	None
Light wells - other	70%	None
Walls - above 7 ft	70%	None
Walls - below 7 ft	50%	None
Floors	20%	None

Commercial	2009 Interim Albuquerque Energy Conservation Code	2009 International Energy Conservation Code
Mechanical		
Electric Resistance Heat	Not allowed for space heating, for reheating of supply air, or for providing warm air in mixing systems (5 exceptions)	Not allowed except as supplementary back up for heat pumps defrost cycle
Seer ratings	Seer ratings on cooling and heating units in the 2009 International Energy Conservation Code are higher or the same as that of the Albuquerque Energy Conservation code. Most are higher.	
Efficiency ratings	Energy efficiency ratings for heating units are the same or slightly higher in the 2009 International Energy Conservation Code	
Duct insulation	R-8	R-5 unless ducts located outside then R-8
Service Water Heating		
Pipe insulation circulating	R-4 for 2" or less R-6 for more than 2"	1" having a conductivity not exceeding 0.27 BTU per inch/hXft²X°F
Pipe insulation non-circulating	The first 8' of piping insulate with R-4 for 2" or less R-6 for more than 2"	The first 8' of piping insulate with .5" having a conductivity not exceeding 0.27 BTU per inch/hXft²X°F
Pool heaters energy source	Solar collectors	None
Pool controls	Time switch that can turn off heater w/o adjusting the t-stat	Time switch that can turn off heater and pumps according to a preset schedule
Electrical		
Lighting controls	Required in offices less than 250 sq. ft., classrooms and lecture halls, non-sales rooms in retail buildings, warehouses and self-storage buildings, lecture, training, or vocational rooms less than 1000 sq ft., employee lunch and break room, rooms used for document copying and printing, restrooms, dressing, locker and fitting rooms, storage and supply rooms less than 1000 sq. ft., multipurpose rooms less than 1000 sq. ft., conference and meeting rooms less than 1000 sq. ft. located in hotels or convention centers (must be manual on-automatic off type except in public corridors and stairwells, restrooms, primary building entrance areas and lobbies, or areas where it might be unsafe) exceptions: spaces with multi-scene lighting controls, shop and laboratory classrooms, where unsafe, & lighting required for 24-hour operation	Automatic lighting shutoff for buildings larger than 5000 sq. ft. except in sleeping units, patient care areas, or where it would be unsafe

Albuquerque Energy Conservation Code		2009 International Energy Conservation Code	
Interior Lighting Power Allowances (505.5.2)		Interior Lighting Power Allowances (505.5.2)	
Building Area Type	**Lighting Power Density (W/ft² Maximum)**	**Building Area Type**	**W/ft²**
Automotive Facility	0.80	Automotive Facility	0.90
Convention Center	1.10	Convention Center	1.20
Court House	1.10	Court House	1.20
Dining: Bar Lounge/Leisure	1.20	Dining: Bar Lounge/Leisure	1.30
Dining: Cafeteria/Fast Food	1.30	Dining: Cafeteria/Fast Food	1.40
Dining: Family	1.44	Dining: Family	1.60
Dormitory	0.90	Dormitory	1.00
Exercise Center	0.90	Exercise Center	1.00
Gymnasium	1.00	Gymnasium	1.10
Health Care Clinic	0.90	Health Care Clinic	1.00
Hospital	1.10	Hospital	1.20
Hotel	0.90	Hotel	1.00
Library	1.20	Library	1.30
Manufacturing Facility	1.20	Manufacturing Facility	1.30
Motel	0.90	Motel	1.00
Motion Picture Theater	1.10	Motion Picture Theater	1.20
Multifamily	0.63	Multifamily	0.70
Museum	1.00	Museum	1.10
Office	0.90	Office	1.00
Parking Garage	0.27	Parking Garage	0.30
Penitentiary	0.90	Penitentiary	1.00
Performing Arts	1.44	Performing Arts	1.60
Police/Fire Station	0.90	Police/Fire Station	1.00
Post Office	1.00	Post Office	1.10
Religious Building	1.20	Religious Building	1.30
Retail	1.30	Retail	1.50
Additional LPD for adjustable lighting equipment that is specifically designed and directed to highlight merchandise and is automatically controlled separately from the general lighting	0.4 (spaces not listed below) 0.6 (sporting goods & small electronics 0.9 (furniture, clothing, cosmetics, and artwork0 1.5 (jewelry, crystal, china)	n/a	n/a
Sources	Halogen IR or CMH	n/a	
Schools/University	0.90	Schools/University	1.20
Sports Arena	1.00	Sports Arena	1.10
Town Hall	1.00	Town Hall	1.10
Transportation	0.90	Transportation	0.80
Warehouse		**Warehouse**	0.80
Bulky and Self-Storage	0.60	n/a	n/a
Fine Storage	0.85	n/a	n/a
Workshop	1.26	Workshop	1.40

2009 International Energy Conservation Code Exterior Lighting Requirements

		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance may be used in tradable or non-tradable surfaces.)		500 W	600 W	750 W	1300W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft²	0.06 W/ft²	0.10 W/ft²	.13 W/ft²
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas, special feature areas	0.14 W/ft²	0.14 W/ft²	0.16 W/ft²	0.2 W/ft²
	Stairways	0.75 W/ft²	1.0 W/ft²	1.0 W/ft²	1.0 W/ft²
	Pedestrian tunnels	0.15 W/ft²	0.15 W/ft²	0.2 W/ft²	0.3 W/ft²
	Building Entrances and Exits				
	Main Entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft²	0.25 W/ft²	0.4 W/ft²	0.4 W/ft²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft²	0.6 W/ft²	0.8 W/ft²	1.0 W/ft²
	Outdoor Sales				
	Open area (including vehicle sales lots)	0.25 W/ft²	0.25 W/ft²	0.5 W/ft²	0.7 W/ft²
	Street frontage for vehicle sales lots in addition to "open area" allowance	no allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
Nontradable surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	no allowance	0.1 W/ft² for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft² for each illuminated wall or surface or 3.5 W/linear foot for each illuminated wall or surface length	0.2 W/ft² for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM location	270 W per location plus 90 W per additional ATM location	270 W per location plus 90 W per additional ATM location	270 W per location plus 90 W per additional ATM location
	Entrances and gatehouse inspection stations at guarded facilities	0.75/ft² of covered and uncovered areas	0.75/ft² of covered and uncovered areas	0.75/ft² of covered and uncovered areas	0.75/ft² of covered and uncovered areas
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of covered and uncovered areas	0.5 W/ft² of covered and uncovered areas	0.5 W/ft² of covered and uncovered areas	0.5 W/ft² of covered and uncovered areas
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking ear 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

Table 505.6.2. Table 505.6.2 of the 2006 International Energy Conservation Code is replaced by Table 505.6.2 of this code.

TABLE 505.6.2
LIGHTING POWER DENSITIES FOR BUILDING EXTERIORS

APPLICATIONS	LIGHTING POWER DENSITIES
Tradable Surfaces (Lighting Power Densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded.)	
Uncovered Parking Areas	
Parking Lots and Drives	0.13 W/ft^2
Building Grounds	
Walkways less than 10 feet wide	1.0 watts/linear foot
Walkways 10 feet wide or greater, plaza areas and special feature areas	0.2 W/ft^2
Stairways	1.0 W/ft^2
Buildings Entrances and Exits	
Main Entries	30 watts/linear foot of door width
Other Doors	20 watts/linear foot of door width
Canopies (free-standing and attached) and Overhangs	
General	1.25 W/ft^2
Warehouses and self-storage buildings	0.5 W/ft^2
Entry Canopies	0.4 W/ft^2
Sales Canopies	1.0 W/ft^2
Outdoor Sales	
Open Areas (including vehicle sales lots)	0.5 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	20 watts per linear foot
Nontradable Surfaces (Lighting Power Density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building Facades	0.2 W/ft^2 for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft^2 of covered and uncovered area
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft^2 of covered and uncovered area
Drive-up windows at fast food restaurants	400 watts per drive-through
Parking near 24-hour retail entrances	800 watts per main entry

SECTION 3

IMPACTED COMMUNITY COMMENTS ON THE 2009 ALBUQUERQUE ENERGY CONSERVATION CODE AND 2009 INTERNATIONAL ENERGY CONSERVATION CODE

New Mexico Regulation and Licensing Department
CONSTRUCTION INDUSTRIES DIVISION
2550 Cerrillos Road • Santa Fe, NM 87505 • (505) 476-4700 • Fax (505) 476-4685
5200 Oakland Ave. NE • Albuquerque, NM 87113 • (505) 222-9800 • Fax (505) 765-5670
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www.rld.state.nm.us/cid

Susana Martinez
GOVERNOR

J. Dee Dennis Jr.
SUPERINTENDENT

Mary Kay Root
DEPUTY
SUPERINTENDENT

Richard W. Tavelli
DIRECTOR

November 8, 2011

Don Harris, President
Albuquerque City Council
One Civic Plaza
Albuquerque, NM 87102

Dear President Harris,

In response to the Recovery Act, funded by the U.S. Department of Energy, the State of New Mexico sent a letter of assurance regarding energy code adoption to the Secretary of Energy. On June 10, 2011, the New Mexico Construction Industries Commission adopted the 2009 New Mexico Energy Conservation Code (NMECC) meeting the Recovery Act's mandate for funding. Adoption of 2009 NMECC is an important first step to advancing the energy performance of newly constructed and renovated buildings across the state.

The NMECC is equivalent to the 2009 International Energy Conservation Code1 (2009 IECC) for residential buildings and the ANSI/ASHRAE/IESNA Standard 90.1–2007 (90.1-2007) for commercial buildings, and has state amendments. With adoption of the 2009 NMECC, New Mexico is dedicated to following up on the Recovery Act commitment. Additionally, and to remain in compliance with the Recovery Act assurance, the state must prove a path to achieve 90% compliance with the established target codes within eight years, or by 2017.

As per statute, the Construction Industries Division (CID) of New Mexico adopts statewide energy codes that serve as the minimum standard of performance. Local jurisdictions that are short on capacity for implementation and enforcement of the energy code defer to CID for these services. Under this model, consistent code implementation and enforcement of the current energy codes occur. However, building divisions with their own energy codes pose a difficult obstacle to achieving 90% energy code compliance with the 2009 New Mexico Energy Conservation Code (NMECC).

As a Recovery Act funds recipient, New Mexico works with the U.S. Department of Energy (DOE) and its Building Energy Codes Program (BECP) to create a detailed set of procedures that will help with measuring and reporting rates of compliance. This includes checklists for gathering information in determination of 90% compliance for both commercial and residential buildings. These check lists are based specifically on the 2009 IECC for residential, and the ANSI/ASHRAE/IESNA Standard 90.1–2007 (90.1-2007) for commercial buildings. Differing codes would not be consistent with these checklists. In areas of the highest construction activity, like Albuquerque, this could create difficulty for the state's procedures in proving 90% compliance. Additionally, the Albuquerque Energy Conservation Code is based

Alcohol and Gaming Division
(505) 476-4875

oards and Commissions Division
(505) 476-4600

Construction Industries Division
(505) 476-4700

Financial Institutions Division
(505) 476-4885

Manufactured Housing Division
(505) 476-4770

Securities Division
(505) 476-4580

Administrative Services Division
(505) 476-4800

on the 2006 IECC, with enhancements, and is not comparable to the checklists used for compliance measurements.

There are benefits, beyond meeting the DOE 90% compliance mandate, to a uniform statewide building code. Training and related support programs can facilitate code compliance and an annual measurement of the rate of compliance. Following the successful adoption of the 2009 NMECC, the state's efforts are now focused on training the professionals within the construction industry to gain familiarity with the code components. The state has developed a training system that works. CID offers certified trainings throughout the year for staff and makes the training available to local governments not covered by CID. Training sessions are most often scheduled near population centers such as Albuquerque, Las Cruces, Santa Fe, and Farmington. This is to the benefit of all local jurisdictions who adopt the state's building code for their minimum standard.

The State of New Mexico and the Construction Industries Division encourages all local jurisdictions, even those with full service building departments, to adopt the 2009 NMECC. This is the best way for the state to accurately measure its 90% compliance mandate from the DOE while sharing resources and information statewide.

Sincerely,

Richard Wm. Tavelli
Director
State of New Mexico
Regulations and Licensing Department
Construction Industries Division
and
Manufactured Housing Division

cc/ via email:
Mayor Richard J. Berry
Councilor Sanchez
Councilor O'Malley
Councilor Benton
Councilor Winter
Councilor Lewis
Councilor Gardūno, Vice President
Councilor Cook
Councilor Jones

County of Bernalillo

State of New Mexico

ONE CIVIC PLAZA N.W. 10th FLOOR
ALBUQUERQUE, NEW MEXICO 87102
ADMINISTRATION 505-468-7000
FAX 505-462-9813

December 2, 2011

HAND DELIVERED

The Honorable Don Harris, President
Albuquerque City Council
One Civic Plaza NW, 9th Floor
Albuquerque, NM 87102

Dear Councilor Harris:

I understand that you and the City Council recently received a letter from Mr. Sanford Fish regarding Council Bill O-11-65, adopting the 2009 International Energy Conservation Code (IECC) for the City of Albuquerque. The letter does not speak for the County or the Board of County Commissioners; I apologize for any confusion that may have resulted.

While staff is encouraged to interact and speak freely with various agencies, and share knowledge and experience toward the common benefit for the citizens of Bernalillo County, any official statements regarding policy or other matters affecting the County, will come directly from the Board of County Commissioners or from me. Please do not hesitate to contact me at 468-7164 should you have any questions or concerns.

Sincerely,

Tom Zdunek
County Manager

Cc: City Council
Board of County Commissioners

SUMMARY OF NAIOP COMMENTS

Suggested Changes to the Albuquerque Energy Conservation Code (AECC) submitted by members of NAIOP, the Commercial Real Estate Development Association- New Mexico Chapter – Summarized by Council staff. Complete comments provided in Appendix.

Chapter 2- Definitions

The definitions of Substantial Alteration and Work Area are not referred to in the text of the 2009 AECC, which causes confusion when interpreting the requirements for existing buildings.

Section 101.6.2- Historic Buildings

The definition of Historic Buildings should include "Buildings of Note", existing adobe structures that are not considered historic, per se, but are examples of lost construction arts and craftsmanship.

Section 101.6.4- Change in Occupancy

The definition of Change in Occupancy focuses on a change in energy use, and not a change in the occupancy classification. This causes confusion in interpretation and may result in major cost issues and legal liability issues for multi-tenant buildings leases. Under this definition, the AECC requires bringing a whole building into compliance if the change requires one more watt of energy use. Also, changes would be required in tenanted/occupied areas and may not comply with the original lease agreements.

Section 101.7.2- Low Energy Buildings Exemption #1

The threshold is set too low for warehouses, factories and other industrial buildings that are cooled with evaporative equipment and whose use requires doors, bays and windows to be left open as part of normal business operations (such as Jiffy Lube). The requirements would result in excessive cost to businesses and may kick Albuquerque out of competitive mode.

Table 502.2 (1)- Building Envelope Requirements- Opaque Assemblies

The specifications in the table require steel frame buildings to be wrapped in exterior insulation. This restricts the treatment of exterior walls to a limited number of systems and increases costs.

Table 502.3- Building Envelope Requirements- Fenestration

The specification for a minimum Projection Factor (PF) of 0.5 may require overhangs/awnings of 3 feet deep over all windows resulting in cost, structural and aesthetic issues. The overhangs are not compatible with territorial or pueblo style buildings.

Products that comply with the U Values prescribed in the table are costly and difficult to procure and install.

Section 502.3.3- Warehouses and Factories (Skylights)

The requirement prescribes a minimum spacing for skylights in warehouses and factories, with centering of racking/shelf systems between skylights. This is a problem for companies with limited specifications on spacing.

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Suggested Changes to the Albuquerque Energy Conservation Code (AECC) submitted by members of NAIOP, the Commercial Real Estate Development Association- New Mexico Chapter – Summarized by Council staff. Complete comments provided in Appendix.

Section 502.6- Reflectivity

Compliance with the requirements is difficult to calculate and document because data on light reflectance of interior materials is not available from manufacturers. It is also very limiting as to what materials and colors can be used. Enforcement is also difficult , as owners may repaint with a non-reflective color after the initial inspection is complete. Reflectance has nothing to do with energy savings (watts/ sq ft).

Section 503.1.2- Prohibited Installations

The section prohibits installation of electric-resistance heating systems with a few exceptions. It should be modified to permit broader selections for optional sources of energy.

Section 503.2.7- Duct and Plenum Insulation and Sealing

As written, the requirements of this section may discourage retrofits. Clarification is needed for the applicability to Tenant Improvements, Remodels or Restorations. For example, for a remodel in which some of the ducts or HVAC system are being replaced, then all the ducts in the existing building or within the space would need to be insulated with higher grade insulation.

Section 504.7.1- Pools

This section limits the primary source of energy for swimming pool heating to solar collectors. There are several alternatives to heating pools using heat recovery systems and other options that are not considered by the AECC.

Section 505.2.2.2.3- Occupancy Sensor Controls

The requirement for occupancy sensors for interior lighting results in added expense. There is conflicting scientific documentation that the installation saves a significant amount of energy in relation to cost. At a minimum, Offices should be removed from the list of room types and clarification is needed for the term "multi-scene light control systems".

Section 505.2.2.2.6 – 505.2.2.2.6.2- Daylight harvesting in warehouses and factories

This section requires a system for automatic controls for dimming or multi-level controls. This section also prescribes the limit of combined day-lighting and artificial lighting to 1.2 times the designed light level. This section is too prescriptive because it considers only electric energy usage. The requirement for skylights will affect the heating and cooling loads and it is not clear that the energy savings are real. The cost of installation and maintenance of these dimming devices is considerable, and the payback period has not been researched.

The requirement for a 1-minute fade is much too fast and will be detected by the most casual observer.

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The requirement for 2-lamp ballasts makes it difficult to achieve the 66% and 33% light levels also prescribed in this section. Requiring 2-lamp ballasts for luminaires may also eliminate the use of 3-lamp, 6-lamp, 8-lamp or 10-lamp luminaires.

Section 505.5.1.4- Linear Florescent Lamps

The requirements do not include T5 lamps and some other types of linear lamps that are becoming or will become available, thereby providing more options and price points for consumers.

Table 505.5.2- Interior Lighting Power Allowances

The requirements of this table are in conflict with nationally recommended standards and best practices. Most of the AECC requirements are too low and do not meet the standards for schools, health care facilities, and manufacturing areas as suggested by The Society of Illumination Engineers and the North American Illuminating Engineering Society .

Table 505.6.2- Lighting Power Densities for Building Exteriors

The requirements of this table raise public safety issues and are conflict with best practices. The method of measuring lighting for parking areas used by the AECC (watts/ sq. ft.) does not take into account the uniformity ratio. The result could be parking areas with real bright and real low spots. It would also not meet the lighting levels required for video surveillance systems in parking areas monitored to control crime. Uniformity ratio is as important as foot candles (FC) when evaluating parking/roadway lighting. Meeting the AECC requirements would provide lighting at almost double the recommended uniformity ration or half of the foot candles as recommended by the Illuminating Engineering Society of North America .

Section 506.1- General (Total Building Performance)

Option (b) for compliance via the performance path requires "the annual energy costs of the proposed design are 30% less than a standard design complying with the unamended minimum requirements of the 2006 International Energy Conservation Code." This option would no longer be necessary if the new base Code was modified to be the 2009 International Energy Conservation Code and the additional energy efficiency would be automatically built into the remaining performance option. Option (b) appears to be a hold-over from the first version of the ABQ Code when the City was still on the 2000 International Energy Code.

Table 502.2 (2)- Metal Building Assembly Descriptions

The requirements in this table should be more performance based than prescriptive. In discussions with our Metal Building installers, it became evident that the methods described here are contrary to their approach, but the results are the same.

NAIOP Statement on why the Performance Path does not resolve the issues with the AECC vs. IECC.

The performance path for commercial construction in the AECC does provide more flexibility allowing a builder/architect/engineer to use other means to reach the required energy savings. However, it creates other kinds of costs and hurdles.

1. Typically, buildings that can efficiently use a performance path are new construction or ground-up remodels of larger commercial projects. The performance path requires that the contractor/architect/engineer must prove that sufficient energy savings will result from the chosen types of materials and construction techniques, consultants must be hired to model the procedures, the materials and the equipment.

   Most buildings in our region are 40,000 square feet or less, and normally use the prescriptive path to avoid the added costs of energy consultants, and other professionals. An energy consultant normally costs a minimum of $40,000 plus the added costs to the contractor or architect to gather all the information needed to provide to the consultant. The cost for the latter usually runs an additional $40,000. On an average size building of 40,000 square feet, that's $2.00 per square foot in consultant costs alone, not including any added construction costs. None of the $2.00 in consultant costs is offset by energy savings.

   In addition, the performance path puts a pretty big "fudge factor" in preliminary budgeting and planning, since you don't really know what a building will cost until AFTER it is engineered. In today's market that is just one more "unknown" that stops people / banks from pulling the trigger on a project.

   For industrial buildings such as distribution warehouses and many types of manufacturing, use of the performance path would not be of help because they are typically low energy buildings anyway, and achieving a substantial energy savings over normal baseline would not be possible, thus pushing these buildings automatically into the prescriptive path.

   Finally, even the performance path requires certain construction procedures that create additional labor costs with no corresponding increase in energy savings (such as tilt-up or CMU construction) and/or equipment that is costlier than commonly used as in the lighting requirements.

2. It is definitely more expensive to use the performance path in remodels since you cannot take advantage of all of the efficiencies of new construction and so must use the prescriptive path which triggers all of the problems in the code. Here is a recent, real-life example that is typical of many Albuquerque remodels.

   The building is constructed from un-insulated concrete block and has little insulation on the roof. The client wanted to transform this warehouse into a document destruction and scanning facility. Since they were using a federal grant, they had limited funds ($20 per square feet) to renovate the building.

NAIOP Statement on Why the Performance Path Does Not Resolve the Issues with the AECC vs. IECC.

The 2009 Albuquerque Energy Conservation Code (09-AECC) requires not only that the building be insulated, but that the insulation be applied in a (post construction) expensive continuous insulation application. The 09-AECC requires that a layer of continuous board insulation be applied to the entire interior surface of the warehouse, then a stud wall built and also insulated and dry walled. The 09-AECC also requires that a high number of skylights be installed in the warehouse area, such that most of the day lighting is sourced from the sun. A lighting sensing and control system is also required which will not allow artificial lighting to be utilized if the room is bright enough from the skylight source. In a nutshell, the AECC is making the realization of this and similar job creating projects impossible. The estimated cost of this remodel, based on this code, would be at least $40 per square foot above their $20 per square foot budget.

Using the performance path would not solve their cost problems, since they would incur even more costs in consultant fees.

3. In short, keeping the AECC and always going with the performance path does not solve the major issues:
   a. The AECC performance path is expensive and not readily usable for small commercial buildings or remodels.
   b. The AECC performance path still makes Albuquerque an uncompetitive island, discouraging job creation by relocating and expanding companies who can build more cost competitively outside the City of Albuquerque or in other states.
   c. The AECC performance path does not allow companies to take advantage of cost efficiencies by using the same code across jurisdictions.

Finally, it should be noted that the added costs of the performance path are not costs to the contractor/engineer/architect. They are costs to the end user either in terms of the cost of a new building or in lease payments for the industrial, office or retail space. Costs, like taxes, are passed on to the consumer. If the costs become too high for the consumer, the building is not built and the office is not leased.

NEW MEXICO HOME BUILDERS ASSOCIATION COMMENTS

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
RESIDENTIAL	Advantages	Disadvantages	Advantages	Disadvantages
Duct Leakage Test	Similar requirement		Similar requirement	
Wood Frame Wall R-value	Higher R Value	Uses more wood (Deforestation) in 2x6 application, Continuous application untested in this market on a large scale.	Inline – with surrounding municipalities. Allows for plan reuse, less waste.	
Skylights/ Low-e glass	Similar requirement		Similar requirement	
Frame Wall U factor				
Lighting Fixtures		Forces customer to use 2 pin fluorescent. Obsolete and does not upgrade to LED. Limited availability and expensive.	Allows builders to use best choices for efficient lighting.	
Fans		Bath Fans? – causes conflict for builders complying with ashrae 62.2 and estar.		

Roof Reflectance		Minimal impact to efficiency. Not appropriate for this climate zone. Expensive.		
GENERAL	Advantages	Disadvantages	Advantages	Disadvantages
		Disqualifies builders from taking advantage of Utility Rebates for Estar!!	Allows additional incentives for builders that build efficient homes.	
		Requires builders to reference 3 separate codes for compliance.	Compatible with state code.	
		Limits industry's ability to adapt to improvements in efficiency.	Allows industry to use joint training programs for the work force.	
		Increases liability for local businesses trying to comply with multiple code volumes.	Reduces city training costs for inspectors and plan checkers.	
			Streamlines City's position for future code updates.	

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White Paper
Albuquerque Energy Conservation Code

Good evening Mr. President and Councilmember's, my name is Chuck Sheldon. I am handing out a document that exemplifies the properties I have worked on for the City of Albuquerque, under the Neighborhood Stabilization Program. These properties are largely in the Trumbull –LaMesa Neighborhoods. I believe that many of you have already seen these buildings, but just to make sure, I have included them. I am here tonight as an advocate for saving energy and have worked to do so as evidenced by the projects we have done to date and continue to renovate.

However, I am not able to support The Albuquerque Enhanced Energy Conservation Code as written, and our objections center on the impact of Rehabilitating, altering, and repairing of older properties:

From our experience with the code, it seems evident that a clear and realistic path to compliance for renovation and retrofit of existing multifamily properties is not readily achievable. Far worse, the code encourages the least investment in energy efficiency improvements while penalizing all efforts to improve the building. For example, the code would allow us to replace existing systems one for one, but if we make the effort to improve the system to any degree we are faced with the full impact of new construction. There is no median ground. This is especially troublesome for existing buildings, which are all electric. This is where the AECC deviates substantially from the International Codes:

1. In a situation where the existing electrical heating system is being replaced, the AECC provides only two options: First is a heat pump. Heat pump systems are effective only a percentage of time given the Albuquerque Climate. In the times when the system is not effective, it requires a much greater utility cost, which creates peaks in the monthly billing. Low income families are not prepared for utility costs that can swing more than 200%. Efforts to increase the envelope and make the system more efficient help only to the degree that the system can be made smaller. They cannot increase the effectiveness of the system when the outdoor climate is not conducive to the system type. The second option under the AECC would be to include a solar plant on the building, which is capable of producing the full electrical load required by the building. This is financially

unrealistic, as the energy cost saving does not pay for the equipment during it's life cycle.

2. Older multifamily residential buildings were constructed with little thermal capacity in the exterior envelope. If a developer seeks to decrease energy loss in the building, improving the envelope can substantially reduce utility costs. Reframing the exterior walls is generally not cost effective, and since most multifamily buildings were constructed with 2x4 wood studs, the existing structure will dictate the full thermal resistance of the envelope system. Relative to the replacement of electrical heating equipment, this means that that any possibility for alternate compliance through the performance based measures of the AECC are effectively impossible. In order for a "highly efficient" unit using electric resistance heating to meet the performance-based measures of the AECC, it would require sub grade excavation and insulation of the existing foundation stem walls and slabs. In renovation and retrofit, this is often impossible and where it could be completed, it could lead to future structural problems.
3. Rehabilitation efforts made to increase the efficiency of a multifamily unit are not encouraged in the AECC. Instead of extending the performance, based alternative to describe a performance increase over the EXISTING building, the AECC only recognizes improvements made over a CODE described building. For purposes of an all-electric building, this means that in order to be deemed a compliant solution; the existing building MUST perform 30% better than a NEW building. This argument defies logic. Why should an existing building be made to perform 30% better than a new building if it uses electrical heat? This is neither logical nor feasible.
4. One of the fundamental challenges with the AECC is that it reclassifies multifamily development into commercial construction. This is a dramatic deviation from the International codes, and breaks convention with all other industry organizations. Even the USGBC in the creation of their LEED programs have differentiated multifamily construction from commercial construction. Multifamily is classified under LEED for HOMES. Where Albuquerque deviates from the rest of the Nation, this creates confusion for equipment suppliers as well as engineers. When a system is legal and code compliant throughout the State of New Mexico, (and in the remainder of the U.S.) but illegal in Albuquerque logistical problems do occur. In our projects, this inherent reality of the AECC has created confusion and frustration, and added costs. Ultimately, it is more expensive to build and rehab units in Albuquerque.
5. The AECC has a clear bias towards GAS fuels for heating. While it is true that gas currently costs less than electricity, there is no guaranty that this will be the case in the future. With global pressure to reduce carbon emissions and the rising costs of fossil fuel extraction, along with the desire to convert to cleaner and greener energy generation methods, REQUIRING ALL Mechanical Systems in the City of Albuquerque to be GAS Fired limits creativity to meet specific requirements.

In Conclusion; The code as written limits the repair and reconstruction of existing building, and increases costs of the elderly people trying to replace their heating systems, and improve the functionality of there homes. It also affects contractors and investors trying to put sub-standard, closed down buildings back into service.

Your consideration of over-turning The AECC and fully implementing the IECC would simplify and clarify the process to upgrading and repairing our older stock of apartments and homes in Albuquerque.

I have a specific example of a project that you are all aware of in the Atrisco project that had gas wall furnaces, which we were planning to replace these out of date systems with electric forced air systems. We also increased the envelope to R-17, and the ceilings to R-38. Now, we were required to spend an additional $48,000 to install "Heat Pumps" due to the code, and not improve efficiency of the heating system. The push is for us to spend $160,000 more to reinstall gas-heating systems. As this is, a city project funding for additional requirements is not as daunting as for those in private business. That is one reason these buildings continue to go un-repaired, unsold or just painted over, resulting in very poor substandard housing for the working poor.

Thanks you for your consideration.

Charles V. Sheldon, CCIM, MBA

Supplemental Information

1. **Comparisons of <u>energy conservation savings</u>** between the 2009 Albuquerque Energy Conservation Code (09-AECC) and the 2009 International Energy Conservation Code (09-IECC that was recently adopted by the State of NM.)
   a. See **Attachment A** with comparisons between the two codes in major categories.

The 09-AECC was a revision of the 07-AECC that was challenged in court due to HVAC requirements which violated national standards. The Energy Conservation efficiencies in the 07-AECC were modeled by a third-party, private-sector company. In the 09-AECC, the HVAC requirements were rolled back to base 06-IECC standards, and the energy efficiencies were supposedly made up primarily in the envelope (more insulation) and in the lighting standards (10% lower than the 06-IECC).

NOTE: **No third-party, private sector modeling was done on the 09-AECC. Hence, there is no third-party verification that the 09-AECC achieves a 30% improvement over base 06-IECC.**

Talking Point: It is the consensus of engineers, contractors and architects who reviewed the attached comparisons, that 09-AECC and 09-IECC are comparable in terms of energy conservation savings for commercial buildings.
In addition, by adopting the most recent version of the IECC (09-IECC) rather than continuing to use the 09-AECC (which is based on the outdated 06-IECC), contractors, engineers, and owners are allowed to take advantage of the increases in efficiency, updates, clarifications, and lessons learned since the 2006 IECC was published.

Examples:

- 09-IECC has higher energy saving requirements in terms of **Air Conditioner Efficiency** (i.e. a 13 SEER as opposed to a 10 SEER).
- 09-AECC has higher requirements in terms of some types of insulation, but not significantly higher (i.e. **Roof Insulation**: R-25 insulation in the 09-AECC vs. R-20 in the 09-IECC).
- 09-AECC has more stringent requirements in terms of **Interior Lighting Power Allowances** (10% less than 06-IECC for all buildings types, all sizes). However, it should be noted that this blanket requirement has caused problems in terms of specific needs for certain types of buildings such as medical facilities and areas needing security video coverage. The result is that supplemental task lighting is often added which negates some of the energy savings.
- In terms of **Gas Furnace Efficiency** and **Water Heater Efficiency**, the two codes are the same.
- For **metal framed construction** the 09-AECC requires a wall construction with R19 batt insulation with 5" continuous insulation on the exterior. The 2009 IECC allows a wall construction of R13 batt with 7.5" of continuous insulation, resulting in a wall insulation system that is comparable in terms of energy conservation savings.

COMPARATIVE ANALYSIS OF 2009 ALBUQUERQUE ENERGY CONSERVATION CODE – VOL. I COMMERCIAL AND MULTI-FAMILY RESIDENTIAL and 2009 INTERNATIONAL ENERGY CONSERVATION CODE

BUILDING ENVELOPE - PRESCRIPTIVE

<u>Wall Insulation</u>

2009 Albuquerque Energy Conservation Code:

- R-21 (wood studs)
- R-19 + R-5 c.i. (steel studs)
- R-12.5 c.i. (Mass Wall)

2009 International Energy Conservation Code:

- R-13 (wood studs)
- R-13 + R-7.5 c.i. (steel studs)
- R-9.5 c.i. (Mass Wall)

<u>Roof Insulation</u>

2009 Albuquerque Energy Conservation Code:

- R-38 (insulation in attic)
- R-25 (insulation entirely above roof deck)

2009 International Energy Conservation Code:

- R-38 (insulation in attic)
- R-20 (insulation entirely above roof deck)

<u>Roof Reflectance</u>

2009 Albuquerque Energy Conservation Code:

- 0.65 (low slope roofs, initial reflectance)
- 0.25 (steep slope roofs, initial reflectance)

2009 International Energy Conservation Code:

- No requirement

<u>Vertical Glazing – Thermal Transmittance</u>

2009 Albuquerque Energy Conservation Code:

- Maximum U-factor = 0.42

2009 International Energy Conservation Code:

- Maximum U-factor = 0.50

<u>Vertical Glazing – Solar Heat Gain Coefficient (SHGC)</u>

2009 Albuquerque Energy Conservation Code:

- Maximum SHGC = 0.38

2009 International Energy Conservation Code:

- No requirement if PF > 0.25
- Maximum SHGC = 0.40 if PF < 0.25

Vertical Glazing – Projection Factor (PF)

2009 Albuquerque Energy Conservation Code:

- Minimum PF = 0.5 (S, E, & W orientations)

2009 International Energy Conservation Code:

- No requirement

Reflectance of Interior Surface

2009 Albuquerque Energy Conservation Code:

- Minimum ceiling reflectance = 70%
- Minimum ceiling reflectance – exposed ducts/structure = 80%
- Minimum wall reflectance – above 7 ft. = 70%
- Minimum wall reflectance – below 7 ft. = 50%

2009 International Energy Conservation Code:

- No requirement

MECHANICAL SYSTEMS AND WATER HEATING - PRESCRIPTIVE

Gas Furnace Efficiency

2009 Albuquerque Energy Conservation Code:

- No amended requirement (defaults to 2006 International Energy Conservation Code)
- Electric-resistance heating systems prohibited (with exceptions)
- (2006 International Energy Conservation Code:
  78% AFUE < 225,000 Btu/h < 225,000 Btu/h (defaults to NAECA)
- National Appliance Energy Conservation Act (NAECA):
  80% AFUE < 225,000 Btu/h

2009 International Energy Conservation Code:

- 78% AFUE < 225,000 Btu/h
- 80% E_t < 225,000 Btu/h

Air Conditioner Efficiency

2009 Albuquerque Energy Conservation Code:

- No amended requirement (defaults to 2006 International Energy Conservation Code)
- 2006 International Energy Conservation Code:
  10 SEER < 65,000 Btu/h (defaults to NAECA)

2009 International Energy Conservation Code:

- 13 SEER < 65,000 Btu/h (additional requirements by size category)

Water Heater Efficiency

2009 Albuquerque Energy Conservation Code:

- No amended requirement (defaults to 2006 International Energy Conservation Code)
- 2006 International Energy Conservation Code:
  80% Et (gas storage)

2009 International Energy Conservation Code:

- 80% Et (gas storage)

ELECTRICAL LIGHTING - PRESCRIPTIVE

Interior Lighting Power Allowances

2009 Albuquerque Energy Conservation Code:

- 10% less than 2006 International Energy Conservation Code (all building types, all sizes)

2009 International Energy Conservation Code:

- Same as 2006 International Energy Conservation Code

Occupancy Sensor Controls

2009 Albuquerque Energy Conservation Code:

- Required in most rooms of all building types and sizes

2009 International Energy Conservation Code:

- No similar requirement

Daylight Harvesting

2009 Albuquerque Energy Conservation Code:

- Required in factories and warehouses > 8,000 sf. -5% of gross roof area

2009 International Energy Conservation Code:

- No requirement

TOTAL BUILDING PERFORMANCE

2009 Albuquerque Energy Conservation Code

- Required improvement over baseline: 30% **(No energy conservation modeling done to support this percentage.)**
- Baseline: 2006 International Energy Conservation Code

2. **Comparison of construction costs between the 09-AECC and the 09-IECC for two model buildings.**
   a. See **Attachment B** with breakdown of costs for each of the codes for two model buildings.

Local contractors, engineers and architects created a construction cost comparison on 2 hypothetical commercial buildings, using both the 09-AECC and the 09-IECC. Even though the energy conservation savings are comparable between the two codes, the cost comparison reveals significant differences in costs to build to the 2 codes.

A 25,000 square-foot warehouse, costs **$91,180.54 more to build on the 09-AECC** than on the 09-IECC. A 25,000 square-foot office building costs **$160,727.94 more to build on the 09-AECC** than the 09-IECC. This has significant implications for job creation and competitiveness with surrounding municipalities.

A 25,000 square-foot warehouse or factory, using a Concrete Tilt or a CMU (Mass Wall)

Total Increased Cost of the 09-AECC over the 09-IECC:	**$91,180.54**
Per Square Foot Increase	**$ 3.65**

A 25,000 square-foot office building, steel framed

Total Increase Cost of the 09-AECC over the 09-IECC:	**$160,727.94**
Per Square Foot Increase	**$ 6.43**

These costs are compounded when looked at in terms of a typical 10-year lease agreement in which a standard 2 cent increase, per square foot, is added for each year of the agreement. If the AECC-09 costs are used as the baseline, the following **<u>additional costs</u>** would accrue to the business leasee:

Year	Lease Annually PSF $	Lease Annually Total $
1	0.64	$16,073
2	0.66	$16,555
3	0.68	$17,052
4	0.70	$17,563
5	0.72	$18,090
6	0.75	$18,633
7	0.77	$19,192
8	0.79	$19,768
9	0.81	$20,361
10	0.84	$20,971
	Ten Year Sum	**$184,257**

3. Problems inherent in the 09-AECC.

The development of the International Codes is an intensive, in-depth process that includes thousands of professionals from a variety of disciplines including civil, mechanical, and electrical engineers, architects, contractors and manufacturers.

In the 09-AECC, the City of Albuquerque attempted to increase energy conservation savings by adding requirements to the 2006 International Energy Conservation Code, but without going through this extensive vetting process by outside professionals and without performing any third-party modeling of the enhanced requirements.

The resulting code contains significant problems, both in terms of costs, availability of product, and other unintended consequences. The following examples illustrate a few of these problems.

Vertical Glazing – Projection Factor (PF)
In essence, this mandate requires that a window be recessed into the building or a canopy placed above it, based on ½ the vertical size of the window. So, as in retail buildings, in which an average window is 9 feet tall, the window would have to be recessed into the wall 41/2 feet or a 41/2 foot permanent canopy be placed above the window.
This adds significantly to the cost in both new construction and in remodels, and is a design problem for typical southwestern construction, as well as limiting other design solutions in achieving energy savings.
In terms of most building types with tall windows typical for good day-lighting, this could result in overhangs over 3' deep over all windows, which is a cost issue, structural issue, and aesthetic issue.

Electrical Lighting – Prescriptive
Table 505.6.2:
The requirements are that parking lot lighting densities be 0.13 W/SF. This is not acceptable for any parking lot where there are requirements for video surveillance or other measures to control crime. For example, a lighting level of at least 1 foot-candle is required for video surveillance and it is common to design for 4 to 5 times that amount to actually achieve an overall average lighting level. Some retail facilities may require lighting levels as high as 15 – 40 foot-candles, which is estimated to approximately equate to lighting densities of about 0.5 – 2.0 W/SF.

Using watts / square foot is a very poor method for measurement of lighting for parking areas. This method could cause parking lots to have real bright spots and real dark spots. This causes visual problems with the human eye. Uniformity ratio is as important as foot candles (FC) when evaluating parking/roadway lighting.

Illuminating Engineering Society of North America (IESNA) recommended lighting levels in a high activity general parking and pedestrian area is .9 FC on the pavement with a 4:1 uniformity ratio. Two 140 watt LED light fixtures spaced 10 feet apart will produce .9 FC at a 4:1 uniformity ratio for an area of 1100 square feet. This equals .25 watts/ square feet almost double the .13 Watts/ square foot required by the 09-AECC. Meeting the Albuquerque Code requirements would provide lighting at almost double the recommended uniformity ration or half of the recommended foot candles.

Table 505.5.2:
Most of the 09-AECC lighting requirements are too low. For instance, in the Code chart, schools are .9 watts per square foot which only gets about 30 foot-candles to a desk top surface, using the most efficient light fixtures and lamps on the market today. Children do not carry task lights to school, and learning will be impaired. The Society of Illumination Engineers advises 75 foot-candles in schools.

In addition, the 09-AECC code requires that hospitals have a lighting density of 1.1 watts/square foot. It is difficult to comply with other applicable health care recommendations, codes and standards for medical lighting, such as the North American Illuminating Engineering Society, and still comply with the 09-AECC requirements. Other lighting requirements for manufacturing areas are equally limiting, as well.

Reflectance of Interior Surfaces
The concept is that you use less energy for lighting if the colors are more reflective but the application can not only be difficult or even impossible to document but can also be extremely limiting as to what materials can and can't be used.

Many products are installed using varied techniques. It is almost impossible to calculate a specific reflectivity on hand-applied stains or materials that vary in luster or intensity as part of an artistic application.

Some plan reviewers are requiring data on light reflectance of interior materials such as carpets but the information is not available from manufacturers. In the 09-AECC, flooring shall have a minimum reflectance of 20%. Flooring specifications do not provide LRV information and also some consideration should be taken to prevent glare.

These surface reflectance requirements virtually prohibit feature walls or walls with darker colors such as navy blue, burgundy or forest green. They also prohibit dark or black-colored ceilings. Exposed structure is often painted black to avoid the cost of putting in a ceiling. The light fixtures are mounted lower and provide down light. This design can comply with the mandated energy savings but would not be allowed by this prescriptive requirement.

In short, Reflectance has nothing to do with energy saving (watts / sq ft). It is a visual design element and visual comfort issue. Many materials such as flooring, wall coverings, etc. do not have published data for reflectance.

4. Competiveness with surrounding cities and surrounding states.

Albuquerque is one of the only cities in New Mexico that is not enforcing a base national code for energy conservation. The 09-AECC is not only more expensive in terms of construction of commercial buildings, but is also more problematic in terms of idiosyncratic mandates that are not scientifically supported, hinder the use of alternative energy-saving options, and require materials or equipment that are often hard or impossible to obtain.

Increased construction costs mandated by the 09-AECC makes Albuquerque uncompetitive with surrounding cities or even with unincorporated portions of Bernalillo County. In addition, the 09-AECC creates design problems for national and international companies that build to national standards and have accommodated their standard building design to abide by those standards. Due to corporate policies, they are often unable or unwilling to compromise those designs for one community. Retail stores, including grocery and drug stores, as well as chain restaurants are examples. Due to the downturn in the construction/development industry, we have not seen the true negative effect of this code on our economy and the creation of jobs.

Finally, in terms of the Southwest, the 09-AECC makes Albuquerque uncompetitive with surrounding states and cities. As of May 2011, only Utah, Austin, Phoenix, and the Transportation Department of Colorado had even passed the base 2009 International Energy Conservation Code. None of them added enhanced regulations. We expect other states to eventually adopt the base 09-IECC, but at this point, here is a snapshot of our competitors:

AZ -- State has officially adopted the 2006 IECC, but some of the small towns are still on the 2003 version. Tempe and Tucson are on the 2006.
CO -- State Transportation is on the 2009, but most of the municipalities are on the 2006, including Golden, Greeley, Littleton & Denver. Colorado Springs is on the 2003 IECC.
TX -- State Transportation is on the 2006, with Carrollton, Dallas & Irving complying. Houston & Lubbock are on the 2000 version of the IECC.
UT -- Entire state is on the 2009 IECC (base version, no additions).

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
RESIDENTIAL	Advantages	Disadvantages	Advantages	Disadvantages
Duct Leakage Test	Delivers energy savings of 8% to 10% over 2006 IECC at relatively low cost		Same requirement Same advantages as AECC	Good chance that amendments to 2009 NMECC will water-down or eliminate
Wood Frame Wall R-value: 2009 AECC = R-21 2009 IECC = R-13 2012 IECC = R-20	Delivers increased energy savings with little cost increase. R-21 fits in same wall framing as R-19. Available in all home improvement stores. Tax rebates available for use in existing buildings. Not a mandatory requirement.*			R-13 = 62% less efficient than R-21 (R-values are linear). No increase in R-value or energy savings, from previous energy conservation codes as far back as the 1980's.
Frame Wall U factor	See wall R-value. U is merely the reciprocal of R			
Lighting Fixtures	Same requirement as ENERGY STAR program in 2009. Reduces electricity consumption for lighting by 80%! Tax incentives available to builders of ENERGY STAR qualified homes.	Two simple revisions needed: 1.Revise to correspond with current ENERGY STAR requirements. 2. Change from mandatory to prescriptive requirement.*		Regulates only lamps (bulbs), not the lighting fixture. Unenforceable by building department as high-efficiency lamps can be replaced with incandescent lamps at any time. Energy savings cannot be guaranteed for same reason.

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
RESIDENTIAL	Advantages	Disadvantages	Advantages	Disadvantages
Fans	Same requirement as ENERGY STAR program. 100's of products available. ENERGY STAR ceiling fans just purchased at Lowe's were half the price of similar fans without ENERGY STAR label. Tax incentives available to builders of ENERGY STAR qualified homes. Same requirement in 2012 IECC. Not a mandatory requirement.*			No standard for fans in 2009 IECC.
Roof Reflectance	Same requirement as ENERGY STAR program. 100's of products in a myriad of colors available. Increased electricity savings at very low cost increase. Easiest and least expensive strategy for mitigating the Urban Heat Island Effect. Tax incentives available to builders of ENERGY STAR qualified homes. Not a mandatory requirement.*			No standard for roof reflectance in 2009 IECC.

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
COMMERCIAL	Advantages	Disadvantages	Advantages	Disadvantages
Roofs	Reduces demand for *peak* electricity which increases energy savings geometrically. Very little cost increase if minimal strategies for compliance used. Does not prohibit built-up bitumen (asphalt) roofs. Easiest and least expensive strategy for mitigating the Urban Heat Island Effect. By reducing demand for *peak* electricity from coal-fired plants, external costs that we have internalized (pollution, health-care, acquifer depletion) are reduced. Necessary to achieve 30% savings over 2006 IECC.** Not a mandatory requirement.*.			No standard for roof reflectance in 2009 IECC.
Walls	Conserves energy. Necessary to achieve 30% savings over 2006 IECC. Not a mandatory requirement.* Low energy use buildings not required to comply.			

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
COMMERCIAL	Advantages	Disadvantages	Advantages	Disadvantages
Floors	Requirement for wood- and steel-framed floors identical to 2009 IECC. Minor increase in requirement for mass floors (R-10 to R-12.5). Necessary to achieve 30% savings over 2006 IECC.** Not a mandatory requirement.* Low energy use buildings not required to comply.			
Slabs	Conserves energy. Necessary to achieve 30% savings over 2006 IECC.** Not a mandatory requirement.* Low energy use buildings not required to comply.			
Opaque Doors	Requirement for non-swinging (roll-up, coiling) identical to 2009 IECC. U-value for opaque swinging doors increased. Conserves energy. Necessary to achieve 30% energy savings over 2006 IECC.** Not a mandatory requirement.*			

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
COMMERCIAL	Advantages	Disadvantages	Advantages	Disadvantages
Mechanical	Requirements identical to 2009 IECC and Federal minimum standards, except electric-resistance heating not permitted. Electric-resistance heating is extremely inefficient and wasteful of electric energy. Not using it reduces waste of energy and saves money. Necessary to achieve 30% energy savings over 2006 IECC.**	Requirements identical to (outdated) Federal minimum standards.		Does not prohibit most wasteful method of heating a building: electric-resistance heating. Requirements identical to (outdated) Federal minimum standards.
Service Water Heating	Requirements identical to 2009 IECC and Federal minimum standards.	Requirements identical to (outdated) Federal minimum standards.		Requirements identical to (outdated) Federal minimum standards.

Comments From John Wm. Bucholz, Albuquerque's First Green Building Program Manager, Staff Advisor to Albuquerque's Green Ribbon Task Force, Editor of the Albuquerque Energy Conservation Code, and Member of the International Code Council

	2009 Interim Albuquerque Energy Conservation Code (IAECC)		2009 International Energy Conservation Code (IECC)	
GENERAL	Advantages	Disadvantages	Advantages	Disadvantages
2009 AECC	* Any energy conservation strategy or feature, or any combination of strategies and features, which result in equivalent energy savings may be substituted for some, or all, requirements of the AECC that are not mandatory. Very few AECC requirements are actually mandatory.			
	** Provisions developed by American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) to achieve 30% energy savings over minimum code requirements. Besides ASHRAE, The American Institute of Architects (AIA), the Illuminating Engineering Society of North America (IESNA), The U.S. Green Building Council (USGBC), and the U.S. Department of Energy (DOE) participated in developing these provisions.			

Roof Reflectance & Urban Heat Islands

Discussion with John Bucholtz 11/29/11

The use of reflective roofing reduces the amount of electricity needed for summertime cooling. In the summer, there is up to a 90 degree difference in surface temperature between a 'black roof' and a reflective roof. This difference reduces the need for air-conditioning in the home throughout the day, resulting in energy savings as well as increasing the life of cooling equipment. The US Department of Energy has recommended reflective roofing for areas as far north as Chicago.

Citywide, reduction in energy use also decreases the peak electricity levels . Residential users normally do not pay peak electricity rates, but instead pay a normalized or average rate throughout the year. However, commercial users are charged peak electricity rates outright. Because the peak rates increase with demand, heavy peak usage could result in significant energy costs for commercial users during summer months.

The reduction in electricity use also reduces the environmental effects of coal burning to produce electric energy (PNM's largest source of electric power comes from coal burning plants in northwest NM). These effects not only include dangerous air emissions, but also water lost during the energy production process. A coal-fired power plant consumes about 0.49 gallons of water through evaporation loss for every kilowatt hour (kWh) of energy produced.

When peak usage levels exceed the capacity of PNM's existing systems, electricity would need to be provided from 'off grid' sources. The cost of electricity from these sources is significantly higher than normal or peak rates. Continued use in excess of PNM's capacity would likely result in the need to construct additional coal-fired plants, furthering the adverse environmental effects.

The use of reflective roofing in dense urban areas can also reduce the intensity of urban heat islands. An urban heat island is the difference in air temperature that is created between an urban area and its surrounding rural areas due to the reduction of vegetation and replacement of natural ground cover with paving and buildings. This difference in temperature can range from 1.8 to 5.4 degrees, and in some cases can be as high as 22 degrees. Researchers at Arizona State University have determined that for every one degree increase in temperature, an average household will consume 677 more gallons of water per year. The easiest, and least expensive, methods to mitigate the urban heat island effect are (1) planting more vegetation and (2) using reflective roofing.

APPENDIX A

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Leatherbury

Date: August 9, 2010

Applicable Section: Section 503.1.2

Proposed Change:

This section should be modified to permit broader selections for optional sources of energy.

Benefits/Reasons:

For example, electric resistance heating may be used if "60% of the annual energy requirement is supplied by site-solar or recovered energy..." Other alternative energy sources besides solar power should be included. I also question why 60% was chosen, as it appears to be an arbitrarily selected number. What is the basis for selecting 60%? Should that be 25%?

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: Section 503.2.7

Why: Confusing Language; Excessive Cost that Discourages Retrofits

Proposed Change:

Add the following language to this section as a clarification: "When referring to Section 503.2.7 for Tenant Improvements, Remodels or Restorations use Section 101.6 for the guideline for when this Section (501.2.7) is applicable or not and to what extent it should be carried out."

Benefits/Reasons:

There has been more than one instance where regulators have required, for just one example, that during a remodel in which some ducts or an HVAC system is being replaced, then all ducts in the existing building or within the space have to be insulated with the higher standard insulation. This clarification would show when to apply this section or not and will simplify the plan check process. In addition, it will reduce the wait time on permitting results and the need for the architect or engineer to come to the city for additional clarifications.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Leatherbury, Tom Payne

Date: August 9, 2010

Applicable Section: Section 504.7.1 Pools

Proposed Change:

Delete "The primary source of energy for heating swimming pools shall come from solar collectors" and replace with "Provide __% energy for heating pools from alternative energy sources..."

Allow the engineers/designers to provide performance based solution, after meeting the 2009 base code.

Benefits/Reasons:

This appears to be an arbitrary requirement to eliminate pool heating systems. There are several alternatives to heating pools using heat recovery systems and other options that are not considered by this arbitrary statement.

As written it can be interpreted as a single solar panel shall be installed as primary with back up heat or all primary heating will all be from solar with back up for cloudy days or anything in between. Either way it is not realistic. We believe the intent is to reduce the use of non-renewable energy while providing an economically feasible solution. The use of a singular solar collector for primary heat to get by the code does not accomplish the goal nor does having the huge expense and designated area for a large solar array that would be required to heat a pool. There may be applications that this would be feasible, however not the norm. There are other methods to heat a pool that utilize energy that is already being spent. Heat exchangers that tie into building comfort systems for example allow heat transfer from building where it is not wanted to the pool water, where it is desired.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: David Shaffer

Date: August 9, 2010

Applicable Section: Section 505.2.2.2.3 Occupancy Sensors

Proposed Change:

Ideally this section should be deleted or made optional. If that is not possible, then the following exemption is requested.
Eliminate Offices from the list of room types.
Clarify/define the term "multi-scene" Light Control Systems.

Benefits/Reasons:

The requirement for sensors does not exist in the International Code. It is an added expense and there is conflicting scientific documentation that the installation saves a significant amount of energy in relation to the cost.

If only the Office type is exempted, consider dual switching requirements for office instead, and call it "scene lighting" to avoid the use of sensors in private offices.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: David Shaffer, Bill Leatherbury

Date: August 9, 2010

Applicable Section: Section 505.2.2.2.4 Occupancy Sensors

Proposed Change:

This section should read as follows: "Occupancy sensor controls shall provide options for automatic operation and may have a manual over-ride provided by a wall-mounted switch."

Benefits/Reasons:

Many tenants may prefer both "on" and "off" operations to be automatic for some spaces, such as bathrooms, storage rooms, small meeting rooms and conference rooms. Exceptions include corridors, restrooms, building entrances and areas where "manual on" compromises safety.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: David Shaffer, Bill Leatherbury

Date: August 9, 2010

Applicable Section: Section 505.2.2.2.6 through 505.2.2.2.6.2 Occupancy Sensors

Proposed Change:

505.2.2.2.6:
This section should either be eliminated or made an optional section rather than a prescribed section or the last 2 sentences of this paragraph should be deleted.
505.2.2.2.6.1:
The last sentence of this section should be deleted.
505.2.2.2.6.2
The words "two-lamp" in the first sentence should be deleted. The second sentence in this section should be changed as follows: "... multi-level daylight control to provide levels of lighting ranging from 20% to 100% of the designed lighting."

Benefits/Reasons:

505.2.2.2.6:
This section requires that there shall be a system for automatic controls for dimming or multi-level controls. This section also prescribes the limit of combined day-lighting and artificial lighting at an arbitrary 1.2 times the designed light level. It also requires a 1-minute fade rate to change lighting levels and further requires that all luminaires use 2-lamp, tandem wired ballasts.
This section is too prescriptive because it considers only electric energy usage. The requirement for skylights will affect the heating and cooling loads and it is not clear that the energy savings are real. The cost of installation and maintenance of these dimming devices is considerable, and the payback period has not been researched.
505.2.2.2.6.1:
The requirement for a 1-minute fade is much too fast and will be detected by the most casual observer.
505.2.2.2.6.2
The requirement for 2-lamp ballasts makes it difficult to achieve the 66% and 33% light levels also prescribed in this section. Requiring 2-lamp ballasts for luminaires may also eliminate the use of 3-lamp, 6-lamp, 8-lamp or 10-lamp luminaires because of this requirement.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Leatherbury

Date: August 9, 2010

Applicable Section: Section 505.5.1.4 Linear Fluorescent Lamps

Proposed Change:

The words "T5HO or T8" should be deleted,

Benefits/Reasons:

It does not include T5 lamps and some other types of linear lamps that are becoming or will become available, thereby providing more options and price points for consumers.

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: Table 505.5.2

Proposed Change:

Delete Table 505.5.2 and Replace text with "Table 505.5.2 is adopted as written in the 2006 International Energy Conservation Code."

Why: In Conflict with National Recommended Standards and Best Practices.

Benefits/Reasons:

"Watts per sq. ft." is a credible way to calculate the saving of energy except for parking areas; however, most of the AECC requirements are too low. For instance, in the Code chart, schools are .9 watts per square foot which only gets about 30 foot-candles to a desk top surface, using the most efficient light fixtures and lamps on the market today. Children do not carry task lights to school, and learning will be impaired. The Society of Illumination Engineers used to advise 75 foot-candles in schools.

In addition, the AECC code requires that hospitals have a lighting density of 1.1 watts/square foot, while the IECC requires 1.2 W/SF. It is generally difficult to comply with other applicable health care recommendations, codes and standards for lighting and comply with the requirement for 1.2 W/SF. For example, NA IES (North American Illuminating Engineering Society) recommendations are for specific lighting levels in specified areas of health care facilities. It is often to achieve these recommendations and comply with the IECC. Other lighting requirements for educational and manufacturing areas are also equally limiting, as well.

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2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: Table 505.6.2

Proposed Change:

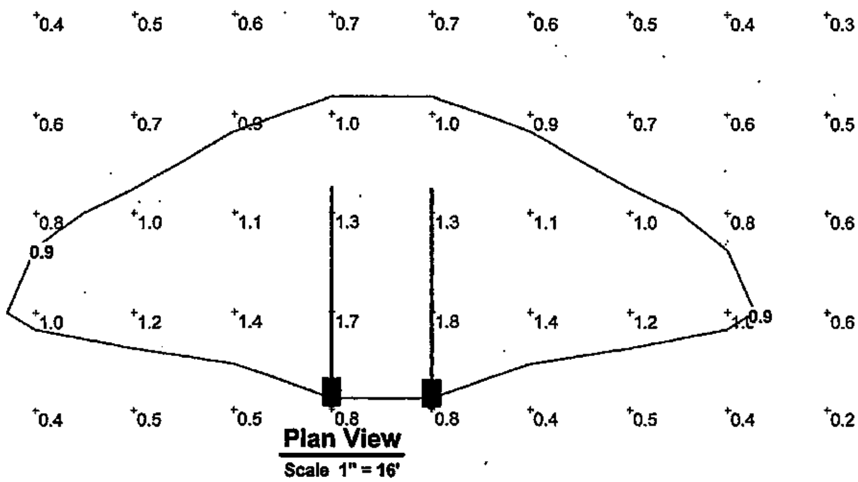
Delete Table 505.6.2 and Replace text with "Table 505.6.2 is adopted as written in the 2006 International Energy Conservation Code."

Why: Public Safety Issue; Not in Compliance with Best Practices

Benefits/Reasons:

The requirements are that parking lot lighting densities be 0.13 W/SF. This is not acceptable for any parking lot where there are requirements for video surveillance or other measures to control crime. For example, a lighting level of at least 1 foot-candle is required for video surveillance and it is common to design for 4 to 5 times that amount to actually achieve an overall average lighting level. That lighting level is estimated to approximately equate to a lighting density of about 0.2 W/SF. Some retail facilities may require lighting levels as high as 15 – 40 foot-candles, which is estimated to approximately equate to lighting densities of about 0.5 – 2.0 W/SF.

Using watts / square foot is a very poor method for measurement of lighting for parking areas. This method could cause parking lots to have real bright spots and real dark spots. This causes visual problems with the human eye. Uniformity ratio is as important as foot candles (FC) when evaluating parking/roadway lighting. Illuminating Engineering Society of North America (IESNA) recommended lighting levels in a High activity general parking and pedestrian area is .9 FC on the pavement with a 4:1 uniformity ratio. Medium activity is .6 FC and Low activity is .2 FC each with a 4:1 uniformity ratio. The attached calculation indicates that two 140 watt LED light fixtures spaced 10 feet apart will produce .9 FC at a 4:1 uniformity ratio for an area of 1100 square feet. This equals .25 watts/ square feet almost double of the .13 Watts/ square foot required by the proposed Albuquerque Code. Meeting the Albuquerque Code requirements would provide lighting at almost double the recommended uniformity ration or half of the recommended foot candles.



280W/1100sf=0.25w/sf

15' Mounting Height

4.0:1 Avg Ratio

LUMINAIRE SCHEDULE

Symbol	Label	Qty	Catalog Number	Description	Lamp	File	Lumens	LLF	Watts
▮	A	2	WP9L3/LED-5100K	WARP9 LED DIE-CAST-ALUMINUM HOUSING. LED EMITTER DECK CONSISTING CARRIER PLATE, HEATSINK, REFLECTORS AND CONSTANT CURRENT BOARDS. CLEAR FLAT LENS. USING (1) 150 WATT DRIVER FROM ADVANCE.	120 DIODES, 5100K. CONSTANT CURRENT	wp9l3-l5k.ies	Absolute	1.00	140

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Richard Reif

Date: August 9, 2010

Applicable Section: 506.1 General

Proposed Change:

Delete Option (b) requiring "the annual energy cost of the proposed design are 30% less than a standard design complying with the un-amended minimum requirements of the 2006 International Energy Conservation Code."

Benefits/Reasons:

This option would no longer be necessary if the new base Code was modified to be the 2009 International Energy Conservation Code and the additional energy efficiency would be automatically built into the remaining performance option of just being better than the requirements of the 2009 International Energy Conservation Code.

Option (b) appears to be a hold-over from the first version of the ABQ Code when the City was still on the 2000 International Energy Code. A 30% figure was doable at that point, using the 2000 IECC. Applying it to the 2006 IECC or the 2009 IECC is not only impractical since products to fulfill that level of energy efficiency are either not available or are so expensive as to be prohibitive for consumers, but is also not supported by cost benefit studies.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Smith

Date: August 9, 2010

Applicable Section: Table 502.2 (2) Metal Building Assembly Instructions

Proposed Change:

Somehow the code should be more performance based here and less prescriptive. I would suggest the City and a couple installers meet to rewrite this table.

Benefits/Reasons:

In discussions with our Metal Building installers, it became evident that the methods described here are contrary to their approach, but the results are the same.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Richard Reif

Date: August 9, 2010

Applicable Section: Chapter 2 - Definitions

Proposed Change:

Delete definition of "Substantial Alteration"

Benefits/Reasons:

This definition is not referenced anywhere in the current ABQ version of the Code and is orphaned from the 2006 version. By having it here it causes potential confusion when trying to understand the requirements for existing buildings which are already defined in the 2009 International Existing Building Code.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Smith

Date: August 9, 2010

Applicable Section: Chapter 2 - Definitions: Work Area

Proposed Change:

Delete definition of "Work Area"

Benefits/Reasons:

This definition is not referenced anywhere in the current ABQ version of the Code and is orphaned from the 2006 version. By having it here it causes potential confusion when trying to understand the requirements for existing buildings which are already defined in the 2009 International Existing Building Code.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: David Shaffer

Date: August 9, 2010

Applicable Section: Section 101.6.2- Historic buildings

Proposed Change:

Historic buildings should include any building an architect feels is "of note" (with justification) and approval of the Albuquerque Planning Department.

Benefits/Reasons:

There are numerous existing adobe structures in Albuquerque that would not comply with this energy code without drastic changes during a remodel. They are sometimes simply examples of "lost construction arts and craftsmanship" that would be destroyed if "furred out and insulated". They are not "historic" nor are they a contributing building in a historic neighborhood. I have already faced 2 such renovations in the State, and have had C.I.D. agree that they are "buildings of note" for their adobe construction detailing.

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: 101.6.4 Change in Occupancy

Proposed Change:

Delete the definition for CHANGE OF OCCUPANCY and substitute: *"means a change in use of an existing building such that the occupancy classification applicable to the new use is different from the occupancy classification of the former use"*. (This same definition should also be applied to the existing Building Code. If the City decided to adopt the proposed 2009 New Mexico Building and IECC Codes, this will not be a problem since this definition is the same in those codes.)

WHY: Legal Liability with Tenants; Major Cost Issue That Discourages Retrofits to Parts of a Multi-Tenant Building

Benefits/Reasons:

Due to the way this section is written, one could interpret a change in occupancy as a change in tenants, and for multi-tenant buildings, bringing a building into compliance would be very problematic. In essence, the Code requires bringing the whole building into compliance if the change requires one more watt of energy use. In addition to the significant cost factor of such a requirement, there is a question on the legitimacy of forcing occupied, tenanted areas to agree to be brought up to a code that is not in compliance with their lease.

This was a problem with the proposed 2009 state code, and a similar section was deleted due to the legal problems created by tenant leases.

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: 101.7.2 Low Energy Buildings Exemption #1

Why: Excessive Cost to Small Businesses; Unnecessary Due to Type of Use

Proposed Change:

Add exemption to Table 502.2 (1) f. "Areas of buildings established as warehouse, factory or industrial space, with either no cooling or evaporative cooling and heating equipment output capacities less than or equal to 15 btu/h per square foot can comply with the requirements of Table 502.2(1) of the 2006 International Energy Conservation Code.

Benefits/Reasons:

There is concern that the threshold here is set too low, and it will significantly increase costs in constructing warehouses, factories and other industrial buildings. These types of buildings are most often used by small businesses such as Jiffy Lube, and are often cooled with evaporative equipment. Doors, bays and windows are open left open. Extra insulation is therefore not only more expensive but also pointless when the building is essentially open to the outdoors. There is a question concerning the heating portion, so that is why we are suggesting a committee to address this issue. The current code will change the way these buildings are constructed, drive the cost unreasonably high and kick Albuquerque out of a competitive mode.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Smith

Date: August 9, 2010

Applicable Section: Table 502.2 (1) Building envelope Requirements

Proposed Change:

I would recommend that this table be exactly as in the 2009 IECC and not be exceeded. The work done by the IECC to work out problems associated with these specs should be adopted. The added insulation requirements which I see in the ABQ code become problematic with some building types and structures.

Benefits/Reasons:

The method this table uses to address thermal block is to wrap steel frame buildings in exterior insulation. This approach restricts the treatment of exterior walls to a limited number of systems and increases costs to the consumer.

Designs should demonstrate that the overall assembly a designer chooses will perform, instead of prescribing usage of specific materials.

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: Table 502.3

Why: Not in Compliance with Best Practices; Impractical on "New Mexican Traditional Architectural Designs"; Not Necessary to Achieve Energy Conservation

Proposed Change:

Delete prescriptive requirement for Projection Factor (PF) to be a minimum of 0.5.

Benefits/Reasons:

With the type of tall windows typical for good day-lighting, this could result in overhangs over 3' deep over all windows, which is a cost issue, structural issue, and aesthetic issue. This type of overhang is not compatible with many types of architectural design. It would be inappropriate on territorial or pueblo style buildings. It could also result in a situation where all new ABQ buildings look the same, due to this prescriptive requirement for very large and obvious shade overhangs. With the current AECC requirement for glazing Solar Heat Gain Coefficient at 0.38 with the projection requirement removed shading systems in Albuquerque will still exceed the requirements of either the 2006 or 2009 versions of the International Energy Conservation Code.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Julie Wallesia and David Shaffer

Date: August 9, 2010

Applicable Section: Table 502.3

Proposed Change:

Adopt the U values in this table as is from the 2009 International Energy Conservation Code.

Benefits/Reasons:

On one recent project with a pretty typical curtainwall system with very good glass (Solarban 70), the National Fenestration Rating Council (NFRC) rated the assembly at U = 0.45, which wouldn't meet this.

When you refer to NFRC's online product directory tool to input the U and SHGC criteria from table 502.3 and search for compliant products from a couple of large manufacturers, there are products available that meet this, but they seem to require strategies such as argon-filled glazing units, top of the line glazing, etc. which would all require significantly higher cost.

This table also requires a Projection Factor of 0.5 on all S, E, and W windows, which means a horizontal overhang whose depth is half the height of the window.

With the type of tall windows typical for good day-lighting, this could result in overhangs over 3' deep over all windows, which is a cost issue, structural issue, and aesthetic issue. This type of overhang is not compatible with many types of architectural design. It would be inappropriate on territorial or pueblo style buildings. It could also result in a situation where all new ABQ buildings look the same, due to this prescriptive requirement for very large and obvious shade overhangs.

The table requires both the projection factor and SHGC values, with no thought given to how these interact. In comparison, IECC 2009 requires different SHGC values depending on projection factor. With a Projection Factor of 0.25 or greater, IECC has no requirement on SHGC in Zones 4 and 5, and a higher (easier) SHGC of .40 or .33 in Zone 3 (for PF .5 or .25) – since the window is shaded, the SHGC requirement is eased or removed. A similar logic of Projection Factor OR SHGC requirement could be applied for ABQ.

2009 Albuquerque Energy Conservation Code – Change Form

Proposed By: Bill Smith

Date: August 9, 2010

Applicable Section: Table 502.3.3 Warehouses and Factories (Skylights)

Proposed Change:

Specify a certain 5 of roof area for sky-lighting and state that skylights are to be centered between racks.

Benefits/Reasons:

This paragraph prescribes a minimum spacing for skylights in warehouses and factories, then goes on to specify that racking shall be installed centered between skylights. This is problematic for a variety of warehouse racking systems, including a number of national companies, which need tight specs on spacing.

2009 Albuquerque Energy Conservation Code – Change Form

Applicable Section: Section 502.6 – Reflectivity

Why: Not in Accord With Best Practices or Scientific Verification

Proposed Change:

Eliminate this section and the table.

Benefits/Reasons:

The cost to monitor an owner simply changing the paint color after the inspectors leave is a clear problem, much less the added time on the architect's part to calculate the reflectivity of all wall, floor and ceiling surfaces. Many products are installed using varied techniques. How can one account for a specific reflectivity on hand applied stains or materials that vary in luster or intensity as part of an artistic application?

Some of the plan reviewers are requiring data on light reflectance of interior materials. They want it for things like carpet and the information is not available from manufacturers. I understand the concept that you use less energy for lighting if the colors are more reflective but the application can not only be really difficult to document but can also be extremely limiting as to what materials can and can't be used.

In the Code, flooring shall have a minimum reflectance of 20%. Flooring specifications do not provide LRV information and also some consideration should be taken to prevent glare. The reflective surface requirement itself is somewhat questionable as I predict most people will paint their interiors white then they will simply paint a non reflective color as they desire after they've received their CO.

These surface reflectance requirements virtually prohibits feature walls or walls with darker colors such as navy blue, burgundy or forest green. It also prohibits dark or black-colored ceilings often seen in some spaces, except those spaces listed in the exceptions.

Reflectance has nothing to do with energy saving (watts / sq ft). It is a visual design element and visual comfort issue. Many materials such as flooring, wall coverings, etc. do not have published data for reflectance. Exposed structure is often painted black to avoid the cost of putting in a ceiling. The light fixtures are mounted lower and provide down light, this design can comply with the energy code but would not be allowed by this prescriptive requirement.

APPENDIX B

EXECUTIVE SUMMARY

As energy markets struggle for stability, state officials have the opportunity for a fundamental reassessment of long-term energy policy. We can now choose alternative fuel sources and new technologies to clean up our future. Ample clean, renewable resources and energy efficiency technologies can provide us with stable, reliable, and cost-effective electricity while reducing pollution.

Traditional Power Production Promotes Global Warming and Damages Public Health

Today's electric power industry is the most polluting industry in the nation. The electric power industry alone is responsible for 53% of New Mexico's carbon dioxide (CO_2) emissions, the principle cause of global warming. Power plants are also the largest industrial source of pollution that causes severe public health damage. New Mexico power plants are responsible for 45% of the state's emissions of sulfur dioxide, 47% of its emissions of nitrogen oxide, and 64% of its emissions of mercury. The New Mexico electric industry emits 11 tons of CO_2 more per person each year than the U.S. average.

Clean Energy Can Grow Rapidly in the Next Decade

Renewables have advanced technologically and commercially to the point where they are now ready for wide-scale development, and there are still many opportunities for efficiency improvements. Huge untapped potential exists at both the state and national levels. Economic analysis and technological considerations suggest that the following targets are both reasonable and desirable.

- Renewable energy sources could provide 15% of the total electricity for the state by 2010. Nearly all of this potential remains untapped today, with coal and nuclear power meeting 89% of New Mexico's power needs.
  - Wind power is the renewable technology the state could develop the quickest. 1,340 peak MW of New Mexico's 166,000 MW potential could come online by 2010.
  - New Mexico has the resources to become the solar powerhouse for the nation. As a first step, it could develop 100 MW of solar thermal power, increasing the contribution of solar thermal power in the U.S. by 28%.
  - The U.S. Geological Survey ranked New Mexico second among the states for geothermal potential. By 2010, 137 MW of its 2,700 MW potential could come online.
- If the entire state were to emulate the performance of state agencies investing in cost-effective energy efficiency measures, New Mexico could reduce anticipated total electricity demand by 7.7% within a year.
- By 2010, 125,000 MW of renewable energy capacity could be operational nationally, enough to replace 80 large fossil fuel power plants.
- Policies promoting energy efficiency could cut the nation's electricity demand by 15%, saving 72,000 average MW annually.

Renewable Energy and Energy Efficiency Reduce Pollution

If these 2010 goals were to be achieved, New Mexico would reduce annual CO_2 emissions by as much as 25%, or 8 million tons, compared to projections for the current path. This would also reduce health-damaging pollution by 26%.

Nationally by 2010, energy efficiency and renewable energy development at the levels described above would enable the U.S. to reduce CO_2 emissions by as much as 37% – one billion tons annually – compared to the current path. Health-damaging pollution would be reduced by as much as 43%.

Clean Energy Is the Best Economic Choice

Policies encouraging renewables and energy efficiency would grow the economy more than a business-as-usual scenario.

- Electricity generation from renewable energy involves a higher proportion of its costs for labor as compared to fossil fuel electricity generation, in which much of the cost goes to fuel. Wind and solar photovoltaic operations each provide 40% more jobs per dollar of investment than do coal operations. Meeting stricter energy efficiency goals would also require increases in employment.
- Policies encouraging clean energy would lead to net increases in employment in the U.S. and in each individual state. New Mexico would see a net gain of 4,200 jobs, while the U.S. as a whole would gain more than 700,000 jobs by 2010.
- The best wind, solar, and geothermal projects can produce electricity at a lower cost than fossil fuels when external life-cycle costs of electricity generation are taken into account.
- Energy efficiency programs of the past five years have avoided the need for 25,000-30,000 MW of generating capacity – the equivalent of 100 power plants – at a cost that is less than that of energy from most new power plants.

Comprehensive Energy Policies Are Needed

Two specific policies in particular would best help New Mexico and the U.S. realize its clean energy potential:

- A renewable energy standard requiring all retail electricity suppliers to obtain a set percentage of their electricity from renewable sources. New Mexico should enact a standard calling for its energy mix to include 12% renewables by 2010 and 20% by 2020, while the national goal should be set at 20% renewables by 2020.
- A utility clean energy fund using a set percentage of revenues to finance programs promoting energy efficiency and renewable energy.

Why Cool Roofs Are Way Cool

COOL ROOF RATING COUNCIL ®

A cool roof reflects and emits the sun's energy as light back to the sky instead of allowing it to enter the building below as heat. In many climate zones, a cool roof can substantially reduce the cooling load of the building, providing several direct benefits to the building owner and occupants:

- increased occupant comfort, especially during hot summer months
- reduced air conditioning use, resulting in energy savings typically of 10-30%[1], and
- decreased roof maintenance costs due to longer roof life.

In addition to these well known benefits to the building owner, cool roofs benefit the environment and public health in far more ways. As recognition of these benefits has become more widespread, cool roof requirements are appearing in building energy codes and green building programs across the nation.

Climate Change Mitigation

Cool roofs directly reduce green house gas emissions by conserving electricity for air conditioning therefore emitting less CO_2 from power plants. Cool roofs also cool the world independently of avoided carbon emissions, simply by reflecting the sun's energy as light back to the atmosphere, thereby mitigating global warming. A Lawrence Berkeley National Laboratory study found that world-wide reflective roofing will produce a global cooling effect equivalent to offsetting 24 gigatons of CO_2 over the lifetime of the roofs. This equates to $600 billion in savings from CO_2 emissions reduction.[2]

Urban Heat Island Mitigation

Cities can be 2° to 8°F warmer than surrounding areas due to dark materials, including roofs, which absorb the sun's light energy as heat during the day and release it at night as heat.[3] This phenomenon removes the opportunity for air to cool down at night and results in higher temperatures being maintained longer. By immediately reflecting solar radiation back into the atmosphere and reemitting some portion of it as infrared light, cool roofs result in cooler air temperatures for the surrounding urban environment during hot summer months.

Reduced Smog

Cool roofs, through mitigation of the urban heat island effect and reduction of ambient air temperatures, in turn improve air quality. Smog is created by photochemical reactions of air pollutants and these reactions increase at higher temperatures. Therefore, by reducing the air temperature, cool roofs decrease the rate of smog formation.

Public Health Benefits

Lower ambient air temperatures and the subsequent improved air quality also result in a reduction in heat-related and smog-related health issues, including heat stroke and asthma.

Peak Energy Savings and Grid Stability

Because cool roofs reduce air-conditioning use during the day's hottest periods, the associated energy savings occur when the demand for electricity is at its peak. Therefore, use of cool roofs reduces the stress on the energy grid during hot summer months and helps avoid shortages that can cause blackouts or brownouts. In addition, for building owners that pay for their energy based on the time of use, they save energy when it is at its most expensive – and hence, save more money!

Secondary Energy Benefits

Cool roofs directly reduce the air conditioning use for buildings by reducing heat gain in the building below, but they also indirectly reduce air conditioning use in urban areas by helping lower ambient air temperatures. Therefore, with cooler daytime temperatures, buildings and vehicles use less air conditioning and save additional energy. In turn, this results in a reduction in the CO_2 emissions from electricity generating power plants.

The Cool Roof Rating Council (CRRC) is a non-profit membership organization. Formed in 1998, the CRRC maintains a credible, third-party rating system to measure and label the radiative properties of roofing materials. Please visit us at www.coolroofs.org.

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[1] Energystar.gov
[1] Akbari, H. (2008). Global Cooling: Increasing Solar Reflectance of Urban Areas to Offset CO2. In press, *Climate Change*.
[3] Energystar.gov

Heat Island Effect

Urban Heat Island Mitigation

Many communities are taking action to reduce urban heat islands using four main strategies: 1) increasing tree and vegetative cover, 2) installing green roofs (also called "rooftop gardens" or "eco-roofs"), 3) installing cool—mainly reflective—roofs, and 4) using cool pavements. The links below lead to detailed information on these strategies and summaries of the activities that governments and communities are implementing.

Further down on this page is an overview of the benefits of reducing urban heat islands.

HEAT ISLAND REDUCTION PROGRAM

Strategies and Technologies

- Trees and Vegetation
- Green Roofs
- Cool Roofs
- Cool Pavements

Federal, State, and Local Actions

- EPA Activities
- State and Local Activities

Benefits of Mitigation

The extent to which urban areas can benefit from heat island reduction strategies depends on a number of factors—some within and some outside of a community's control. Although prevailing weather patterns, climate, geography, and topography are beyond the influence of local policy, decision makers can select a range of energy-saving strategies that will generate multiple benefits, including vegetation, landscaping, and land use design projects, and improvements to building and road materials.

Trees, vegetation, and green roofs can reduce heating and cooling energy use and associated air pollution and greenhouse gas emissions, remove air pollutants, sequester and store carbon, help lower the risk of heat-related illnesses and deaths, improve stormwater control and water quality, reduce noise levels, create habitats, improve aesthetic qualities, and increase property values.

Cool roofs can lower cooling energy use, peak electricity demand, air pollution and greenhouse gas emissions, heat-related incidents, and solid waste generation due to less frequent re-roofing.

Cool pavements can indirectly help reduce energy consumption, air pollution, and greenhouse gas emissions. Depending on the technology used, cool pavements can improve stormwater management and water quality, increase surface durability, enhance nighttime illumination, and reduce noise.

Using these strategies in combination can enhance their effectiveness. For example, installing a permeable pavement parking lot that includes shade trees can extend the longevity of the pavement and vegetation.

Widespread implementation of these strategies also provides additional benefits. For example, a single cool roof will mainly result in benefits to the building owner and occupants. Community-wide cool roof installations, though, will provide savings to the building owner and occupants and to the community at large, as a large number of cool roofs can reduce air temperatures, resulting in multiple benefits associated with cooler summertime air.

Reducing Urban Heat Islands: Compendium of Strategies

Cool Roofs

Acknowledgements

Reducing Urban Heat Islands: Compendium of Strategies describes the causes and impacts of summertime urban heat islands and promotes strategies for lowering temperatures in U.S. communities. This compendium was developed by the Climate Protection Partnership Division in the U.S. Environmental Protection Agency's Office of Atmospheric Programs. Eva Wong managed its overall development. Kathleen Hogan, Julie Rosenberg, and Andrea Denny provided editorial support. Numerous EPA staff in offices throughout the Agency contributed content and provided reviews. Subject area experts from other organizations around the United States and Canada also committed their time to provide technical feedback.

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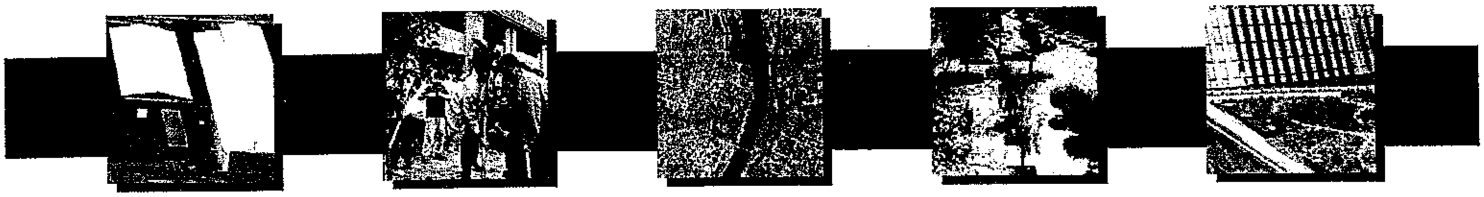
Contents



Cool Roofs

Cool roofing can help address the problem of heat islands, which results in part from the combined heat of numerous individual hot roofs in a city or suburb. Cool roofing products are made of highly reflective and emissive materials that can remain approximately 50 to 60°F (28-33°C) cooler than traditional materials during peak summer weather. Building owners and roofing contractors have used these types of cool roofing products for more than 20 years. Traditional roofs in the United States, in contrast, can reach summer peak temperatures of 150 to 185°F (66-85°C),[2] thus creating a series of hot surfaces as well as warmer air temperatures nearby.

This chapter provides detailed information that mitigation program organizers can use to understand, plan, and implement cool roofing projects and programs. The chapter discusses:

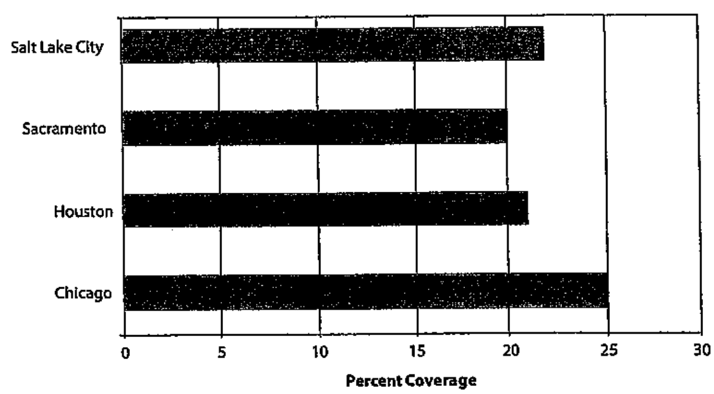
- Key cool roof properties and how they help to mitigate urban heat
- Types of cool roofing
- Specific benefits and costs of cool roofing
- Measurement and certification of cool roof products
- Installation and maintenance of cool roofs
- Tools and resources to further explore this technology.

Opportunities to Expand Use of Cool Roofs in Urban Areas

Most U.S. cities have significant opportunities to increase the use of cool roofs. As part of the U.S. Environmental Protection Agency's (EPA's) Urban Heat Island Pilot Project, the Lawrence Berkeley National Laboratory conducted a series of analyses to estimate baseline land use and tree cover information for the pilot program cities.[1]

Figure 1 shows the percent of roof cover in four of these urban areas. The data are from 1998 through 2002. With roofs accounting for 20 to 25 percent of land cover, there is a large opportunity to use cool roofs for heat island mitigation.

Figure 1: Roof Cover Statistics for Four U.S. Cities (Below Tree Canopy)



1. How It Works

Understanding how cool roofing works requires knowing how solar energy heats roofing materials and how the properties of roofing materials can contribute to warming. This section explains solar energy, the properties of solar reflectance and thermal emittance, and the combined temperature effect of these two properties working together.

1.1 Solar Energy

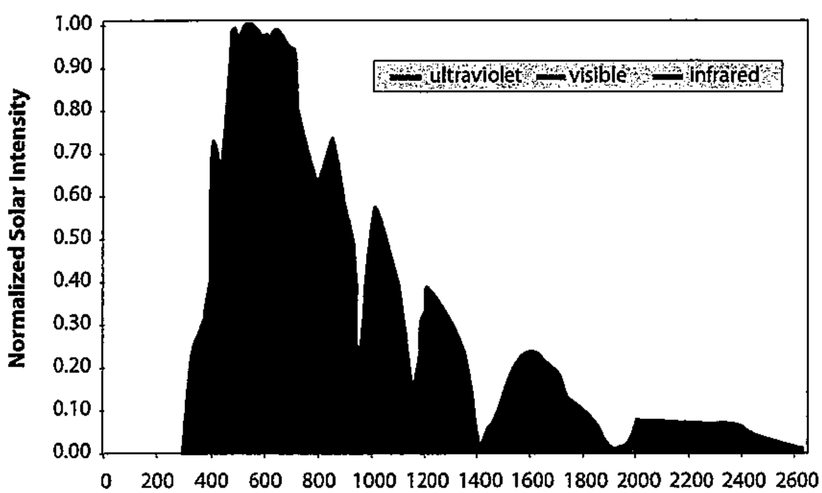
Figure 2 shows the typical solar energy that reaches the Earth's surface on a clear summer day. Solar energy is composed of ultraviolet (UV) rays, visible light, and infrared energy, each reaching the Earth in different percentages: 5 percent of solar energy is in the UV spectrum, including the type of rays responsible for sunburn; 43 percent of solar energy is visible light, in colors ranging from violet to red; and the remaining 52 percent of solar energy is infrared, felt as heat.

Cool Roof Market

The number of ENERGY STAR® Cool Roof Partners has grown from 60 at the program's inception to nearly 200 by the end of 2007; the number of products has grown even faster, from about 100 to almost 1,600. Based on 2006 data from more than 150 ENERGY STAR Partners, shipments of ENERGY STAR products constitute about 25 percent of the commercial roofing market and about 10 percent of the residential market. The overall market share for these products is rising over time, especially with initiatives such as cool roof requirements in California.

"Cool roofing" refers to the use of highly **reflective and emissive materials.** "Green roofs" refer to rooftop gardens.

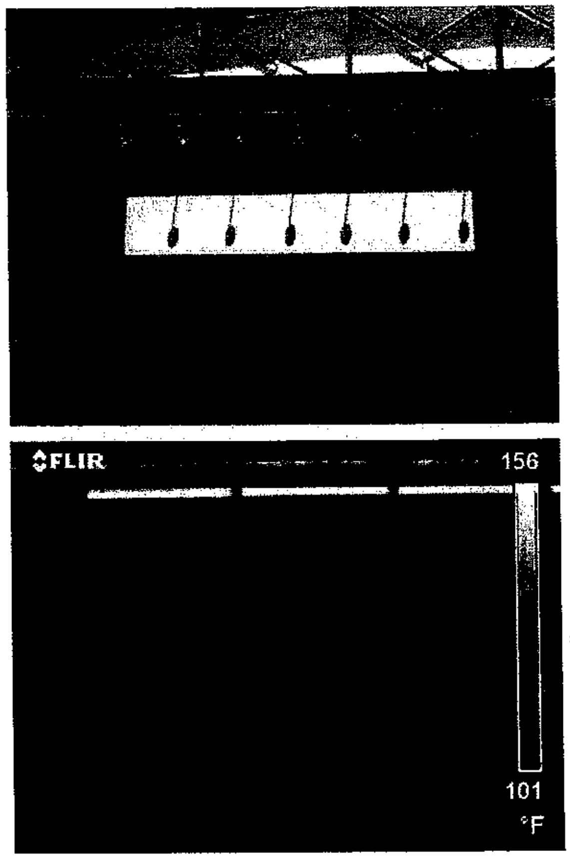
Figure 2: Solar Energy versus Wavelength Reaching Earth's Surface



Solar energy intensity varies over wavelengths from about 250 to 2500 nanometers. White or light colored cool roof products reflect visible wavelengths. Colored cool roof products reflect in the infrared energy range.

Many **cool roof products** are bright white. These products get their high solar reflectance primarily from **reflecting in the visible portion of the spectrum** depicted in Figure 2. Given the desire for colored roof products for many buildings, such as the typical single family home, manufacturers are continuing to develop **cool colored products that reflect in the "near-infrared"** range, or the infrared wavelengths from about 700 to 2500 nanometers shown in Figure 2.

Figure 3: Effect of Albedo on Surface Temperature



ASU National Center of Excellence

Albedo alone can significantly influence surface temperature, with the white stripe on the brick wall about 5 to 10°F (3-5°C) cooler than the surrounding, darker areas.

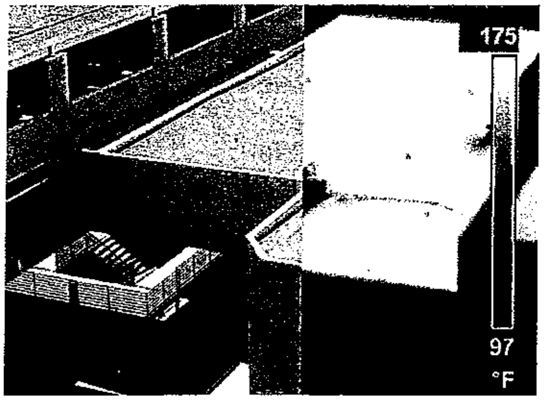
1.2 Solar Reflectance

Solar reflectance, or albedo, is the percentage of solar energy reflected by a surface. Researchers have developed methods to determine solar reflectance by measuring how well a material reflects energy at each solar energy wavelength, then calculating the weighted average of these values (see Section 4.1). Traditional roofing materials have low solar reflectance of 5 to 15 percent, which means they absorb 85 to 95 percent of the energy reaching them instead of reflecting the energy back out to the atmosphere. The coolest roof materials have a high solar reflectance of more than 65 percent, absorbing and transferring to the building 35 percent or less of the energy that reaches them. These materials reflect radiation across the entire solar spectrum, especially in the visible and infrared (heat) wavelengths.

1.3 Thermal Emittance

Although solar reflectance is the most important property in determining a material's contribution to urban heat islands, thermal emittance is also a part of the equation. Any surface exposed to radiant energy will get hotter until it reaches thermal equilibrium (i.e., it gives off as much heat as it receives). A material's thermal emittance determines how much heat it will radiate per unit area at a given temperature, that is, how readily a surface gives up heat. When exposed to sunlight, a surface with high emittance will reach thermal equilibrium at a lower temperature than a surface with low emittance, because the high-emittance surface gives off its heat more readily.

Figure 4: Temperature of Conventional Roofing



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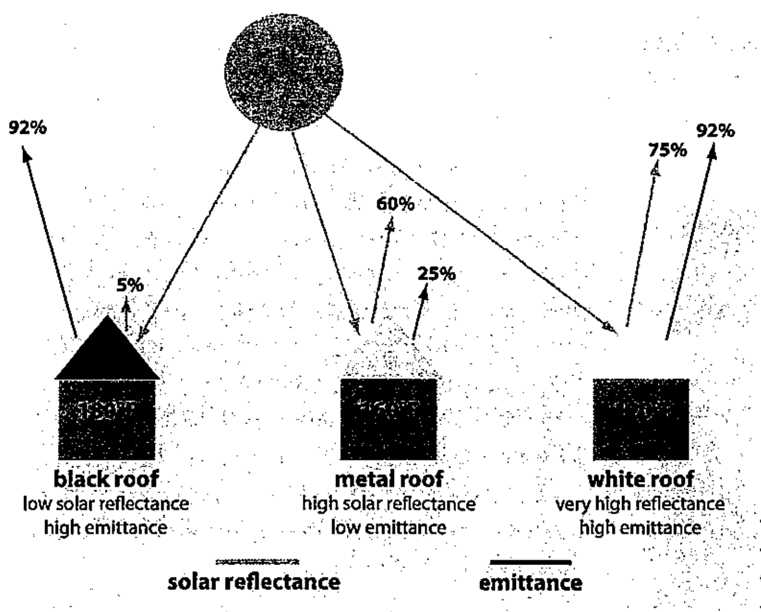
The left half of this traditional bitumen roof in Arizona is shown in visible wavelengths and the right in infrared. The roof's temperature reaches almost 175°F (80°C).

1.4 Temperature Effects

Solar reflectance and thermal emittance have noticeable effects on surface temperature. Figure 5 illustrates these differences using three different roof types. Conventional roof surfaces have low reflectance but high thermal emittance; standard black asphalt roofs can reach 165 to 185°F (74 - 85°C) at midday during the summer. Bare metal or metallic surfaced roofs have high reflectance and low thermal emittance and can warm to 150 to 165°F (66 - 77°C). Research has shown that cool roofs with both high reflectance and high emittance reach peak temperatures of only 110 to 115°F (43-46°C) in the summer sun. These peak values vary by local conditions. Nonetheless, research reveals that conventional roofs can be 55 to 85°F (31-47°C) hotter than the air on any given day, while cool roofs tend to stay within 10 to 20°F (6-11°C) of the background temperature.[3]

Figure 5: Example of Combined Effects of Solar Reflectance and Thermal Emittance on Roof Surface Temperature[4]



Lisa Gartland

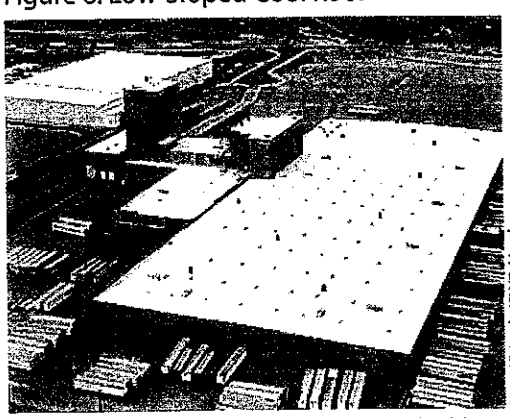
On a hot, sunny, summer day, a black roof that reflects 5 percent of the sun's energy and emits more than 90 percent of the heat it absorbs can reach 180°F (82°C). A metal roof will reflect the majority of the sun's energy while releasing about a fourth of the heat that it absorbs and can warm to 160°F (71°C). A cool roof will reflect and emit the majority of the sun's energy and reach a peak temperature of 120°F (49°C).

These reduced surface temperatures from cool roofs can lower air temperature. For example, a New York City simulation predicted near-surface air temperature reductions for various cool roof mitigation scenarios. The study assumed 50-percent adoption of cool roofs on available roof space and ran models to evaluate the resulting temperature changes. Averaged over all times of day, the model predicted a city-wide temperature reduction of 0.3°F (0.2°C). The city-wide, 3:00 p.m. average reduction was 0.6°F (0.3°C) and ranged from 0.7 to 1.4°F (0.4 - 0.8°C) in six specific study areas within the city.[5]

2. Cool Roof Types

There are generally two categories of roofs: low-sloped and steep-sloped. A low-sloped roof is essentially flat, with only enough incline to provide drainage. It is usually defined as having no more than 2 inches (5 cm) of vertical rise over 12 inches (30 cm) of horizontal run, or a 2:12 pitch. These roofs are found on the majority of commercial, industrial, warehouse, office, retail, and multi-family buildings, as well as some single-family homes.

Figure 6: Low-Sloped Cool Roof



Ron Whipple/SWD Urethane

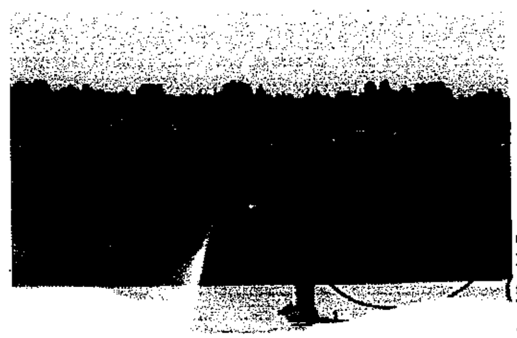
Buildings with a large roof area relative to building height, such as this warehouse, make ideal candidates for cool roofing, as the roof surface area is the main source of heat gain to the building.

Steep-sloped roofs have inclines greater than a 2-inch rise over a 12-inch run. These roofs are found most often on residences and retail commercial buildings and are generally visible from the street.

2.1 Low-Sloped Cool Roofs

Low-sloped and steep-sloped roofs use different roofing materials. Traditionally, low-sloped roofs use built-up roofing or a membrane, and the primary cool roof options are coatings and single-ply membranes.

Figure 7: Cool Coating Being Sprayed onto a Rooftop



Lisa Gartland/PositivEnergy

Cool coating being sprayed onto a rooftop.

Cool Roof Coatings. Coatings are surface treatments that are best applied to low-sloped roofs in good condition. They have the consistency of thick paint and contain additives that improve their adhesion, durability, suppression of algae and fungal growth, and ability to self-wash, or shed dirt under normal rainfall. Building owners can apply cool roof coatings to a wide range of existing surfaces, including asphalt capsheet, gravel, metal, and various single-ply materials.

When purchasing cool roof elastomeric coatings, building owners can require that products meet the **ASTM international standard, ASTM D 6083-05e1**, "Standard Specification for Liquid Applied Acrylic Coating Used in Roofing," to ensure the product achieves certain specifications. There is currently no similar standard for cementitious coatings.

There are two main types of cool roof coatings: cementitious and elastomeric. Cementitious coatings contain cement particles. Elastomeric coatings include polymers to reduce brittleness and improve adhesion. Some coatings contain both cement particles and polymers. Both types have a solar reflectance of 65 percent or higher when new and have a thermal emittance of 80 to 90 percent or more. The important distinction is that elastomeric coatings provide a waterproofing membrane, while cementitious coatings are pervious and rely on the underlying roofing material for waterproofing.

Common Cool Single-Ply Materials

- **EPDM (ethylene propylene diene monomer)**, a synthetic rubber material, with seams that must be glued or taped together.
- **CSPE (chlorosulfonated polyethylene)**, a polymer material, with seams that can be heat-welded together.
- **PVC (polyvinyl chloride) and TPO (thermoplastic olefins)**, thermoplastic materials, with seams that can be heat-welded together.

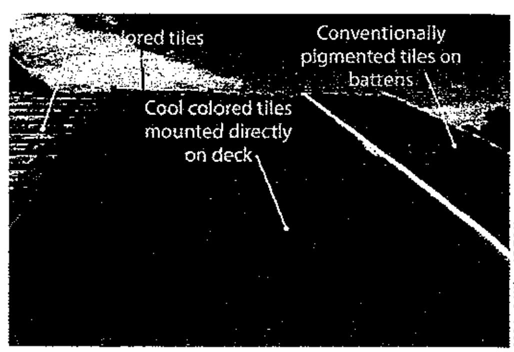
Single-Ply Membranes. Single-ply membranes come in a pre-fabricated sheet that is applied in a single layer to a low-sloped roof. The materials are generally glued or mechanically fastened in place over the entire roof surface, with the seams sealed by taping, gluing, or heat-welding. A number of manufacturers formulate these products with cool surfaces.

Building owners generally consider cool roof options when their roof begins to fail. They typically use a ***cool roof coating*** if an existing roof needs only moderate repair, and a ***single-ply membrane*** for more extensive repairs. The cut-off point between moderate and extensive repairs is not easily determined. In making a choice between these options, however, building owners can gather input from many sources, including roofing consultants and contractors, product manufacturers, and contacts at other facilities that have had cool roofing installed.

2.2 Steep-Sloped Cool Roofs

Most cool roof programs focus on the low-sloped roofing sector, but cool roof options are becoming available for the steep-sloped sector as well. Asphalt shingles are the

Figure 8: Conventional and Cool Colored Tiles



Cool roof products can be indistinguishable from their conventional counterparts. The rightmost row of curved tiles uses conventional colored pigments, whereas the other two rows use cool pigments.

most common roofing materials used on steep-sloped roofs. Other products include metal roofing, tiles, and shakes.

The market for steep-sloped cool roofing materials is growing, although the solar reflectance for these products is generally lower than for low-sloped cool roofs. A number of products are available for tiles and painted metal roofing.

The solar reflectance of traditional tiles, typically made of clay or concrete, ranges from 10 to 30 percent. Manufacturers have begun producing "cool colored" tiles that contain pigments that reflect solar energy in the infrared spectrum. The ENERGY STAR Roof Products List as of April 2008 has approved tiles for steep-sloped roofs with initial solar reflectances ranging from 25 to almost 70 percent, depending on color. These tiles come in traditional colors, such as brown, green, and terra cotta. They are durable and long-lasting, but not widely used. Where tiles are used, the cool tile alternatives can be available at little or no incremental cost over traditional tiles.[6]

Cool Colors

The California Energy Commission has sponsored the "Cool Colors Project," under which LBNL and Oak Ridge National Laboratory (ORNL) are collaborating with roofing industry partners to research and develop cool colored roof products that could expand significantly the use of cool roofing in the residential sector. See <http://coolcolors.lbl.gov/> for more information.

Figure 9: Cool Metal Roofing

Cool colored metal roofs lend themselves readily to the steep-sloped market, as this house demonstrates.

Cool colored metal roofing products also use infrared-reflecting pigments and have high durability and long life. About one-half of the products on the ENERGY STAR Roof Products List as of April 2008 were metal roofing products for steep-sloped roofs, with initial solar reflectances ranging from about 20 to 90 percent.

Asphalt shingles are the most commonly used material for steep-sloped roofs, with a market share of about 50 percent, depending on the region,[7] and a low initial cost of just over $1.00 per square foot (0.930 m^2). As of April 2008, several manufacturers offered a line of asphalt shingles on the ENERGY STAR Roof Products List, with initial solar reflectances ranging from about 25 to 65 percent. Other shingle products on the list are metal. Manufacturers, researchers, and other stakeholders are working together to develop additional, cool-colored shingle products that use infrared-reflecting pigments.[8]

3. Benefits and Costs

The use of cool roofs as a mitigation strategy brings many benefits, including lower energy use, reduced air pollution and greenhouse gas emissions, and improved human health and comfort. At the same time, there can be a cost premium for some cool roof applications versus traditional roofing materials. This section highlights some of the key benefits and costs of cool roof programs and individual projects. Section 6 also introduces cool roof energy savings calculators that community planners or individual building owners can use to help determine whether to pursue cool roofs as a mitigation option.

3.1 Benefits

Reduced Energy Use. A cool roof transfers less heat to the building below, so the building stays cooler and more comfortable and uses less energy for cooling. Every building responds differently to the effects of a cool roof. For example, Table 1 lists examples of the general characteristics and cooling energy savings of different one-story buildings in California, Florida, and Texas. The measured savings varied from 10 to almost 70 percent of each building's total cooling energy use. In addition, a 2004 report summarized more than 25 articles about the cooling energy used by buildings with cool roofs and identified energy savings ranging from 2 to over 40 percent, with average savings of about 20 percent.[9]

Local climate and site-specific factors, such as insulation levels, duct placement, and attic configuration, play an important role in the amount of savings achieved (see the range in Table 1). Other site-specific variables also can strongly influence the amount of energy a particular building will save. For example, a study of a San Jose, California, drug store documented cooling energy savings of only 2 percent. The cooling demands in this store were driven by the design of the building, including a radiant barrier under the roof and a well ventilated plenum space, so that heat transfer through the roof contributed little to the store's cooling demand.[10] Thus, in gauging potential energy savings for a particular building, the building owners will need to consider a range of factors to make cool roofing work for them.

Another benefit of cool roofing is that it saves energy when most needed—during peak electrical demand periods that generally occur on hot, summer weekday afternoons, when offices and homes are running cooling systems, lights, and appliances. By reducing cooling system needs, a cool roof can help building owners reduce peak electricity demand. The last column in Table 1 lists reductions in the peak demand for cooling energy that range from 14 to 38 percent after installation of a cool roof.

Lower peak demand not only saves on total electrical use but also can reduce demand fees that some utilities charge commercial and industrial building owners. Unlike residential customers, who pay for only the amount of electricity they use, commercial and industrial customers often pay an additional fee based on the amount of peak power they demand. Because cool roofing helps reduce their peak demand, it lowers these costs.

Insulation and R-Values

The "R-value" of building insulation indicates its ability to impede heat flow. Higher R-values are correlated with greater insulating properties.

Researchers have conducted in-depth modeling to assess how building-level energy savings can affect city-wide energy usage. The Lawrence Berkeley National Laboratory (LBNL) ran simulations to evaluate the net energy impacts of applying cool roofing in 11 U.S. cities.[11] The original study was based on 1993 energy prices and buildings that use electrical cooling systems and gas furnaces. Figure 10 uses 2003 state-level prices for electricity and natural gas, based on Energy Information Administration data for the commercial sector.

Cool roofs reflect solar energy year round, which can be a disadvantage in the winter as they reflect away desirable wintertime heat gain. The net effect is generally positive, though, because most U.S. cities have high cooling and peak cooling demand, and electricity is expensive. Figure 10 presents the total anticipated cooling energy savings and the net savings after considering increased heating costs. Although northern and mid-Atlantic cities with relatively long heating seasons, such as Chicago, Philadelphia, and Washington D.C., still reap net savings, the net benefits for New York City remain particularly high because of the high price of electricity in that area. (See Section 3.2 for further discussion of the heating penalty.)

This same LBNL study extrapolated the results to the entire United States and estimated that widespread use of cool roofs

Table 1: Reported Cooling Energy Savings from Buildings with Cool Roofs[12]

Building	Location	Citation	Size (ft^2)	Roof Insulation*	Roof Space	Annual Cooling Saved	Peak Demand Savings
Residence	Merritt Island, FL	(Parker, D., S. Barkaszi, et al. 1994)	1,800	R-25	Attic	10%	23%
Convenience Retail	Austin, TX	(Konopacki, S. and H. Akbari 2001)	100,000	R-12	Plenum	11%	14%
Residence	Cocoa Beach, FL	(Parker, D., J. Cummings, et al. 1994)	1,795	R-11	Attic	25%	28%
Residence	Nobleton, FL	(Parker, D., S. Barkaszi, et al. 1994)	900	R-3	Attic	25%	30%
School Trailer	Volusia County, FL	(Callahan, M., D. Parker, et al. 2000)	1,440	R-11	None	33%	37%
School Trailer	Sacramento, CA	(Akbari, H., S. Bretz, et al. 1993)	960	R-19	None	34%	17%
Our Savior's School	Cocoa Beach, FL	(Parker, D., J. Sherwin, et al. 1996)	10,000	R-19	Attic	10%	35%
Residence	Cocoa Beach, FL	(Parker, D., J. Cummings, et al. 1994)	1,809	None	Attic	43%	38%
Residence	Sacramento, CA	(Akbari, H., S. Bretz, et al. 1993)	1,825	R-11	None	69%	32%

* Note: These insulation levels are lower than the energy efficiency levels recommended by ENERGY STAR. If insulation levels were higher, the cooling savings likely would be less.

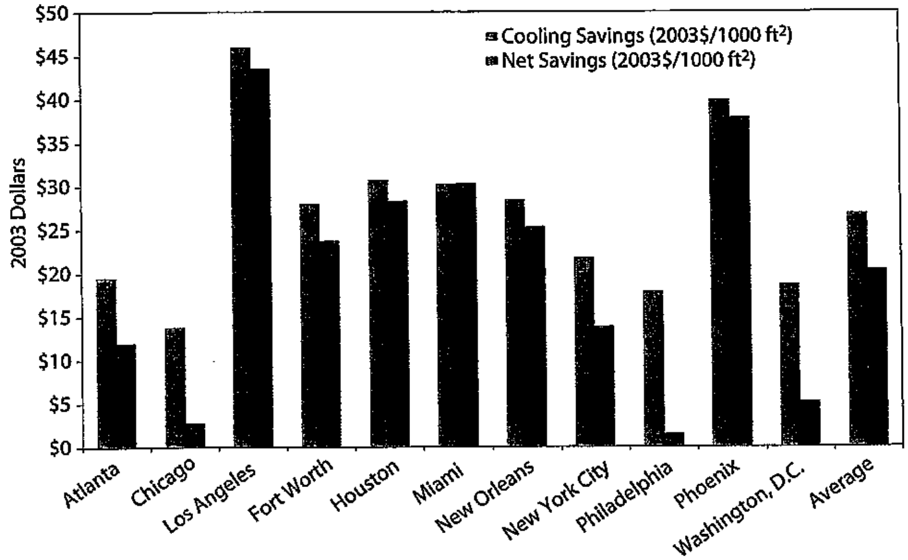
could reduce the national peak demand for electricity by 6.2 to 7.2 gigawatts (GW),[13] or the equivalent of eliminating the need to build 12 to 14 large power plants that have an energy capacity of 500 megawatts each.

Reduced Air Pollution and Greenhouse Gas Emissions. The widespread adoption of heat island mitigation efforts such as cool roofs can reduce energy use during the summer months. To the extent that reduced energy demand leads to reduced burning of fossil fuels, cool roofs contribute to fewer emissions of air pollutants, such as nitrogen oxides (NO_X), as well as greenhouse gases, primarily carbon dioxide (CO_2). The CO_2 reductions can be substantial. For example, one study estimated potential CO_2 reductions of 6 to 7 percent in Baton Rouge and Houston from reduced building energy use.[14] Reductions in air pollutant emissions such as NO_X generally provide benefits in terms of improved air quality, particularly ground-level ozone

Case Examples of Building Comfort Improvements

- **"Big-box" retailer Home Base, Vacaville, California.**[15] Installing a cool roof at this store helped solve the problem created by an incorrectly sized cooling system. This store used an undersized evaporative cooling system that was unable to meet the building's cooling loads. Indoor temperatures above 90°F (32°C) were recorded, even with the building coolers working around the clock. After adding a cool roof, peak indoor temperatures were reduced to 85°F (29°C) or lower, and 10 more shopping hours a week were deemed comfortable (below 79°F (26°C) and 60 percent humidity) inside the store. Although the evaporative coolers were still not powerful enough to meet the hottest conditions, the cool roof helped reduce temperatures inside the store.
- **Apartment complex, Sacramento, California.**[16] Adding cool roofs at these residences lowered indoor air temperatures, improving resident comfort. These non-air conditioned buildings were composed of two stories and an attic, with an R-38 level of insulation above the second story and below the attic space. Adding a cool roof lowered peak air temperatures in the attic by 30 to 40°F (17-22°C). Generally, the higher the insulation level, the less effect a cool roof will have on the space beneath it; however, in this case, even with high insulation levels, the cool roof reduced second-story air temperatures by 4°F (2°C) and first floor temperatures by 2°F (1°C).
- **Private elementary school, Cocoa Beach, Florida.**[17] Cool roof coatings at this school improved comfort and saved energy. This 10,000-square foot (930 m^2) facility had an asphalt-based roof, gray modified bitumen, over plywood decking with a measured solar reflectance of 23 percent. The dropped ceiling was insulated to R-19 levels, and insulated chiller lines were used in the hot roof plenum space. Once the roof was covered by an acrylic white elastomeric coating, the solar reflectance rose to 68 percent. The classrooms became cooler and the chiller electric use was reduced by 10 percent. School staff noticed improved comfort levels due to the new roof.

Figure 10: Modeled Net Energy Cost Savings* ($/1,000 ft²) in Various U.S. Cities from Widespread Use of Cool Roofing[18]



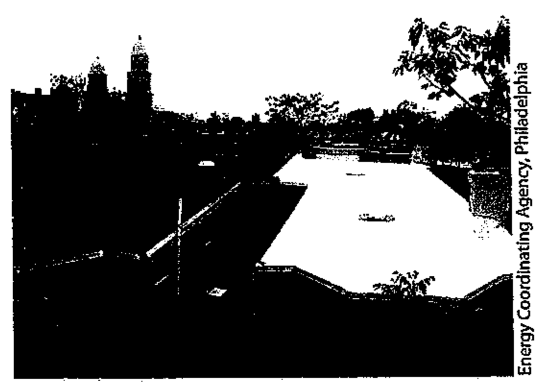
Costs are based on state-specific data applied to each city, using 2003 Energy Information Administration reported prices for the commercial sector.[19]

(smog). The relationships between pollutant reductions and improved air quality are complex, however, and require air quality modeling to demonstrate the benefits in specific urban areas.

Improved Human Health and Comfort. Ceilings directly under hot roofs can be very warm. A cool roof can reduce air temperatures inside buildings with and without air conditioning.

For residential buildings without air conditioning, cool roofs can provide an important public health benefit during heat waves. For example, Philadelphia operates a program to add cool roofs and insulation to residential buildings that lack air conditioning to prevent heat-related illnesses and deaths. A study measured significant cooling benefits from this program.[20] The study controlled for differences in outside temperature before and after the installing the cool roofs and insulation; these treatments lowered the daily maximum ceiling surface temperature by about 4.7°F (2.6°C), while daily maximum room air temperatures dropped by about 2.4°F (1.3°C). The study noted that on a 95°F (35°C) day, these types of reductions represent large reductions in heat gain to the room and significantly improve perceived human comfort.

Figure 11: Cool Roofing on Urban Row Homes



Philadelphia reduced temperatures in row houses by installing cool roofs, which improves the comfort for occupants and may help reduce deaths from excessive heat events. Baltimore, with similar building stock, took similar steps following the success in Philadelphia.

3.2 Potential Adverse Impacts

Cool roofs can have a wintertime heating penalty because they reflect solar heat that would help warm the building. Although building owners must account for this penalty in assessing the overall benefits of cool roofing strategies, in most U.S. climates this penalty is not large enough to negate the summertime cooling savings because:

- The amount of useful energy reflected by a cool roof in the winter tends to be less than the unwanted energy reflected in the summer. This difference occurs primarily because winter days are shorter, and the sun is lower in the sky. The sunlight strikes the Earth at a lower angle, spreading the energy out over a larger area and making it less intense. In mid-Atlantic and northern states with higher heating requirements, there also are more cloudy days during winter, which reduces the amount of sun reflected by a cool roof. Snow cover on roofs in these climates also can reduce the difference in solar reflectivity between cool and non-cool roofs.
- Many buildings use electricity for cooling and natural gas for heating. Electricity has traditionally been more expensive than natural gas per unit of energy, so the net annual energy savings translate into overall annual utility bill savings. Note, however, that natural gas and electricity prices have been volatile in some parts of the country, particularly since 2000. As shown in Figure 10, with elevated natural gas prices in recent years, the net benefit in terms of cost savings might be small in certain northern cities with high heating demands.

> California-based research indicates a **cost premium ranging from zero to 20 cents per square foot** for cool roof products.

3.3 Costs

A 2006 report (see Table 2) investigated the likely initial cost ranges for various cool roof products.[21] The comparisons in Table 2 are indicative of the trade-offs in cost and reflectance and emittance factors between traditional and cool roof options. For low-sloped roofs, the report noted that:

- Cool roof coatings might cost between $0.75 and $1.50 per square foot for materials and labor, which includes routine surface preparation like pressure-washing, but which does not include repair of leaks, cracks, or bubbling of the existing roof surface.
- Single-ply membrane costs vary from $1.50 to $3.00 per square foot, including materials, installation, and reasonable preparation work. This cost does not include extensive repair work or removal and disposal of existing roof layers.
- For either type of cool roof, there can be a cost premium compared to other roofing products. In terms of dollars per square foot, the premium ranges from zero to 5 or 10 cents for most products, or from 10 to 20 cents for a built-up roof with a cool coating used in place of smooth asphalt or aluminum coating.
- As with any roofing job, costs depend on the local market and factors such as the size of the job, the number of roof penetrations or obstacles, and the ease of access to the roof. These variables often outweigh significantly the difference in costs between various roofing material options.[22]

Table 2: Comparison of Traditional and Cool Roof Options[23]

Warmer Roof Options				Cooler Roof Options			
Roof Type	Reflectance	Emittance	Cost ($/ft²)	Roof Type	Reflectance	Emittance	Cost ($/ft²)
Built-up Roof			**1.2-2.1**	**Built-up Roof**			**1.2-2.15**
With dark gravel	0.08-0.15	0.80-0.90		With white gravel	0.30-0.50	0.80-0.90	
With smooth asphalt surface	0.04-0.05	0.85-0.95		With gravel and cementitious coating	0.50-0.70	0.80-0.90	
With aluminum coating	0.25-0.60	0.20-0.50		Smooth surface with white roof coating	0.75-0.85	0.80-0.90	
Single-Ply Membrane			**1.0-2.0**	**Single-Ply Membrane**			**1.0-2.05**
Black (PVC)	0.04-0.05	0.80-0.90		White (PVC)	0.70-0.78	0.80-0.90	
				Color with cool pigments	0.40-0.60	0.80-0.90	
Modified Bitumen			**1.5-1.9**	**Modified Bitumen**			**1.5-1.95**
With mineral surface capsheet (SBS, APP)	0.10-0.20	0.80-0.90		White coating over a mineral surface (SBS, APP)	0.60-0.75	0.80-0.90	
Metal Roof			**1.8-3.7**	**Metal Roof**			**1.8-3.75**
Unpainted, corrugated	0.30-0.50	0.05-0.30		White painted	0.60-0.70	0.80-0.90	
Dark-painted, corrugated	0.05-0.08	0.80-0.90		Color with cool pigments	0.40-0.70	0.80-0.90	
Asphalt Shingle			**0.5-2.0**	**Asphalt Shingle**			**0.6-2.1**
Black or dark brown with conventional pigments	0.04-0.15	0.80-0.90		"White" (light gray)	0.25-0.27	0.80-0.90	
				Medium gray or brown with cool pigments	0.25-0.27	0.80-0.90	
Liquid Applied Coating			**0.5-0.7**	**Liquid Applied Coating**			**0.6-0.8**
Smooth black	0.04-0.05	0.80-0.90		Smooth white	0.70-0.85	0.80-0.90	
				Smooth, off-white	0.40-0.60	0.80-0.90	
				Rough white	0.50-0.60	0.80-0.90	
Concrete Tile			**1.0-6.0**	**Concrete Tile**			**1.0-6.0**
Dark color with conventional pigments	0.05-0.35	0.80-0.90		White	0.70	0.80-0.90	
				Color with cool pigments	0.40-0.50	0.80-0.90	
Clay Tile			**3.0-5.0**	**Clay Tile**			**3.0-5.0**
Dark color with conventional pigments	0.20	0.80-0.90		White	0.70	0.80-0.90	
				Terra cotta (unglazed red tile)	0.40	0.80-0.90	
				Color with cool pigments	0.40-0.60	0.80-0.90	
Wood Shake			**0.5-2.0**	**Wood Shake**			**0.5-2.0**
Painted dark color with conventional pigment	0.05-0.35	0.80-0.90		Bare	0.40-0.55	0.80-0.90	

3.4 Benefit-Cost Considerations

Based on the benefits of cool roofs and the cost premiums noted in Table 2, a community can develop a benefit-cost analysis to determine whether a cool roof project or program will provide overall net benefits in a given area. For example, the cost study referenced in Table 2 also evaluated the cost effectiveness of low-sloped cool roofs for commercial buildings in California by quantifying five parameters (see summary results in Table 3):[24]

- Annual decrease in cooling electricity consumption
- Annual increase in heating electricity and/or gas
- Net present value (NPV) of net energy savings
- Cost savings from downsizing cooling equipment
- Cost premium for a cool roof

The study recognized that other parameters can provide benefits or reduce costs that were not part of the analysis. These include:

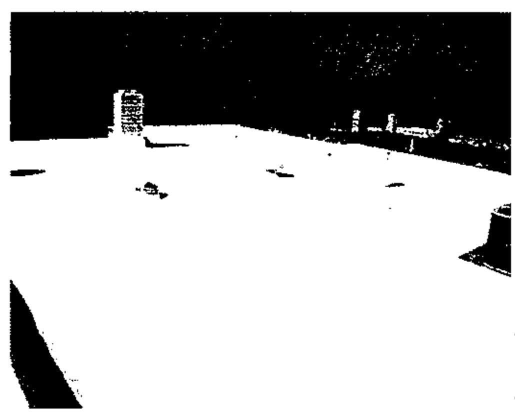
- Reduced peak electric demand for cooling
- Financial value of rebates or energy saving incentives that can offset the cost premiums for cool roofing materials
- Reduced material and labor costs over time resulting from the extended life of the cool roof compared to a traditional roof

Given the information at hand, the study found that expected total net benefits, after considering heating penalty costs, should range from \$0.16 to \$0.66/square foot (average \$0.47/ft^2) based on the California climate zones studied (see Table 3). California relied in part on this benefit-cost analysis to establish mandatory statewide low-sloped cool roof requirements.

In 2006, California began evaluating whether to extend the state's mandatory cool roof requirements to the steep-sloped market. One analysis in support of this approach anticipated positive cost effectiveness in many but not all California climate zones.[25] The state will consider that analysis, as well as public comments on benefits and costs in deciding what final action to take on steep-sloped roof requirements. A final rule is expected in 2008.

Although the results of Table 3 are specific to California in terms of electricity rates and typical cooling and heating energy use, the cost effectiveness approach can be replicated by other communities considering cool roof projects or programs.

Figure 12: Cool Roof on a Condominium



Gary Cook

Homeowners can also reap the benefits of cool roofs.

Table 3: Example Cool Roof Cost/Benefit Summary for California[26]

California Climate Zone	Roof R-Value	Annual Energy/1000 ft^2			Peak Power/1000 ft^2		Net Present Value (NPV)/1000 ft^2			
		kWh	therm	Source MBTU	kW	$equip	$kWh	$therm	$energy	$total
1	19	115	-8.3	0.3	0.13	67	157	-62	95	162
2	19	295	-5.9	2.4	0.20	100	405	-43	362	462
3	19	184	-4.9	1.4	0.15	76	253	-35	218	294
4	19	246	-4.2	2.1	0.18	90	337	-31	306	396
5	19	193	-4.7	1.5	0.17	83	265	-35	230	313
6	11	388	-4.1	3.6	0.22	111	532	-29	503	614
7	11	313	-2.6	2.9	0.25	125	428	-20	408	533
8	11	413	-3.7	3.9	0.25	125	565	-28	537	662
9	11	402	-4.5	3.7	0.20	101	552	-33	519	620
10	19	340	-3.6	3.1	0.18	89	467	-26	441	530
11	19	268	-4.9	2.3	0.15	75	368	-37	331	406
12	19	286	-5.3	2.4	0.19	95	392	-39	353	448
13	19	351	-5.1	3.1	0.19	96	480	-37	443	539
14	19	352	-4.7	3.1	0.21	105	483	-33	450	555
15	19	380	-1.7	3.7	0.16	82	520	-13	507	589
16	19	233	-10.6	1.3	0.18	90	319	-78	242	332
min		115	-10.6	0.3	0.13	67	157	-78	95	162
max		413	-1.7	3.9	0.25	125	565	-13	537	662
avg		297	-4.9	2.6	0.19	94	408	-36	372	466

* This table presents dollar savings from reduced air conditioning use (in kWh) and reduced air conditioning equipment sizing ($equip), offset by natural gas heating penalty costs (measured in therms). The "Net Present Value (NPV)/1000 ft^2" column uses the kWh and therm information to project savings for energy only and in total (energy plus equipment).

4. Other Factors to Consider

4.1 Product Measurement

To evaluate how "cool" a specific product is, ASTM International has validated test methods to measure solar reflectance and thermal emittance (see Table 4). The Cool Roof Rating Council (CRRC) also has developed a test method for variegated roof products such as composite shingles, including laboratory and field tests. Laboratory measurements help determine the properties of new material samples, while field measurements are useful for evaluating how well a roof material has withstood the test of time, weather, and dirt.

The final method listed in Table 4 is not an actual test but a way to calculate the "solar reflectance index" or SRI. The SRI is a value that incorporates both solar reflectance and thermal emittance in a single value to represent a material's temperature in the sun. This index compares how hot a surface would get compared to a standard black and a standard white surface. In physical terms, this scenario is like laying a roof material next to a black surface and a white surface and measuring the temperatures of all three surfaces in the sun. The SRI is a value between zero (as hot as a black surface) and 100 (as cool as a white surface) and calculated as follows:

$$SRI = \frac{(Tblack - Tsurface)}{(Tblack - Twhite)} \times 100$$

Table 4: Test Methods to Evaluate Coolness of Roofing Materials

Property	Test Method	Equipment Used	Test Location
Solar reflectance	ASTM E 903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres	Integrating sphere spectrophotometer	Laboratory
Solar reflectance	ASTM C 1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer	Portable solar reflectometer	Laboratory or field
Solar reflectance	ASTM E 1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field	Pyranometer	Field
Solar reflectance	CRRC Test Method #1 (for variegated roof products, [i.e. products with discrete markings of different colors]); used in conjunction with ASTM C1549	Portable solar reflectometer	Laboratory or field
Thermal emittance	ASTM E 408-71 - Standard Test Method for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques	Reflectometer or emissometer	Laboratory
Thermal emittance	ASTM C 1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers	Emissometer	Field
Solar reflectance index	ASTM E 1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces	None (calculation)	---

The U.S. Green Building Council, as part of its **Leadership in Energy and Environmental Design (LEED) Rating System,** has developed an SRI Calculator to assist project sponsors in calculating a roof's SRI under "LEED-NC, Version 2.2, Sustainable Site Credit 7.2: Heat Island Effect: Roof." See <www.usgbc.org>.

4.2 Product Labeling

ENERGY STAR for Roof Products and the Cool Roof Rating Council (CRRC) both operate voluntary labeling programs for manufacturers. Many building codes and energy efficiency rebate programs require that cool roofing materials meet recognized specifications and standards, and that a vendor's product be listed with either or both of these voluntary labeling programs.

Figure 13: Olympic Oval, Salt Lake City, Utah

The Olympic Oval features a cool roof covering almost 205,000 square feet (19,000 m^2). ENERGY STAR partners, who helped build the oval's roof, have played key roles in advancing cool roofing technology.

ENERGY STAR for Roof Products. Manufacturers can participate voluntarily in the ENERGY STAR for Roof Products program. A product qualifies for ENERGY STAR if it meets the solar reflectance criteria expressed in Table 5. The program uses significantly different criteria for low-sloped versus steep-sloped roof products. Highly reflective products, which are currently bright white for the most part, are available for low-sloped roofs. For aesthetic reasons, bright white options are generally not marketable for steep-sloped roofs. Instead, steep-sloped cool roof products generally use moderately reflective, colored options.

Version 2.0 of the program guidelines became effective in January 2008. The guidelines require manufacturers to test their products' initial solar reflectance and maintenance of solar reflectance after at least three years of service. For the initial testing, manufacturers can rely on tests conducted for purposes of certifying a product under the Cool Roof Rating Council's Product Rating Program, if applicable. To ensure the long-term integrity of reflective products, ENERGY STAR also requires products to maintain warranties comparable to those offered for non-reflective roof products. Finally, the Version 2.0 guidelines also require manufacturers to report a product's initial emissivity as part of the application process. There is no emissivity level required, but this information can provide valuable information on the potential savings and benefits

The most up-to-date list of **ENERGY STAR qualified roof products,** and current, proposed, and prior specifications, can be found on the ENERGY STAR Web site at <www.energystar.gov>.

Table 5: ENERGY STAR for Roof Products (Version 2.0) Qualifying Criteria

Type of Roof Product	Initial Solar Reflectance: Standard	Initial Solar Reflectance: Test Methods	Maintenance of Solar Reflectance*: Standard	Maintenance of Solar Reflectance*: Test Methods
Low-sloped	65% or higher	ASTM E 903 or ASTM C 1549**	50% or higher	ASTM E 1918 or ASTM C 1549
Steep-sloped	25% or higher	ASTM E 903 or ASTM C 1549**	15% or higher	ASTM C 1549

* Maintenance of solar reflectance is measured on a roof that has been in service for three years or more.
** Manufacturers can also use CRRC Test Method #1 for variegated roof products and can use results from tests conducted as part of CRRC Product Rating Program certification.

of a specific product in the region where it will be used.

Based on data from almost 90 percent of the ENERGY STAR Partners, the market share of cool roof products from these manufacturers has grown in recent years. In 2004, cool roof products represented 8 percent of these manufacturers' shipments in the commercial roofing sector and 6 percent in the residential. In 2006, their shipments of commercial cool roof product tripled to represent more than 25 percent of their commercial roof products, and the residential share almost doubled, reaching 10 percent.

Cool Roof Rating Council. CRRC is a non-profit organization with members from the business, consulting, and research fields. The CRRC was formed in 1998 and applied to join the American National Standards Institute (ANSI) ten years later. In September 2002, CRRC launched its product rating program with a list of solar reflectance and thermal emittance values of roofing materials. As of February 2007, this list included only initial or new values of roofing material properties, but work is underway to add three-year weathered values to the list. The weathered values of solar reflectance and thermal emittance will come from test farms located in different areas of the country, where roof materials are exposed to the elements for three years.

See the **CRRC Rated Product Directory** at <www.coolroofs.org>.

Manufacturer participation in the CRRC program is entirely voluntary. Participating manufacturers must adhere to stringent requirements; however, to ensure accurate reported values, only agencies or laboratories accredited by CRRC can perform tests, and their test programs must use the ASTM and CRRC standards listed in Table 4.

A material does not need to meet a solar reflectance or thermal emittance value to appear on the CRRC Rated Product Directory roofing products list. Because any product can be listed, regardless of how cool it might be, it is up to the consumer to check the values on the CRRC list and decide which products meet their own criteria for cool materials. Building owners and heat island mitigation groups can use the CRRC ratings in conjunction with the ENERGY STAR guidelines to help to identify cool materials on the basis of solar reflectance.

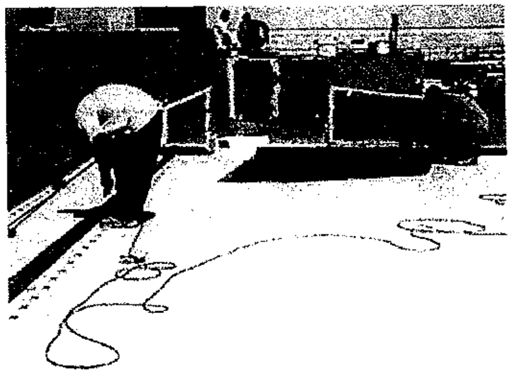
4.3 Installation and Maintenance

A coating or single-ply membrane on a low-sloped roof can serve as the top surface of a roofing assembly and can be applied directly over a roof deck or on top of other existing materials. Proper installation is important to the long-term success of a cool roof project. For example, when applied properly, many cool roof coatings have been shown to last more than 20 years. When applied poorly, cool roof coatings can peel or flake off the roof within a couple of years. To ensure good product performance, building owners can seek appropriate warranties for both the product and the installation service.

> On **steep-sloped roofs**, professionals do not recommend using cool coatings over existing shingles. This technique can cause moisture problems and water damage because the coating can inhibit normal shingle drying after rain or dew accumulation, allowing water to condense and collect under the shingles.

A key concern for cool roofs is maintaining their high solar reflectance over time. If a building's roof tends to collect large amounts of dirt or particulate matter, washing the roof according to the manufacturer's recommended maintenance procedures can help retain solar reflectance. Also, smoother surfaces and higher sloped surfaces tend to withstand weathering better. With proper maintenance, coatings are able to retain most of their solar reflectance, with decreases of only about 20 percent, usually in the first year after application of the coating.[27]

Figure 14: Installation of a Cool Single-Ply Membrane



Lisa Gartland/PositivEnergy

Cool roofs can be applied to existing buildings or designed into new ones.

4.4 Cool Roofing and Insulation

Cool roofing and roof insulation are not comparable options for saving building energy—they work very differently. Building owners must make separate decisions to upgrade roof insulation levels or install cool roofing.

Some studies have evaluated the insulation levels needed to produce the same summertime energy savings as a cool roof.[28,29,30] These studies have been used to support building codes that allow less roof insulation if cool roofing is installed.[31,32] The conditions for choosing levels of roof insulation or cool roofing vary based on climate, utility prices, building use, building and fire code considerations, and preference. Thus, the following factors for choosing insulation or cool roofing are general approximations. Building owners might consider adding roof or ceiling insulation if:

- There is less roof insulation than called for in the latest state or local building codes

- The building is in a climate with significant cold weather or heating needs
- The roof accounts for much of the building's envelope (i.e., the roof area equals or exceeds one-fourth of the building's exterior surface area, calculated as the walls plus the roof).

Cool roofing can be used on any building, but is especially useful if:

- The building is in a climate with hot and sunny weather during at least part of the year (80°F or hotter weather with clear skies for at least three months of the year)
- Significant cooling energy is used (three or more months of cooling use)
- The duct system is in the attic or plenum space
- There are problems maintaining indoor comfort in the summer (if air conditioning equipment cannot maintain the desired temperature, or without air conditioning, if indoor temperatures exceed 80°F)
- The roof accounts for much of the building's envelope (i.e., the roof area equals or exceeds one-fourth of the building's exterior surface area, calculated as the walls plus the roof)
- The roof materials tend to crack and age prematurely from sun damage (if damage begins before the warranty period or the roof life ends).

Generally, adding roof insulation means adding insulation under the roof or above the ceiling, which can be disruptive to building occupants. Another option on the market is to spray insulating foam or affix rigid insulation onto the top of the roof surface. Each of these products adds approximately an R-6 level of long-term thermal resistance for each inch (2.5 cm) of thickness added. These technologies by themselves are not cool roofing materials; however, they are often applied as part of a complete roofing system, where the top surface is a cool coating or single-ply membrane.

5. Cool Roof Initiatives

Communities have developed cool roof programs by taking action in their own buildings, often called leading by example; through voluntary incentives; and through mandatory requirements.

Local governments have frequently started by installing cool roofs in public buildings. Their efforts have included launching demonstration projects and adapting public building procurement practices to require cool roofs for new public buildings and roofing renovation projects. Beginning with the public sector allows a community to demonstrate the technology, make contractors aware of the products available, and promote the use of cool roof materials in other building sectors.

In many communities, voluntary cool roof incentives have been provided by local energy companies as part of their demand-side management programs. A few local government agencies also offer incentives to assist low-income or other households with installing cool roofs.

Some governments have mandated implementation of cool roofs in certain areas. These actions generally require adopting specific energy code provisions that require cool roofs or include cool roofs in the calculation of how much insulation is required to meet minimum energy efficiency requirements.

Mandatory requirements for cool roofs have played an increasingly significant role in implementation. Before 1995, the only regulations affecting cool roofing mandated that roof color not cause undue glare. The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) has since developed energy-efficient design standards that provide minimum requirements for both commercial and residential buildings. ANSI/ASHRAE/IESNA Standard 90.1-1999, *Energy Standards for Buildings Except Low-Rise Residential Buildings* and ANSI/ASHRAE Standard 90.2-2001, *Energy-Efficient Design of Low-Rise Residential Buildings* provide guidelines for new equipment, systems, and buildings. These standards were originally developed in response to the 1970s energy crisis and now serve as the generally accepted basis for many state building and energy codes. Both ASHRAE standards include credits pertaining to cool roofing. An example of a cool roofing credit is Addendum f to 90.2-2001, which allows the use of high-albedo roofs in hot and humid climates as part of the energy efficiency ceiling calculation for a residential building.[33]

A number of states and localities now have developed specific energy code requirements to encourage or require cool roofing. For example:

- In 1995, Georgia was the first state to add cool roofs to its energy code. The code allowed building owners to reduce roof insulation if they installed a cool roof that had a minimum solar reflectance of 75 percent and a minimum thermal emittance of 75 percent.[34] Note that if a building owner uses less insulation when installing a cool roof, he may not accrue net energy savings.
- Florida is using a similar approach to Georgia in its energy code.[35] Because of the energy efficiency gains from cool roofs, the Florida code allows commercial and multi-family residential buildings using a roof with at least 70 percent solar reflectance and 75 percent thermal emittance to reduce the amount of insulation required to meet building energy efficiency standards. The adjustment does not apply for roofs with ventilated attics or semi-heated spaces.
- In January 2003, Chicago amended its energy code requirements for low-sloped roofs.[36] This code applies to all buildings except separated buildings that have minimal peak rates of energy use and buildings that are neither heated nor cooled. Low-sloped roofs installed on or before December 31, 2008, must achieve a minimum solar reflectance (both initial and weathered) of 0.25 when tested in accordance with ASTM standards E 903 and E 1918 or by testing with a portable reflectometer at near ambient conditions. For low-sloped roofs installed after that date, roofing products must meet or exceed the minimum criteria to qualify for the ENERGY STAR Roof Products label.
- In 2001, in response to electrical power shortages, California updated its building energy code (Title 24), adding cool roofing as an energy efficiency option.[37] A cool roof is defined as having minimum solar reflectance of 70 percent and minimum thermal emittance of 75 percent, unless it is a concrete or clay tile, in which case it can have a minimum solar reflectance of 40 percent. This 40 percent rating incorporates new cool colored residential products. Owners must use specific methods to verify building energy use to account for cool roofing as an energy efficiency option. In this case, the heat

gain of the roof is reduced to account for use of a cool roof. In 2005, these cool roof provisions became mandatory for all new non-residential construction and re-roofing projects that involve more than 2,000 square feet (190 m^2) or 50 percent replacement. The code also provides alternatives to the standard criteria as additional compliance options. In 2006, California began considering planned 2008 updates to Title 24 and is studying the possibility of extending cool roof requirements to the steep-sloped market.[38]

For further information on **California Title 24**, see <www.energy.ca.gov/efficiency/blueprint/index.html>.

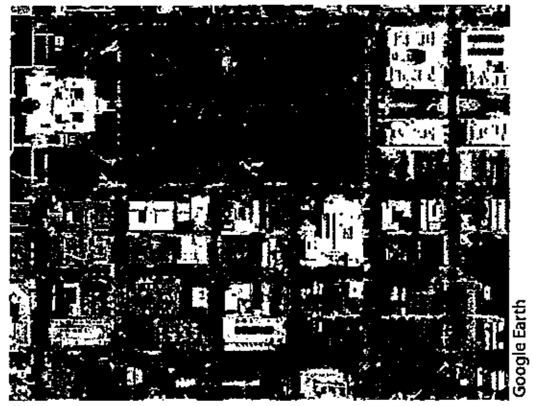
Table 6 lists many of the primary types of cool roof activities. The "Heat Island Reduction Activities" chapter provides more detailed examples.

6. Resources

6.1 Cool Roof Energy Savings Calculators

Federal agencies have developed two Web-based calculators that compare energy and cost savings from different cool roof technologies for various building types. Consumers also can find calculator tools on Web sites of cool roof product manufacturers. All of these tools use different assumptions and formulas and generate different results; therefore, they provide a range of potential impacts rather than precise statements of the savings any individual building owner will obtain.

Figure 15: Aerial View of Sacramento, California, with Capitol



California's Title 24 has accelerated the diffusion of cool roofing across the state. The reflective roof of the capitol in Sacramento and other buildings around Capitol Park stand out among the vegetation, pavement, and darker roofs.

ENERGY STAR Roofing Comparison Calculator. The Web-based ENERGY STAR Roofing Comparison Calculator helps to estimate the energy and money that can be saved by using ENERGY STAR roofing products on air-conditioned buildings of at least 3,000 square feet (280 m^2). This calculator estimates savings of typical building types with non-metallic-surfaced roofs under typical weather conditions.

This EPA calculator requires input on the age, type, and location of the building; the efficiency of the heating and cooling systems; the local cost of energy; and information about the roof area, insulation levels, and type of roofing systems used. Based on these factors, the tool provides an estimate of annual electricity savings in kWh and dollars per 1,000 square feet (93 m^2). The annual effects of any heating penalties are included, given in therms and dollars per 1,000 square feet if natural gas is used to fuel the heating system, or subtracted from the annual electricity savings if an electric heat pump is used. This calculator does not model electric resistance heating systems.

Table 6: Examples of Cool Roof Initiatives

Type of Initiative	Description	Links to Examples
Research	National laboratories	**<http://eetd.lbl.gov/HeatIsland>** - The Heat Island Group at Lawrence Berkeley National Laboratory provides research and information about cool roofing and other heat island mitigation measures. The Cool Roofing Materials Database lists the solar reflectance and thermal emittance of numerous roof products, including cool colored roofing.
		<www.ornl.org> - ORNL conducts research on reflective roofing and solar radiation control. Its Web site includes fact sheets, a cool roof calculator, background information about cool roofing, and research publications.
Voluntary efforts	Demonstration programs	**<www.swenergy.org/casestudies/arizona/tucson_topsc.htm>** - Tucson, Arizona, Cool Roof Demonstration Project (city office building).
	Incentive programs	**<www.pge.com/res/rebates/cool_roof/index.html>** - Pacific Gas & Electric's utility rebate program for cool roofs.
		<www.sce.com/RebatesandSavings/Residential/_ Heating+and+Cooling/CoolRoof/> - Southern California Edison's Cool Roof Rebate Program.
		<www.austinenergy.com/Energy%20Efficiency/Programs/Rebates/ Commercial/Commercial%20Energy/buildingEnvelope.htm> - Austin Energy's Reflective Roof Coating and Roof and Ceiling Insulation rebate information.
		<http://egov.cityofchicago.org/> - Chicago announced in Fall 2007 that it was expanding a green roof grant program to include cool roofs, with up to 55 $6,000 grants targeted per year; see information under Department of Environment portion of the City's website.
	Outreach & education	**<www.epa.gov/heatisland/>** - EPA's Heat Island Reduction Initiative provides information on the temperature, energy, and air quality impacts from green roofs and other heat island mitigation strategies.
	Weatherization programs	**<www.ecasavesenergy.org/ses/whiteroof.html>** - Philadelphia cool roof incentive program for low-income housing.
Policy efforts	State and municipal energy codes that require or provide recognition of cool roofs	**<www.energy.ca.gov/title24/index.html>** - California building energy code that requires cool roofs on nonresidential low-sloped roofs; applies to new and retrofit projects over certain size thresholds.
		<http://rules.sos.state.ga.us/docs/110/11/1/03.pdf> - Georgia Energy Code revision applicable to cool roofs.
		<http://egov.cityofchicago.org/> - See Energy Code listings under Chicago Department of Construction and Permits under local government portion of the website.

Access these **calculators on the Web:**

ENERGY STAR Calculator:
<www.energystar.gov>,
under "Roof Products."

ORNL Calculator:
<www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm>.

For information on an effort begun in 2007 to develop an integrated EPA/Department of Energy (DOE) calculator, see: **<www.govforums.org/e&w>**.

The roofing calculator is intended to estimate the savings that a reflective roof can offer to a typical building and to aid in the decision of whether to choose an ENERGY STAR-qualified roof product. It is only one of many tools that can be used in the decision making process. A more detailed building energy simulation would be needed to estimate savings for a particular building or calculate specific benefit-cost ratios for a project.

Note that the ENERGY STAR calculator estimates could underpredict the energy savings from a cool roof in some cases. This is because the equations used in the ENERGY STAR calculator were derived from multiple runs of a DOE building energy analysis model, which does not consider the effects of widely varying roof temperatures or duct location. These effects include changes in the thermal conductivity of the insulation, thermal radiation in the attic or plenum, and conduction gains to cooling ducts.

ORNL Cool Roof Calculator. This cool roof calculator is a Web-based tool that helps estimate the energy and financial impacts from installing cool roofs on buildings with low-sloped roofs that do not have ventilated attics or plenums.

To generate the equations used in this tool, researchers ran a computer model of a roof and ceiling assembly over a range of climates for roofs with varying levels of insulation, solar reflectance, and thermal emittance. This model was calibrated to emulate heat transfer measurements made on a special roof and ceiling test assembly at ORNL.[39]

This calculator requires input on building location (a choice of 235 different U.S. cities is provided); information about the insulation, solar reflectance, and thermal emittance of the proposed roof; and the cost of energy and efficiency of the heating and cooling systems. The tool provides the annual cost savings on a square-foot basis in comparison to a black roof, as well as annual heating energy savings or penalty, also in dollars per square foot.

6.2 Roofing Programs and Organizations

Table 7 lists a number of programs that actively promote cool roofs or that are currently involved in cool roof research.

Table 7: Cool Roof Programs and Organizations

Program/Organization	Role	Web Address
Cool Metal Roofing Coalition	This industry group educates architects, building owners, specifiers, code and standards officials, and other stakeholders about the sustainable, energy-related impacts of cool metal roofing.	<www.coolmetalroofing.org>
Cool Roof Rating Council (CRRC)	Created in 1998 as a nonprofit, educational organization, CRRC's members include manufacturers, utilities, researchers, and consultants. CRRC maintains a product rating program and associated product directory.	<www.coolroofs.org>
ENERGY STAR	ENERGY STAR is a joint EPA and DOE program that helps consumers save money and protect the environment through energy-efficient products and practices. Regarding cool roofs, the Web site provides information on qualified roofing products, industry partners, and case studies.	<www.energystar.gov>
National Roofing Contractors Association (NRCA)	This trade association includes roofing, roof deck, and waterproofing contractors and industry-related associate members. It provides technical and safety information, news, and calendars of industry events.	<www.nrca.net>
Roof Consultants Institute (RCI)	This international, nonprofit association includes professional roof consultants, architects, and engineers. It hosts trade conventions and develops standards for professional qualifications.	<www.rci-online.org>
Roof Coatings Manufacturers Association (RCMA)	RCMA is a national trade association representing the manufacturers of cold-applied coatings and cements for roofing and waterproofing. It promotes the availability and adaption of energy-efficient materials.	<www.roofcoatings.org>
Single Ply Roofing Industry (SPRI)	SPRI is a trade organization representing sheet membrane and component suppliers to the commercial roofing industry. It provides information about and forums to discuss industry practices, workforce training, and other concerns.	<www.spri.org>

Endnotes

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ADDENDUM A

ADDITIONAL COMMENTS RECEIVED FROM THE IMPACTED COMMUNITY AFTER INITIAL REVIEW OF THE EIA

12/2/2011

Subject: Comments on AECC / IECC comparison Study - Heating/Cooling Systems

Comment:

The biggest issue with the AECC vs. IECC study, mechanically speaking, is that the study simply compares a single mechanical system (water source heat pump) without acknowledging that the requirements of the AECC completely eliminate the less costly alternatives for the mechanical system for the building in question. The AECC basically says "let's go shop for a car, but we can't shop for anything less than a Lexus. Now let's compare all those (higher cost) options.

A definite alternate for the building in question is a Package rooftop, constant volume with electric reheat, or a VAV (variable volume) system with electric reheat. Both of these could be available for the 25,000 sf building (or smaller) using the performance path. The AECC DOES NOT ALLOW the use of electric reheat. So if individual zone control is required (IE multiple thermostats) a (much) more costly alternate system is required.
In the case of the 25,000 sf building this drives the cost from a baseline system of (less than) $250,000 to an AECC required system of (greater than) $400,000. This is an increase of $150,000 and it is not reflected anywhere in the study. The study merely compares one very efficient system to another very efficient system, not accounting for the restrictions of the AECC. Basically eliminating the Chevrolet option and only allowing the Lexus option.

Kevin Yearout
President
Yearout Mechanical, Inc.

Subject: Financial Parameters – Inflation & Energy Escalation

Comment:

We asked that the financial parameters indicated on Page 12 of the Energy Conservation Code Comparison report be reviewed. Currently they are:

Inflation =3.525%
Power Escalation = 3.022%
Gas Escalation = 3.540%

These numbers were reported to be determined by averaging actual rates over the last five years and may not be relevant when projecting a Life Cycle Cost Analysis out over the next 20 years or so. The DOE produces a report annually that projects inflation rates, discount rates, and energy escalation rates forward that may be more appropriate. The report can be found at the attached link:

http://www1.eere.energy.gov/femp/pdfs/ashb11.pdf

Richard J. Reif
Vice President
Bridgers & Paxton Consulting Engineers, Inc.

Subject: HBA Comments on the Economic Impact Study

Comment:

Thank you for allowing the HBA to participate in the process of developing the Economic Impact Study for the adoption of the 2009 International Energy Conservation Code. I would like to thank you for managing the process with openness and transparency. It truly has been a refreshing experience.

Per the meeting on December 2, the HBA would like to request that the following comments be added to the Economic Impact Study.

1. The total energy saved by using the AECC is overstated in both residential models. This statement is based on the notes in the report produced by M&E engineering. Page 5, Item 9 describes how M&E engineering applied the rules for lighting to the model. The item states that if the 2009 IECC is followed then the project would also comply with the AECC. Because of this, the report assigned no cost to the item. M&E contradicted their written application of the code by modeling significant savings due to lighting. This is not accurate and materially alters the results. HBA requests that a foot note be added adjusting the energy savings and associated cost savings with lighting to be consistent with Page 5, Item 9. This results in a 27.7% reduction in the difference of dollars saved between the two codes on the three bedroom model. The 4 bedroom model should be adjusted accordingly.

2. M&E engineering agreed that certain aspects of the code could not be modeled using software. M&E intended to use estimates for these areas. The HBA believes these items are subjective since they cannot be accurately quantified. This concept was discussed during the open meeting prior to modeling being performed. The HBA believes these numbers should either be eliminated or at least separated from the items that can be accurately measured.

3. The total revision for the items above would change annual dollars reduced on the three bedroom model from $191 to $107. On the 4 bedroom model the numbers would change from $296 to $213. These are significant revisions.

Thank you again for allowing the HBA to provide input on this critical issue. If you have any further questions please feel free to contact me directly.

Bret Bailey

HBA of Central New Mexico

Subject: Prescriptive vs. Performance Paths, Energy Consumption Data

Comment:

One thing to remember.

The energy code has two compliance paths, prescriptive and performance. Any well trained architect or designer should be able to use the performance path and meet the energy code requirement at no cost (or cost savings) by incorporating the hundreds of available energy saving design strategies, - e.g., building orientation; window orientation; shading strategies, passive heating, cooling and ventilation strategies; daylighting strategies; passive hot water heating, building and roof color, etc.

On 12/4/11 11:57 AM, Edward Mazria wrote:

I sent the following to Dale Dekker today in response to some questions, I think you will also find it of interest.
Ed

Source: US Energy Information Administration

Annual US Energy Consumption by Fuel Type:
85% fossil fuel, 9% nuclear, 6% renewables

Annual US Energy Consumption by Sector:
49% Building Sector (48 QBtu), 28% Transportation (27.5 QBtu), 23% Industry (23 QBtu)

Annual US Building Sector Energy Consumption by Type (48 QBtu):
42.3 QBtu - Building Operations (heating, lighting, cooling, plug loads),
5.7 QBtu - Building Products and Construction

Annual US Transportation Sector Energy Consumption by Type (27.5 QBtu):
16.0 QBtu - Auto, SUV, Minivan, Light Duty Trucks (Pick Up's)
5.2 QBtu - Heavy Duty Truck
6.3 QBtu - Rail, Bus, Air, Ship

Projected Annual Energy Consumption Increase from 2010 to 2035:
7.7 QBtu - Building Operations
2.6 QBtu - Auto/SUV/Minivan/Light Duty Truck (this estimate will decrease significantly since it does not take into account the new gas mileage improvements recently worked out between the EPA and US based automakers - moving the current fleet average from 27.5mpg incrementally to 54.5mpg by 2025).

Nuclear Energy:

US currently has 104 operating nuclear reactors (France has 58 nuclear reactors) that produce 2.19 QBtu of delivered energy and 6.2 QBtu of energy looses (waste heat and electric line losses).

EIA projects that we will add 0.21 QBtu of additional delivered nuclear energy and 0.59 QBtu of nuclear energy losses in the US between 2010 and 2035.

It takes approximately thirty-seven 1000MW (large) nuclear plants to produce 1.0 QBtu of delivered energy. One 1000MW nuclear plant cost $6 to $9 billion to build (not including land and infrastructure costs, and government incentives and guarantees).

The last nuclear plant to come on-line in the US (Watts Bar 1 in Tennessee) had a construction period of 23 years and 9 months.

Some other US EIA statistics to be aware of:

46.9% of total US CO_2 emissions is attributed to the Building Sector (percentage expected to increase between 2010 and 2035).

19.5% of total US CO_2 emissions is attributed to Auto/SUV/Minivan/Light Duty Trucks (percentage expected to decrease between 2010 and 2035).

81% of U.S. electricity CO_2 emissions come from coal, 77% of this electricity is consumed by building operations.

Also of Interest:

http://news.yahoo.com/world-five-years-avoid-severe-warming-iea-170519443.html
http://uk.reuters.com/article/2011/11/09/uk-climate-iea-idUKTRE7A83G120111109

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Subject: **A House is Not a Home**

There is a difference between a house and a home. A home shelters a family. It is where we raise our children, celebrate Thanksgiving, and live our lives. In most cases a home also represents the lion's share of our net financial worth: the equity we leave to our children. For young families, a home is a toe-hold on the ladder of the American Dream.

A house is sold as a commodity. It is brokered as collateral for a mortgage. In most cases, a house is the product of an industry controlled by financial interests outside of our community: a cog in a machine greased by the incentive of short-term profit. For most young families today, a house is a linchpin of what has turned out to be a false economy.

For the past fifty years house builders have operated on the assumption that abundant supplies of inexpensive energy make it easier to pump vast amounts of cold air into houses in the summer and hot air into houses in the winter than to build energy-efficient homes. And it is easier for them. Once a house is sold, the house builders do not have to live with the long-term costs of heating and cooling it. For the sake of a more competitive initial purchase price, house builders prefer not to have to account for wasteful energy use over the life of the house.

To put it another way, the contemporary American house buyer favors the short-term advantage of a low down payment on a smaller mortgage over the long-term advantage of energy efficiency resulting from responsible design and construction. Rather than pay for overhangs to shade windows from the sun, higher insulation values, or heat-reflecting roofs, the contemporary American house buyer favors larger houses with more space to heat and cool. The prevailing attitude is to postpone until the future what you don't have to pay for today.

According to the National Association of Home Builders and the US Census, the average new house floor area increased from 983 square feet in 1950 to 2266 square feet in 2000. During this same period the number of family members per household decreased. This resulted in an increase in the floor area per capita from 286 square feet per capita in 1950 to 847 square feet per capita in 2000. As modern Americans we have grown fat from our indulgences at the expense of creating a legacy of well-designed and well-built energy-efficient homes for our children.

The record is clear: For the past fifty years the marketplace has ignored the long-term costs of building poorly-designed and poorly-constructed homes. It has ignored the long-term costs of energy consumption that can burden a family's annual budget. And it has ignored the consequences to a family that finally pays off the thirty-year mortgage only to find that their equity in home ownership has evaporated due to poor design and construction and the depreciation of their house's value because of higher costs to heat and cool it.

On the consumption side of the marketplace, this false economy has to do with living in an age of instant gratification where success is defined by the realization of short-term goals. On the production side, it has to do with the fact that the interests of large, publically-traded house-building corporations with the responsibility of making quarterly financial reports to their out-of-state shareholders may not coincide with the long-term interests of our community. *And yet sustained and sustainable prosperity is in everyone's interest.*

Two facts lead to a critical question. First, house builders are not rewarded financially by the appreciation of long-term value; they are only rewarded by the profit margin at the time of the initial sale. Second, the enhanced value of well-designed and well-built energy-efficient homes contributes positively both to the individual property owner's equity and to the local government that depends on appraised value as the basis for property tax revenue. The critical question is this: How can the short-term profit that motivates the house builder be harnessed to the creation of long-term property value?

The answer to this question has to do with the building regulations we --- as a community --- choose to adopt to ensure that the long-term interests of our children and our community are protected. The City of Albuquerque's Energy Conservation Code provides this protection. Consider the return on investment for the economic viability of our community when our children and their children are not burdened by the costs of living in poorly designed and constructed homes. This is why it is so important for the citizens of Albuquerque to let our Mayor and our City Councilors know that we do not want Albuquerque's Energy Conservation Code repealed.

Anthony Anella, AIA

Albuquerque Architect

ADDENDUM B

NEW MEXICO STATE CONSTRUCTION INDUSTRIES DIVISION AMENDMENT TO THE 2009 NEW MEXICO ENERGY CONSERVATION CODE

This is an amendment to 14.7.6 NMAC, Sections 11 and 12, effective January 1, 2012.

14.7.6.11 CHAPTER 3 - CLIMATE ZONES: See this Chapter of the IECC except delete the text of section 301.1 General and replace with the following: the table below in conjunction with Table 301.3(2) shall be used to determine the applicable requirements for Chapters 4 & 5. Locations not in the table below shall use either Table 301.1, Section 301.3, or the building official may designate a climate zone consistent with the elevation, HDD & CDD from the table below for the unlisted location.

Table 301.2
New Mexico Climate Zones Based on Heating and Cooling Degree Days

City	County	Elev. (feet)	Heating Degree Days (HDD) 65°F	Cooling Degree Days (CDD) 50°F day	Climate Zone
Abiquiu Dam	Rio Arriba	6380	5872		5B
Angel Fire	Colfax	8406	9769	195	7B
Alamogordo	Otero	4350	3053	5309	3B
Albuquerque	Bernalillo	5312	4332	4462	4B
Artesia	Eddy	3380	3366	5374	3B
Aztec Ruins	San Juan	5644	5757		5B
Belen	Valencia	4800	4432	5012	3B
Bernalillo	Sandoval	5052	4782	4138	4B
Bloomfield	San Juan	5456	5490		5B
Bosque del Apache	Socorro	4520	3916	5012	3B
Carlsbad	Eddy	3295	2813	5997	3B
Carrizozo	Lincoln	5438	4234	3631	4B
Cedar Crest	Bernalillo	6581	5703		5B
Chaco Canyon	San Juan	6200	6137		5B
Chama	Rio Arriba	7871	8254		6B
Clayton	Union	5056	5150	3170	4B
Cloudcroft	Otero	8801	7205		6B
Clovis	Curry	4268	4033	4252	4B
Corona	Valencia	6690	5389	3631	4B
Cuba	Sandoval	7035	7122		5B
Deming	Luna	4305	3347	5292	3B
Dulce	Rio Arriba	6793	7979		6B
Eagle Nest	Colfax	8262	9254		7B
Edgewood	Santa Fe	6649	6146		5B
Espanola	Rio Arriba	5643	5641		5B
Farmington	San Juan	5395	5747		5B
Fence Lake	Cibola	7055	6396		5B
Fort Sumner	De Baca	4032	3799	4616	3B
Gallup	McKinley	6465	6207		5B
Glenwood	Catron	4725	3632	4427	4B
Grants	Cibola	6460	6143		5B
Hatch	Dona Ana	4052	3270	5904	3B
Hobbs	Lea	3622	2954	5181	3B
Jemez Springs	Sandoval	6198	5260	2059	4B

Las Cruces	Dona Ana	4000	3223	5904	3B
Las Vegas	San Miguel	6424	5738		5B
Lordsburg	Hidalgo	4250	3213	5210	3B
Los Alamos	Los Alamos	7320	6381		5B
Los Lunas	Valencia	4856	4725	4462	4B
Magdalena	Socorro	6572	5074	2093	4B
Mescalero	Otero	6611	5540		5B
Moriarty	Torrance	6220	4735	3786	4B
Mosquero	Harding	5485	5209	3631	4B
Mountainair	Torrance	6520	5558		5B
Organ	Dona Ana	5245	3215	4919	3B
Placitas	Sandoval	5955	4917	3701	4B
Portales	Roosevelt	4006	3845	4347	4B
Raton	Colfax	6680	6001		5B
Red River	Taos	8671	8742	179	7B
Reserve	Catron	5847	5483		5B
Rio Rancho	Sandoval	5282	4880	3949	4B
Roswell	Chaves	3573	3565	5505	3B
Ruidoso	Lincoln	6920	6309		5B
Sandia Crest	Bernalillo	10680	10034		7B
Sandia Park	Bernalillo	7077	7510		6B
Santa Fe	Santa Fe	7260	6001		5B
Santa Rosa	Guadalupe	4620	3749	4714	3B
Shiprock	San Juan	4892	5475		5B
Silver City	Grant	5895	4438	3975	4B
Socorro	Socorro	4603	3984	5147	3B
Springer	Colfax	5797	5653		5B
Taos	Taos	6967	6827		5B
Taos Ski Valley	Taos	9321	9769		7B
Tatum	Lea	3999	3680	4721	3B
Thoreau	McKinley	7200	5789		5B
Tierra Amarilla	Rio Arriba	7425	7901		6B
Tijeras	Bernalillo	6322	6338		5B
Tohatchi	McKinley	6447	5418		5B
Truth or Consequences	Sierra	4245	3394	5103	3B
Tucumcari	Quay	4096	3767	4429	4B
Tularosa	Otero	4508	3056	5130	3B
Zuni	McKinley	6293	5742		5B

[14.7.6.11 NMAC - Rp, 14.7.6.11 NMAC, 8-1-11; A, 1-1-12]

14.7.6.12 CHAPTER 4 - RESIDENTIAL ENERGY EFFICIENCY. See this Chapter of the IECC except for the following:

A. **401.2 Compliance.** Delete the text of this section and replace with the following: projects shall comply with sections 401, 402.4, 403.1, 403.2.2, 403.2 through 403.9, and 404.1 (referred to as the mandatory provisions), and one of the following:

(1) sections 402.1 through 402.3, 402.5, and 403.2.1 (prescriptive); or

(2) specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code, such as ResCheck, RemRate, and worksheet trade-off sheets from the New Mexico energy conservation code residential applications manual; or

(3) performance path to compliance;

(a) section 405, simulated performance alternative or;

(b) a home energy rating system (HERS) index of 83 or less in climate zone 3, or a HERS index of 89 or less in climate zones 4-7, confirmed in writing by a ResNet-certified energy rater . Compliance may be demonstrated by use of the ResNet sampling protocols (see chapter 6 of the national standard for home energy ratings).

(4) above code programs see IECC section 102.1.1.

B. 402.4.3 Fireplaces. See this section of the IECC and add the following **exception:** one wood burning masonry fireplace without a gas log igniter per residence is allowed without gasketed doors providing:

(1) the residence being constructed exceeds compliance of this code by 20 percent or better with compliance demonstrated by either section 401.2(2) or (3) with a HERS index of 70, and

(2) the fireplaces have outdoor combustion air supplied directly to the fireboxes.

[14.7.6.12 NMAC - Rp, 14.7.6.12 NMAC, 8-1-11; A, 1-1-12]