Table III-4
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Technology and Standards in Perspective

Residential: Multi-Family (3 Story or Less)

Building Envelope

Building Component/ Equipment Type	Rating Method		Federal	Base	MEC 92	Alternate Standard Options				
	Standard	Unit	Minimum	Current Practice in Missouri	EPAct 92 Required	ASHRAE 90.2 (21)	Federal @ 8% (22)	Federal @ 10% (22)	Federal @ 12% (22)	Best Available Technology Range
Foundation										
Basement	NA	R-Value	NA	R-0	R-7.5-10 (9, 10)	R-7.5-15 (27)	R-5-10 (17)	R-5-10 (17)	R-5-10 (17)	R-10 (5)
Crawl Space (Exterior Wall) (8)	NA	R-Value	NA	R-0	R-10-15 (12, 13)	R-10-15	NA	NA	NA	R-10
Slab-on-Grade (Unheated)	NA	R-Value	NA	R-0	R-5 (11)	R-5 (28)	R-5 (18)	R-5 (18)	R-0-5 (18)	R-5-10 (14)
Walls										
Exterior	NA	R-Value	NA	R-11	R-11 (#)	R-19 (25)	R-11	R-11	R-11	R-15-24
Ceiling										
Flat w/ Attic	NA	R-Value	NA	R-30	R-30-38	R-30 (23)	R-30	R-19-30	R-19-30	R-38-55 (2)
Cathedral	NA	R-Value	NA	R-19 (15)	R-30-38	R-33 (24)	R-30	R-19-30	R-19-30	R-35-42 (3)
Floors										
Over Unconditioned Space	NA	R-Value	NA	R-13	R-19 (16)	R-13-19 (26)	NA	NA	NA	R-19-38
To Exterior	NA	R-Value	NA	R-13	R30-38 (6)	R-30	R-13-30	R-13	R-13	R-19-38
Windows										
Conduction	NFRC (32)	R-Value	NA	R-1.65 (7)	NA(#)	R-1.2-2.0 (30)	R-3 (20)	R-3 (20)	R-3 (20)	R-4-8 (1)
Air Leakage	ANSI-NWWDA I.S. 2-87	CFM/ Ft.	NA	NA	0.34	0.34 (31)	NA	NA	NA	0.05-.15 (4)
Doors										
Conduction	NA	R-Value	NA	R-2	NA(#)	R-2.5-5.0 (29)	NA	NA	NA	R-5-14
Air Leakage	NA	CFM/ Sq.Ft.	NA	NA	0.5	0.5	NA	NA	NA	0.15-0.30

For Base, MEC 92 and the "enhanced standard options" the more and less stringent requirements are applicable to northern and southern locations in Missouri, respectively.

MEC 92 requires a blended U-value of the entire wall assembly (insulated walls, windows, and doors) of R-3.3-3.6. Value in table represents the insulated wall portion only.

1. Center of Glass values; ACEEE 1992 Summer Study: Improving Thermal Performance of U.S. Residential Window Stock.
2. Insulation levels in attics are typically limited by cost-effectiveness, not physical constraints. R-55 for Missouri represents the upper bound.
3. Cathedral ceilings with 2x12 rafters and a foam underlayment represent the high end of cathedral insulation.
4. ACEEE 1992 Summer Study: Improving Thermal Performance of U.S. Residential Window Stock.
5. Exterior basement insulation beyond R-10 has diminishing thermal benefit.
6. MEC 92 requires floors over outside air to have the same insulation levels as ceilings.
7. Value represents the "unit" R-value, which accounts for glass and window frame, and is equivalent to a double glazed aluminum window w/o thermal break.
8. Crawl spaces may be vented or unvented; unvented crawl spaces are typically insulated vertically at the perimeter wall (Builders Foundation Handbook, 1990)
9. Values represents the R-value of exterior foam insulation required to meet MEC 92 total basement wall U-value; insulation must extend to bottom of basement wall.
10. Builders Foundation Handbook recommends R-10 (8 ft.) for heated basements; for unheated basements, Handbook only recommends R-5 (4 ft.) at high heating energy costs.
11. Actual range is R-4-5 from MEC 92; R-5 represents nominal R-value of 1 inch foam. Insulation must extend down 24" from top of slab or 24" under slab from perimeter.
12. Values represent the R-value of insulation required to meet MEC 92 total crawl space wall U-value; insulation must extend 24" below exterior grade.
13. Builders Foundation Handbook recommends no more than R-10 exterior vertical insulation, or no more than R-5 interior vertical insulation for an unvented crawl space.
14. Builders Foundation Handbook suggests that R-10 placed vertically to a depth of 48" is justifiable in Missouri housing with "high" energy costs
15. Based on assumption of 2x8 rafter with R-19 fiberglass batt.
16. MEC 92 requires a total floor assembly R-20; R19 insulation with carpet and floor deck will achieve this level.
17. Insulation to depth of 48 inches.
18. Insulation to depth of 24 inches.
20. Double glass w/ low-e. R-value is center of glass.
21. ASHRAE 90.2P values based on prescriptive path. Ductwork assumed to be in conditioned space.
22. Per DOE's ARES 1.2 standards generator for multi family; % represents mortgage rate (assumptions: 20 year loan, inflation 3.5% below mortgage rate, 20% income tax rate.
23. R-value of R-28 actually required for entire assembly (framing, insulation, ceiling, and air films).
24. R-value of R-30 actually required for entire assembly (framing, insulation, ceiling, shingles, felt paper, roof deck, air films).
25. R-value of R-16 actually required for opaque frame walls and band joists, excluding windows and doors.
26. R-value of R-14-21 actually required for wood framed floors over unconditioned spaces such as crawl spaces, basements, enclosed garages. Carpet and floor deck assist.
27. R-value for insulation only; insulation is full height of wall.
28. Insulation to depth of 24".
29. Low R-value is for wood doors; high end is for non-wood doors.
30. ASHRAE 90.2P requires R1.2-2.0 for entire window assembly (glass and frame).
31. Value for wood windows; for aluminum and PVC windows, air leakage shall not exceed 0.37 cfm/foot.
32. EPAct requires a national window rating program operated by National Fenestration Rating Council; DOE may develop test procedures if voluntary program is unsuccessful.

Table III-5
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Technology and Standards in Perspective

Residential — **Building Systems and Appliances**

Building Component/ Equipment Type	Rating Method		Federal	Base	MEC 92	Alternate Standard Options				
	Standard	Unit	Minimum	Current Practice in Missouri	EPAct 92 Required	ASHRAE 90.2 (19)	Federal @ 6% (20)	Federal @ 8% (20)	Federal @ 10% (20)	Best Available Technology Range
Heating and Cooling										
Gas Furnace	DOE Test Procedure, ANSI/ASHRAE 103-88	AFUE	78 (21)	78	74% (1)	78	85 (22)	78 (22)	78 (22)	78-96.6 (17)
Electric Heat Pump (Heating)	ARI 240-89	HSPF	6.8 (11)	6.8	2.7 COP @ 47 deg. 1.8 COP @ 17 deg. (2)	6.8	7.3 (23)	7.3 (23)	7.3 (23)	6.8-10.2 (14)
Electric Heat Pump (Cooling)	ARI 240-89	SEER	10 (11)	10	2.28 COP (3)	10	10 (23)	10 (23)	10 (23)	10-16.4 (14)
Central Air Conditioner	ARI 210-89	SEER	10 (11)	10	2.28 COP (3)	10	10 (23)	10 (23)	10 (23)	10-16.9 (14)
Room Air Conditioner	ANSI/AHAM RAC-1	EER	8-9 (12)	8-9	7.8 EER (3)	8-9	NA	NA	NA	8-12.6 (15)
Water Heating										
Gas Water Heater	DOE Test Procedure	EF	0.52 (13)	0.52	75% (4)	0.52	NA	NA	NA	0.52-.72 (16)
Electric Water Heater	DOE Test Procedure	EF	0.86 (13)	0.86	4 W/ft2 (5)	0.86	NA	NA	NA	0.86-.97 (16)
Appliances										
Clothes Washer	DOE Test Procedure	ft3/ kWh/ cycle	1.2 (6)	NA	NA	NA	NA	NA	NA	NA
Clothes Dryer (Electric)	DOE Test Procedure	lbs./ kWh	3 (7)	NA	NA	NA	NA	NA	NA	NA
Clothes Dryer (Gas)	DOE Test Procedure	lbs./ kWh	2.67 (7)	NA	NA	NA	NA	NA	NA	NA
Refrigerator/Freezer (Top Freezer)	DOE Test Procedure, ANSI/AHAM HRF-1	kWh/ year	690 (8)	NA	NA	NA	NA	NA	NA	400-690 (10)
Dishwasher	DOE Test Procedure	cycles/ kWh	0.46 (9)	NA	NA	NA	NA	NA	NA	NA (18)

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DOE Test Procedures are found in National Appliance and Energy Conservation Act (NAECA).Title 10, CFR, Chapter II, Part 430, Apendices A-O.

AFUE: Annual Fuel Utilization Efficiency (in percent; described in Title 10, CFR, Chapter II, Part 430, Subpart B, Appendix N).

HSPF: Heating Seasonal Performance Factor (total BTUs delivered in heating season divided by total energy consumed in watt-hours).

SEER: Seasonal Energy Efficiency Ratio (total BTUs removed in cooling season divided by total energy consumed in watt-hours).

EER: Energy Efficiency Ratio (heat removal rate in BTU per hour divided by the input power in watts; described in Title 10, CFR, Chapter II, Part 430, Subpart B, Appendix F).

EF: Energy Factor (a unitless value whose test procedure is described in Title 10, CFR, Chapter II, Part 430, Subpart B, Appendix E).

1. MEC 1992 efficiency value is steady state combustion efficiency, not AFUE.
2. MEC 1992 requires minimum COPs based on steady state performance at two outdoor temperatures, not HSPF.
3. MEC 1992 cooling efficiency values are based on a steady state COP or EER at specific indoor/outdoor conditions.
4. MEC 1992 requirements are based on combination of recovery efficiency (%) and standby heat loss. MEC 92 uses ANSI Z21.10.3-1987 test procedure, not DOE Test Procedure.
5. MEC 1992 requirements are based on standby heat loss (W/ft2 of tank surface). MEC 92 uses ANSI Z21.10.3-1987 test procedure, not DOE Test Procedure.
6. NAECA minimum standard effective May, 1994 for standard (greater than 1.6 cubic feet capacity) top-loading clothes washers.
7. NAECA minimum standard effective May, 1994 for standard (greater than 4.4 cubic feet capacity) electric clothes dryers and all gas dryers.
8. Based on NAECA January 1, 1993 standard for units with automatic defrost, no through-the-door ice, and 18 cubic feet capacity (20.8 cubic feet adjusted volume).
9. NAECA minimum standard effective May, 1994 for standard (greater than 22 inches in width) residential dishwashers. Corresponds to 498 kWh/yr for new dishwasher.
10. ACEEE's Emerging Technologies to Improve Energy Efficiency in the Res./Comm. Sectors notes a Golden Carrot 18 cf refrigerator/freezer will use about 400 kWh/yr (pg. 17).
11. Effective January 1992 for split systems w/ <65,000 Btuh capacity; rating method described in ARI's Directory of Certified Unitary Air Conditioners and Air-Source Heat Pumps.
12. Based on NAECA standards effective January 1990; values range depending on rated capacities and unit configurations.
13. NAECA minimum standards effective April, 1991 for 52 gallon storage water heaters; applicable to gas and electric units with < 75,000 Btuh and 12 kW capacities, respectively.
14. As found in the August 1993-January 1994 ARI Directory of Certified Unitary Air Conditioners and Air Source Heat Pumps and reverified in the Energy Source Directory.
15. ACEEE's Consumer's Guide to Home Energy Savings (3rd Ed., 1993).
16. ACEEE's Consumer's Guide to Home Energy Savings (3rd Ed., 1993).
17. ACEEE's Consumer's Guide to Home Energy Savings (3rd Ed., 1993); GAMA's 4/93 Directory of Certified Efficiency Ratings for Residential Heating/Water Heating Equipment.
18. Most units now on the market do not meet the forthcoming federal efficiency standard for dishwashers.
19. Based on ASHRAE 90.2P Second Public Review Draft, May 1990.
20. Determined by DOE's ARES 1.2 standards generator; % represents mortgage rate (other assumptions: 30 year loan, inflation 3.5% below mortgage rate, 20% income tax rate).
21. Per ANSI/ASHRAE 103-88, Methods of Testing for AFUE for Residential Central furnaces and Boilers; applicable to furnaces below 225,000 Btu/hour capacity.
22. Retail natural gas rate of $5.00 per mcf. ARES 1.2 recommended furnace efficiencies may exceed the current federal equipment standard.
23. Retail electric rate of $0.075 per kWh; winter heat rate of $0.0375. ARES 1.2 recommended heat pump heating efficiencies exceed the current federal equipment standard.

Residential Efficiency Analysis

Building Descriptions and Economic Parameters - In order to place the performance of MEC 92 (or its equivalent) in perspective, four energy efficiency levels were modeled:

- Current Practice
- EPAct Standard (MEC 92)
- Enhanced Case
- Resource Case

The four energy efficiency levels were applied to three residential buildings:

- Single Family (One Story)
- Single Family (Two Story)
- Multi Family (Apartment)

To determine energy performance, each combination of efficiency level and housing type were modelled for the two Missouri climate zones (north and south). Further, each of the buildings was modeled with two heating/cooling systems:

- Gas Furnace/Electric Air Conditioning, and
- Electric Heat Pump (heating and cooling).

An overall summary of the technical specifications of the cases investigated are shown in Table III-6 on the following page.

Table III-6

DESCRIPTION OF RESIDENTIAL BUILDING CASES										
	Basement Wall	Crawl Space Wall	Slab	Frame Wall	Ceiling	Windows	Infiltration (ACH)	Gas Heating Efficiency	Electric Heating Efficiency	Electric Cooling Efficiency
SINGLE FAMILY - 1 STORY (1700 FT2)										
NZ: Current Practice	R-0	NA	NA	R-13	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
NZ: MEC 92	R-10	NA	NA	R-19	R-38	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
NZ: Enhanced Case	R-10	NA	NA	R-19	R-38	R-2.8	0.50/0.40	85 AFUE	7.5 HSPF	11 SEER
NZ: Resource Case	R-10	NA	NA	R-24	R-45	R-4.0	0.50/0.40	92 AFUE	8.5 HSPF	14 SEER
SZ: Current Practice	NA	R-0	NA	R-13	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
SZ: MEC 92	NA	R-10	NA	R-15	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
SZ: Enhanced Case	NA	R-10	NA	R-19	R-38	R-2.8	0.50/0.40	85 AFUE	7.5 HSPF	11 SEER
SZ: Resource Case	NA	R-10	NA	R-24	R-45	R-4.0	0.50/0.40	92 AFUE	8.5 HSPF	14 SEER
SINGLE FAMILY - 2 STORY (2460 FT2)										
NZ: Current Practice	R-0	NA	NA	R-13	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
NZ: MEC 92	R-10	NA	NA	R-19	R-38	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
NZ: Enhanced Case	R-10	NA	NA	R-19	R-38	R-2.8	0.50/0.40	85 AFUE	7.5 HSPF	11 SEER
NZ: Resource Case	R-10	NA	NA	R-26	R-55	R-4.0	0.50/0.40	92 AFUE	8.5 HSPF	14 SEER
SZ: Current Practice	R-0	NA	NA	R-13	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
SZ: MEC 92	R-7.5	NA	NA	R-15	R-30	R-1.65	0.75/0.60	78 AFUE	6.8 HSPF	10 SEER
SZ: Enhanced Case	R-7.5	NA	NA	R-19	R-38	R-2.8	0.50/0.40	85 AFUE	7.5 HSPF	11 SEER
SZ: Resource Case	R-7.5	NA	NA	R-26	R-55	R-4.0	0.50/0.40	92 AFUE	8.5 HSPF	14 SEER
MULTI FAMILY (960 FT2)										
NZ: Current Practice	NA	NA	R-0	R-11	R-30	R-1.65	0.50/0.40	78 AFUE	6.8 HSPF	10 SEER
NZ: MEC 92	NA	NA	R-5	R-11	R-38	R-1.65	0.50/0.40	78 AFUE	6.8 HSPF	10 SEER
NZ: Enhanced Case	NA	NA	R-5	R-15	R-38	R-2.1	0.40/0.32	85 AFUE	7.5 HSPF	11 SEER
NZ: Resource Case	NA	NA	R-5	R-19	R-45	R-3.1	0.40/0.32	92 AFUE	8.5 HSPF	14 SEER
SZ: Current Practice	NA	NA	R-0	R-11	R-30	R-1.65	0.50/0.40	78 AFUE	6.8 HSPF	10 SEER
SZ: MEC 92	NA	NA	R-5	R-11	R-30	R-1.65	0.50/0.40	78 AFUE	6.8 HSPF	10 SEER
SZ: Enhanced Case	NA	NA	R-5	R-15	R-30	R-2.1	0.40/0.32	85 AFUE	7.5 HSPF	11 SEER
SZ: Resource Case	NA	NA	R-5	R-19	R-45	R-3.1	0.40/0.32	92 AFUE	8.5 HSPF	14 SEER

All values were modeled in ESPRE as is except for walls...wall values listed here were derated in the modeling by 10-15% to account for frame.

Efficiency Levels

Current Practice - To determine if adopting MEC 92 (or its equivalent) has merit for Missouri, prevailing construction practices in the state had to be identified. State and Federal housing and energy information agencies do not track and disseminate information on Missouri residential construction practices, nor do the homebuilders associations in the state. The National Association of Homebuilders Research Foundation, in conjunction with F.W. Dodge does conduct an annual survey (by state) of residential construction practices, but the information is proprietary and was not made available for this assessment. Given assessment schedule, a meaningful survey of Missouri homebuilders could not be conducted. In lieu of more detailed survey data, the Current Practice efficiency levels for single family and multi family housing were estimated based largely on phone conversations with Missouri building inspectors and the familiarity of the authors with historical and current Missouri construction practices and . The Current Practice efficiency values were also discussed with the Kansas City Home Builders Association, which concurred with the estimates.

EPAct Standard - Energy efficiency requirements for single family and multi family for this level were derived directly from the 1992 edition of the Model Energy Code. MEC 92 has a series of nomographs where required efficiency values (based on heating degree days) may be found. Using a range of Missouri degree day information, insulating properties for foundations, walls, ceilings, and windows were derived from the nomographs.[4] MEC 92 efficiency values, which are provided as U-value (conductance), were converted to the more builder-friendly R-value (resistance) terminology to be more easily communicated.

Enhanced Case - To demonstrate, based on an net cash flow/affordability test, that more aggressive energy efficiency measures than found in MEC 92 often have economic merit, the Enhanced Case represents what many associated with the homebuilding industry may describe as "recommended practice" for Missouri housing. The Enhanced Case for single family housing was developed based on a review of the Kansas City Homebuilders Association *SAVE*™ Program[5] and builder support programs offered by Missouri utilities.

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[4] The hourly simulation model, ESPRE, uses Typical Meteorological Year (TMY) weather tapes, which represent 30 year historical weather conditions. Heating degree days (HDD) associated with these tapes (Columbia, Mo.: 5334 HDD; Springfield, Mo.: 4857 HDD) were used to extract values from the MEC 92 nomographs.

[5] The Enhanced Case is generally equivalent to a high "Silver" or low "Gold" level home in the KC HBA *SAVE* Program.

Resource Case - The Resource Case was developed based on conducting an analysis of even more aggressive efficiency levels where avoided electrical capacity credits are applied to the cost of energy efficiency measures above and beyond the Enhanced Case and externality credits are applied to the energy savings from Current Practice. While ideally, the total cost of ownership of this energy efficiency level would be the same as Current Practice, multiple iterations to achieve exact convergence with the Current Practice values were not possible given the assessment schedule. The Resource Case does represent one iteration cycle to achieve relative agreement with Current Practice.

Housing Types

Single Family - In the years 1990-1992, single family detached housing represented over 90% of new housing square footage annually in Missouri. In the period 1995-2000, single family housing is expected to have an 85% annual share of all new housing square footage. For the forecast period, the Missouri-specific McGraw-Hill data set yielded an average size of 1890 ft2 for single family housing.[6] From F.W. Dodge's *Changing America's Houses: 1992 State Addition*, single family housing in Missouri in 1991 was equally split between single story (47%) and two story (43%) construction. Single family foundation types consisted of full basements (72%), crawl spaces (17%), partial basements (9%), and slabs (< 2%).[7] Full or partial basements are the predominant foundation type in the northern two-thirds of Missouri, while basements and crawl spaces are both common in southern Missouri.[8]

Two prototype houses, a one story house and a two story house, were developed that represent common, single family housing configurations in the state. General descriptions of these two housing types are presented on the following page.

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[6] Other housing statistical data sets generally support this forecasted size. *Characteristics of New Housing 1991* indicate that the average square footage for single family units in the Midwest region (which includes Missouri) for the period 1989-1991 was 1960 ft^2.

[7] Other housing statistical data sets support these housing characteristics. Characteristics of New Housing 1991 indicates 44% of new housing in the Midwest region during the period 1989-1991 were one story, with 45% two story. The same data set indicates that 80% of new housing in the Midwest region during the period 1989-1991 had full or partial basements and 11% had crawl spaces.

[8] Phone conversations with building inspectors in southern Missouri (Joplin and Springfield) indicated that basements and crawl spaces were equally common (each found in about 50% of the market). Inspectors indicated that basements were more common in larger homes and crawl spaces were more frequently used in smaller homes. Slab-on-grade was indicated to be used infrequently.

Single Family (1 Story)[9]
Size: 1700 ft^2
Dimensions/Orientation: 34'x50'; aspect ratio of 1.5; long dimension facing north/south
Window-to-Floor Area: 12% (204 ft^2)
Windows: 4% South (68 ft^2), 4% North (68 ft^2), 2% West (34 ft^2), 2% East (34 ft^2)
Foundation Type: Unheated, Full Basement (North), Crawl Space (South)
Roof/Ceiling Type: Flat Ceiling w/ Attic
Thermostat Settings: 70°F Winter, 76°F Summer

Single Family (2 Story)
Size: 2460 ft^2
Dimensions/Orientation: 28.5'x43'; aspect ratio of 1.5; long dimension facing north/south
Window-to-Floor Area: 12% (294 ft^2)
Windows: 4% South (98 ft^2), 4% North (98 ft^2), 2% West (49 ft^2), 2% East (49 ft^2)
Foundation Type: Unheated, Full Basement (North/South)
Roof/Ceiling Type: Flat Ceiling w/ Attic
Thermostat Settings: 70°F Winter, 76°F Summer

Multi Family - Due to overbuilding in the mid-1980s, new multi family square footage in Missouri declined to less than 10% of total housing square footage in the period 1990-1992. With a moderate recovery expected, multi family units are forecasted to account for about 15% of all new housing square footage in the period 1995-2000. For the forecast period, the Missouri-specific McGraw-Hill data set yielded an average size of 960 ft^2 per multi family unit, or 7880 ft^2 per multi family building (which yields about 8 units per building).[10] One prototype apartment unit was developed that represents common, multi family housing configurations in the state. General descriptions of this multi family building is presented below.

[9] The 1700 ft^2 unit nearly matches the results of a 1988 mail survey conducted by Associated Electric Cooperatives and a prototype now used in energy analyses by AEC.

[10] Characteristics of New Housing 1991 indicate that the average square footage for multi-family units in the Midwest region for the period 1989-1991 was 1030 ft^2. This data set also indicates that over 85% of new multi family buildings in the Midwest are 1-3 stories. A study conducted by Lawrence Berkeley Laboratory, Low Rise Multi Family Housing: A Preliminary Survey of Building Characteristics and Prototype Development, concluded that 75% of multi family units built each year are in buildings with more than 4 units, and that a building with six units of 964 ft^2 each and slab-on-grade construction is a representative multi family building for many areas of the country.

Multi Family (Apartment)
Size: 960 ft^2
Configuration: Two Story, Interior Unit w/ Two Exterior Walls
Dimensions/Orientation: 15'x32'; exterior walls facing north and south
Window-to-Floor Area: 10% (96 ft^2)
Window Distribution: 5% South (48 ft^2), 5% North (48 ft^2)
Foundation Type: Slab-on-Grade
Roof/Ceiling Type: Flat Ceiling w/ Attic
Thermostat Settings: 70°F Winter, 76°F Summer

Mechanical System Options

Natural gas and electricity are the predominant energy sources for space heating in new housing in Missouri, accounting for over 97% of all systems. Given the market share of gas and electricity, only gas-fired furnaces (with electric air conditioners) or electric heat pumps were modelled for each combination of efficiency level and housing type.[11]

Prior to conducting monthly and annual simulations, ESPRE 2.1 was used to calculate design heating and cooling loads based on the weather conditions of either Columbia (north zone) or Springfield (south zone). These design load calculations provided the basis for proper sizing of heating and cooling equipment, and as overall building envelope efficiencies improved, mechanical systems were downsized accordingly. Detailed information in the Appendix provides a summary of the mechanical system efficiencies and capacities and design heating and cooling loads used in the assessment. After mechanical systems were sized and selected, the performance of each building and mechanical system was simulated on an hourly basis.[12]

Economic Parameters

Table III-7 provides a summary of key financing assumptions used in the assessment for both single family and multi family. Table III-7, on the following page, also provides a summary of the utility rates used in the residential portion of this assessment.

[11] While there are a number of opportunities for energy efficiency related to storage water heating, appliances and lighting in housing, energy efficiency changes in these areas were not assessed because they are largely determined by NAECA, not MEC 92 or other residential building energy standards.

[12] For the gas furnace/AC scenario, end-use loads included electric consumption by the furnace fan, household lighting and electric appliances, and gas consumption for water heating. For the electric heat pump scenario, end-use loads were the same with the exception that electric water heating was assumed.

Table III-7
Summary of Residential Economic Parameters

Ownership	**Single Family**	**Multi Family**
Mortgage		
Term	30 years	20 years
Rate	8%	10%
Down Payment	10%	25%
Financing Fees	2%	2%
Taxes		
Property (Base Building)	1%	1%
Property (Energy Improvements)	0.01%	0.01%
Construction Costs		
One Story with Basement: 1770 ft^2 (North)	\$55/ft^2	NA
One Story with Crawl Space: 1700 ft^2 (South)	\$53/ft^2	NA
Two Story with Basement: 2460 ft^2 (North/South)	\$55/ft^2	NA
Apartment with Slab: 960 ft^2 (North/South)	NA	\$45/ft^2
Utility Rates *		
Electricity - *Residential Service*		
High Case	$0.080/kWh	
Low Case	$0.065/kWh	
Electricity - *Residential All Electric*		
High Case	$0.080/kWh (Summer: June to September)	
	$0.050/kWh (Winter: October to May)	
Low Case	$0.065/kWh (Summer: June to September)	
	$0.040/kWh (Winter: October to May)	
Natural Gas		
High Case	$0.60/therm	
Low Case	$0.45/therm	

*Utility rates account for customer charges and 4% sales tax.

Energy and Demand Results (Building Level)

Figures III-3, on the following page, represent a distillation of detailed data presented in the Appendix and provides a summary of the net cash flow/affordability values for the four efficiency levels for single family and multi family housing in Missouri.[13] In Figure III-3 the results of the modeling of the two single family units (1700 ft^2 one story and 2460 ft^2 two story) were integrated to reflect results applicable to the average single family house forecasted for Missouri.[14]

The following observations are drawn from a comparison of the PITIE values for single family housing:

- **EPAct Standard** slightly increases the annual cost of ownership relative to Current Practice in all of the single family cases investigated. The primary reason for this is MEC's requirement for R-10 foundation insulation which represents an overinvestment for unheated basements (the typical configuration) in Missouri.[15]
- **The Enhanced Case**, which represents an aggressive package of energy efficiency measures, more closely maintains the same affordability as Current Practice than MEC 92. Even though the Enhanced Case also has R-10 foundation insulation, its overinvestment is masked by the cost effectiveness of the other measures.
- **The Resource Case**, with even more aggressive efficiency measures, has a higher cost of ownership than Current Practice when comparing PITIE. When credit for avoided electrical capacity and environmental externalities are applied, the Resource Case's PITIEC or PITECE values are nearly the same or less than Current Practice. Where PITIEC or PITIECE values are lower than Current Practice, it suggests that the building may still be underinvested from an energy efficiency standpoint.

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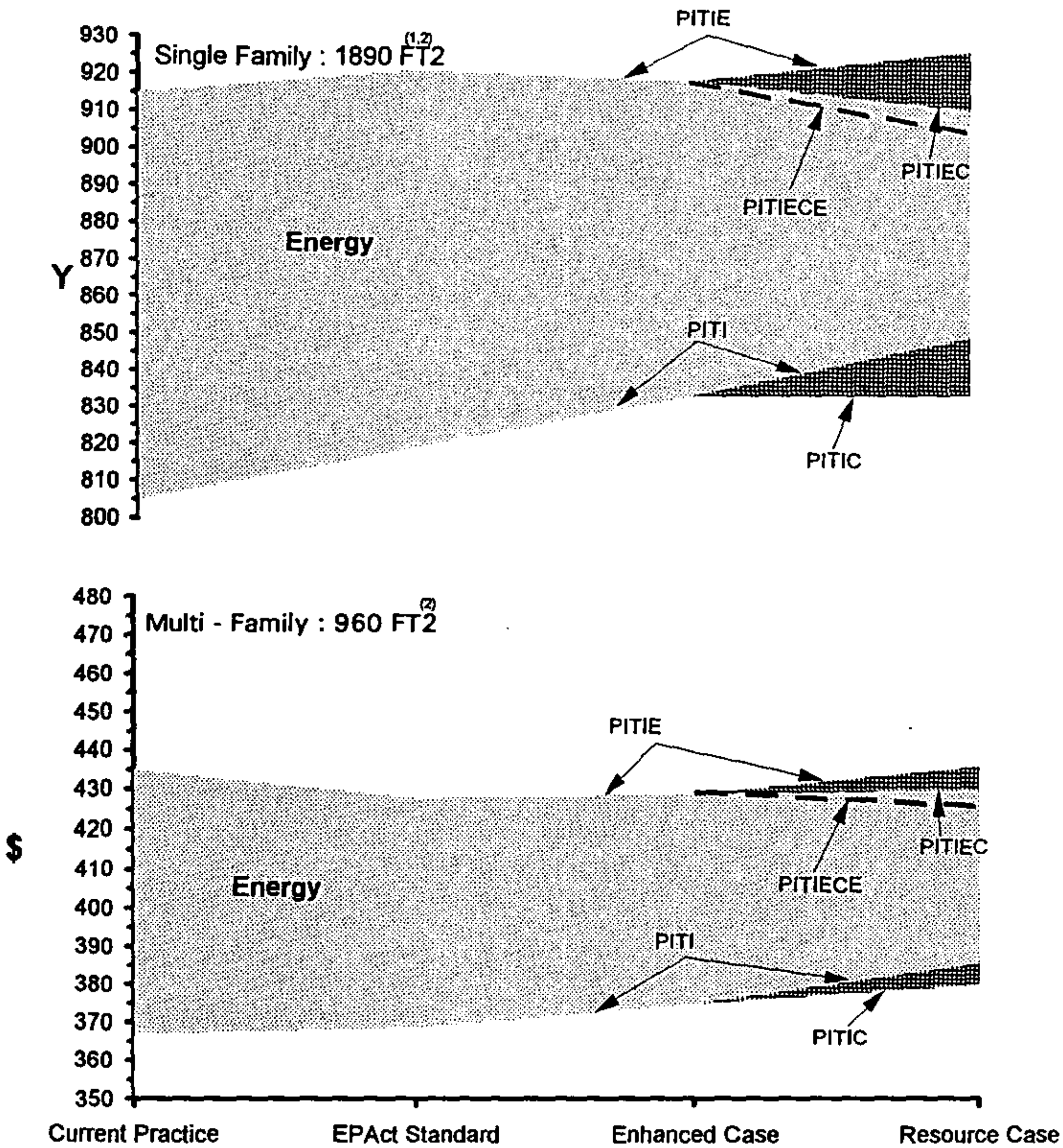
[13] One and two story single family housing have been combined. When analyzed separately, two story single family housing consistently demonstrated about 10% lower energy costs per square foot of floor space than one story single family housing due to a lower ratio of exposed wall, ceiling and foundation area to square footage and internal volume.

[14] According to F.W. Dodge data, the projected average size of single family units in Missouri in the 1995-2000 period is 1890 ft^2. It is assumed that 75% of new single family units in that period will be 1700 ft^2 and 25% of new single family units will be 2460 ft^2 [(0.25 x 2460) + (.75 x 1700) = 1890 ft^2].

[15] The MEC 92 case for the two story house in the north zone with unheated basement and gas furnace/AC was modeled with the MEC required R-10 basement insulation to a depth of 8 feet. The annual PITI value for the case was $5.27 per ft^2, with an energy cost of $0.62 per ft^2 (total cost of ownership of $5.89 per ft^2). The same building was modeled with three alternate foundation conditions: R-5 to 8 feet; R-5 to 4 feet; and, R-0 (no insulation). PITI and energy costs for the three cases, respectively, were found to be $5.25 per ft^2 and $0.63 per ft^2, $5.24 per ft^2 and 0.63 per ft^2, and $5.22 per ft^2 and $0.64 per ft^2. Although foundation insulation reduces overall energy costs, it slightly increases total cost of ownership based on PITIE.

Figure III-3

Average Monthly Ownership Costs



(1) Blended values for North and South, Gas and Electric Space Conditioning, 1-Story and 2-Story
(2) Forecasted Statwide Average

PITI = Principal, Interest, Taxes, Insurance
PITIE = Principal, Interest, Taxes, Insurance, and Energy
PITIC = PITI Capacity Credit
PITIEC = PITI with Energy with Capacity Credit
PITIECE = PITI with Energy with Capacity and Externality Credit

The following observations are drawn from a comparison of the PITIE values for multi family housing:

- **EPAct Standard** efficiency improvements compared to Current Practice, which primarily involved insulating the slab perimeter of the housing unit and adding ceiling insulation in the north climate zone, were found to be cost effective for all cases; in fact, MEC 92 values indicate a slight underinvestment relative to the same affordability level as Current Practice.
- **The Enhanced Case**, which represents an aggressive package that is rarely used in low-rise multi family construction, has about the same affordability values as MEC 92.
- **The Resource Case**, even with its aggressive efficiency package, has a lower cost of ownership (PITIE) than Current Practice, yet is slightly higher than MEC 92 or the Enhanced Case. When avoided capacity credits and environmental externalities are included, the Resource Case has the lowest annual cost (PITIECE) of the four cases.

As shown in Figure III-3, single family homes in Missouri built with prevailing construction practices have average monthly PITI costs of $805 and average monthly energy costs $110 (total cost of ownership: $915 per month). MEC 92 slightly increases monthly PITI payments to $819 per month while reducing energy costs to $102 per month (total cost of ownership: $921 per month). Incorporating energy efficiency to the Enhanced Case level results in a PITI cost of $833 per month and an energy cost to $85 per month (total cost of ownership: $918 per month). When avoided capacity credits and externalities are considered, the Resource Case has the same PITI as the Enhanced Case, $833 per month, and energy costs of $71 per month (total cost of ownership: $904 per month). Similar trends are demonstrated for multi family housing, although PITI and energy costs are intrinsically lower than single family due to the relative size of the housing units.

On the average, there was not a sizable difference in the monthly and annual energy costs of identical residential buildings modelled in the two Missouri climate zones. Single and multi family housing built to Current Practice efficiency levels typically had annual energy costs about 5% higher than the same housing in the south zone. As energy efficiency levels increased to Enhanced or Resource Case levels, annual energy costs for housing in the north zone were only 2 to 3% higher than equivalent housing in the south zone.[16] Based on average seasonal gas and electricity rates presently available in Missouri, the net cash flow/affordability (PITIE)

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[16] The use of Columbia and Springfield weather to represent northern and southern Missouri climate conditions does not fully address the extremes of Missouri climate conditions (e.g. Maryville in the northwest and Poplar Bluff in the southeast). Energy costs for these locations, depending on efficiency level, may vary from results reported in Appendix B by approximately 5%.

values for housing with either gas heating/electric cooling or electric heating/electric cooling showed similar annual economic results.[17]

Energy and Demand Results (Macro Level)

By 1995, Missouri will have a standing stock of single and multi family housing of nearly 2.4 billion square feet. All of this stock will have been constructed in absence of a state-wide energy standard. This 1995 standing stock will annually require 146 trillion Btus of energy (at the building boundary). The F.W. Dodge data forecasts a total of nearly 172 million square feet of new single family housing and 26 million square feet of multi family housing to be added between 1995 and 2000. In lieu of a residential energy efficiency standard, this new housing stock is estimated to require 52.4 trillion Btus on a cumulative basis by the year 2000. If Missouri were to meet its voluntary obligation set forth in EPAct to adopt a state-wide standard, this block of construction would be affected by the new standards.[18] Adopting MEC 92 or its equivalent would reduce the cumulative consumption of energy for new housing between 1995 and 2000 by nearly 6 trillion Btus, or 11%, compared to Current Practice as shown in Figure III-4 on the following page. The Enhanced Case and the Resource Case -- which both represent more aggressive energy efficiency levels than MEC 92 -- yield savings of 28% and 34%, respectively, when compared to Current Practice. While Btu savings as a result of adopting MEC 92 or an equivalent standard translate to cumulative operating cost savings for Missouri homeowners of nearly $55 million by the year 2000 (and other benefits as discussed below), their significance is dwarfed by the energy consumption of the pre-1995 standing housing stock.[19]

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[17] Electric heating is competitive with gas heating where winter electric heat rates – which may be as much as 50% of summer rates – are offered. Most electric utilities in the state offer discounted winter electric rates for homes with electric space and water heating.

[18] EPAct requires that states certify that they have reviewed energy standards for appropriateness by October, 1994. Assuming this date for a standard to be in place, it would begin to affect building efficiency in 1995. Although the benefits of energy standards continue far beyond the 1995-2000 period both for post-2000 housing starts and houses built between 1995-2000, the year 2000 represented a mid-term horizon for this evaluation.

[19] While it was beyond the scope of this study to assess the performance and energy efficiency improvement opportunities for existing housing in Missouri, it is evident that the opportunity is sizable and should be addressed in a coordinated manner with new housing energy programs.

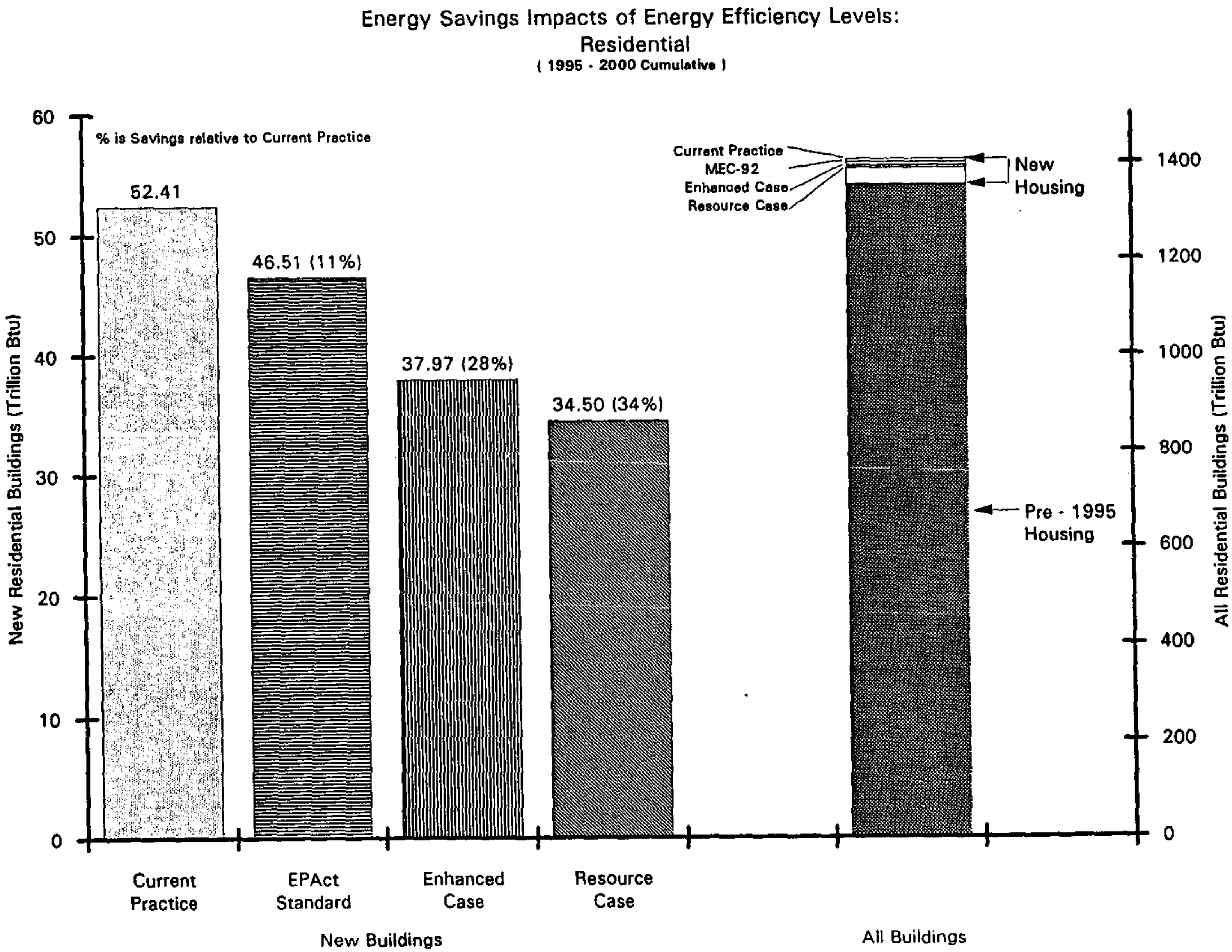
Energy Savings Impacts of Energy Efficiency Levels:
Residential
(1995 - 2000 Cumulative)
% is Savings relative to Current Practice
New Residential Buildings (Trillion Btu)
0
10
20
30
40
50
60
52.41
46.51 (11%)
37.97 (28%)
34.50 (34%)
Current Practice
EPAct Standard
Enhanced Case
Resource Case
New Buildings
Current Practice
MEC-92
Enhanced Case
Resource Case
New Housing
Pre - 1995 Housing
All Buildings
All Residential Buildings (Trillion Btu)
0
200
400
600
800
1000
1200
1400

Figure III-4

Commercial Buildings

Section 101 of EPAct states that each State shall certify by October 1994 to the Department of Energy that it has reviewed its commercial building code regarding energy efficiency and such certification shall demonstrate that its code meets or exceeds the provisions of the American Society of Heating, Refrigeration, and Air Conditioning Engineers' (ASHRAE) Standard 90.1-1989. At present, Missouri does not have a state-wide commercial building code. Certain jurisdictions in Missouri have adopted and do enforce varying consensus building codes applicable to commercial buildings. One section that follows discusses and analyzes the merits of ASHRAE Standard 90.1-1989 and alternate commercial energy efficiency standard scenarios.

As discussed in the Residential Buildings section building efficiency codes are highly related to the national appliance and equipment standards. Until the passage of EPAct, NAECA minimum efficiency standards for equipment, such as air conditioners and storage water heater was limited to residential-scale equipment. Provisions in Section 122 of EPAct now call for minimum standards, as well as testing procedures and labeling, to extend to a variety of commercial building equipment types, including small and large commercial package air conditioning and heating systems furnaces and boilers, storage water heaters, electric motors, lighting systems, and office equipment.

ASHRAE 90.1-1989

ASHRAE, in conjunction with the Illuminating Engineering Society (IES), developed Standard 90.1 through a consensus-building process involving engineering and design professionals, trade associations, equipment manufacturers, code officials, and government agencies.[20] Unlike MEC 92, ASHRAE Standard 90.1 is not a code, although ASHRAE recently approved a code language version intended for state and local use. Its requirements are intended to be adopted by state and local jurisdictions into their building code framework. In fact, provisions set forth by Standard 90.1 are now the basis for commercial building requirements in the 1993 supplement to MEC 92 and will be fully embedded in MEC 95.

ASHRAE 90.1-1989 has a basic set of requirements that <u>all</u> buildings must meet, and three differing paths for determining compliance.

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[20] ASHRAE and IES are also in the process of formulating consensus on Standard 90.1-1989's successor, widely believed to be Standard 90.1-1994. The new standard is expected to appear in draft form in June 1994, and is reportedly very different than Standard 90.1-1989. If and when it is passed as the new ASHRAE consensus standard, states will be required to recertify within three years that their commercial building code meets or exceeds Standard 90.1-1994.

Basic Requirements - Standard 90.1-1989 contains technical requirements for various aspects of commercial buildings that must be met without exception. Examples of the basic requirements in Standard 90.1-1989 are separately controlled lighting systems, the air leakage rate of the envelope, off-hour controls for HVAC systems, and minimum efficiency levels for equipment (which are now tied to minimums set forth in EPAct).

Prescriptive Compliance -- The prescriptive path is the simplest way to demonstrate compliance but the requirements are the most stringent and least flexible. This path applies to lighting systems, the building envelope, HVAC systems, and service water heating systems.

System Performance Compliance -- The system performance path is an alternative to the prescriptive path that demonstrates compliance of the building's envelope and lighting systems. This path creates an overall interior lighting power allowance and allows tradeoffs between different wall components. To assist in determining compliance of the structure and lighting systems, the *ENVSTD* (envelope) and *LGTSTD* (lighting) computer programs have been developed by ASHRAE.

Energy Cost Budget Compliance -- The energy cost budget (ECB) compliance path requires that the energy operating cost of two buildings be evaluated. The first is a hypothetical base building of the same total size as the proposed building which meets the requirements of either the prescriptive or system performance path. The proposed building complies, provided its estimated energy operating costs are equal to or less than the hypothetical base building. The ECB compliance path requires detailed hourly simulation of the building energy performance and careful analysis of the impact of utility rates to determine estimated operating costs of the two building designs.

Alternate Commercial Standards

DOE Voluntary Standard - In January 1989, the Department of Energy issued a sister standard, *Performance Standards for New Commercial and Multi-Family High-Rise Residential Buildings,* that is mandatory for all new Federal commercial and multi family high-rise residential buildings and voluntary for non-Federal buildings in the same category. The DOE performance standard is identical in most respects to ASHRAE Standard 90.1. The DOE standard includes the same three methods for determining compliance and has similar base requirements that must be met.

MEC 92 - While the Model Energy Code is referenced in EPAct as the benchmark for residential energy codes, it also is used widely as a code for commercial buildings. With EPAct's provisions for mandatory use of ASHRAE

Standard 90.1-1989 or equivalent, and with ASHRAE Standard 90.1-1994 expected to be approved soon, the Council of American Building Officials has and is likely to continue to incorporate significant portions of ASHRAE's standards in the Model Energy Code.

Commercial Technology Overview

In an effort to accelerate the adoption of new energy efficient space conditioning, water, heating and household appliances, the Federal government, through passage of EPAct, has set new minimum efficiency levels for much of the energy-using equipment found in commercial buildings. With its mandate for state adoption of ASHRAE 90.1-1989 or better, the Federal government is seeking to promote the inclusion of minimum levels of efficiency in commercial building envelopes and lighting design.

The discussion below provides a summary, by envelope component/assembly or equipment type, of the Federal minimum standard (if applicable), current practice for commercial building design and construction in Missouri, the efficiency levels required by ASHRAE Standard 90.1-1989 and the range of efficiencies available in the market that are above and beyond ASHRAE Standard 90.1-1989 or the Federal minimum.

Many people consider commercial building construction slow to adopt fundamental changes in technology, pointing out that most buildings are built with essentially the same processes and components as they were fifty years ago. Actually, commercial building technology affecting energy performance continues to evolve rapidly, with wide spread market acceptance of new, proven technology.

Assessing the impact of implementing new building energy standards requires a realistic analysis of current practice, the base from which to measure change. The rapid pace of energy technology evolution and the highly varied nature of commercial building construction practices across Missouri, have made defining the base difficult.

The diversity of conditions and equipment found in the six commercial buildings that were evaluated as part of this assessment required that technology and code requirements be evaluated for each individual building. Detailed work papers are available that provide an outline of the building envelope components, mechanical system types and efficiencies and major control system parameters for each building, for each code level.

Foundations - The foundations of a majority of commercial buildings in Missouri are slab-on-grade. These foundations are as often uninsulated as they are insulated. Uninsulated perimeters of floor slabs are a major source of heat loss during winter and can significantly affect occupant comfort. When insulated, 1" (R-4-5) of foam insulation applied to the exterior foundation wall or between the slab and the foundation wall to a depth of 24" is typical. Application of 1-1/2" to 2" (R-7.5 to 10) of foam insulation is an efficient and feasible option. Perimeter slab insulation levels beyond R-10 in most buildings is typically not merited.

Walls - Wall assemblies in commercial buildings vary widely. Wall systems may be wood frame, metal frame, single or double width masonry walls or precast concrete, among others. Determining appropriate wall insulation levels for commercial buildings requires consideration of a number of factors, including climate conditions, internal loads, and occupancy profile. In commercial buildings with lower levels of internal loads and higher occupancy (e.g. hotels, motels, nursing homes, etc.), higher levels of insulation are usually required than buildings with high internal loads and partial occupancy (e.g. restaurants, retail stores). Not all new Missouri commercial buildings have insulated walls. Some do not include insulating materials, relying only on the insulating properties of the structure and interior and exterior finish materials.

When insulated, frame walls are typically insulated with insulating batts that achieve about an R-11 rating. Single width masonry walls are typically insulated on the exterior with 1" to 1-1/2" of foam insulation that achieves an R-5 to R-7.5 rating. Double width masonry walls (and precast concrete panels) typically sandwich similar foam insulation levels between widths. In all of these wall assemblies, higher levels of insulation are achievable. Depending on the commercial building type, R-values of 10 to 15 may be merited.

Roof - The importance of roof insulation in a commercial building is largely dependent on the building's size and design. If a building is a one or two story structure, the roof may represents a sizable avenue for heat loss and gain. As the number of stories in a building increase, the relative significance of roof insulation decreases. Roof insulation levels are also subject to the same considerations as walls (i.e. internal loads, occupancy, etc.). A very common roof assembly for commercial buildings of all sizes and designs is a flat, built-up roof that consists of a metal structural deck, a 2" (R-10) overlayment of rigid foam insulation, and a single-ply membrane or built-up roof consisting of multiple layers of felt and asphalt. Depending on building type, roof insulation levels up to the R-30 level (6" of rigid foam) may have merit.

Windows -The impact of windows on commercial building energy performance ranges from profound to insignificant, depending primarily on the fraction of exterior wall area that is glazed. In larger buildings with high internal loads from lighting, equipment and people, large window areas result in significant solar loads, causing perimeter zones in such buildings to require cooling virtually year-around. Window energy performance is a function of thermal resistance, shading coefficient and visible light transmission. The frame and glazing edge of windows typically have the least thermal resistance, resulting in larger windows having better thermal performance. Thermal performance can also be improved with the use of frames with thermal breaks, wood frames and the use of low-e coatings and inert gases. Shading coefficient, the fraction of solar radiation passing through the glass, can be varied with tinted or coated glass, suspended reflective films or interior or exterior shading devices such as overhangs and blinds.

The dominant type of windows used in Missouri commercial buildings today incorporate double glazing with a non-thermally broken aluminum frame, yielding a unit R-value of 1.4 to 1.7 and a shading coefficient of .70 - .80 (70-80% of the solar spectrum passes through the glazing assembly). Color tinted or reflective coated glass is common in larger buildings with a large portion of their exterior walls glazed (>20%) and high internal loads in order to reduce the shading coefficient to .35 - .45. Metal frames with thermal brakes, low-e coatings, and argon gas fill, yielding typical unit R-values from 2.0 - 2.5, may be cost effective in specific circumstances, particularly when reduced HVAC system sizes yield first cost savings to complement the value of energy savings. Use of clad wood frames, suitable for some commercial buildings can further improve the unit R-value to greater than 3.0. Even higher performance glazing systems are available.

ASHRAE 90.1 provides considerable leeway regarding the type of glazing systems that can be used. The biggest constraint is percent of glazed wall area, which is often held below levels commonly found in many commercial buildings, particularly large offices. Under the system performance compliance path ASHRAE 90.1 provides a variety of trade-offs that permit increasing the wall area. Since these are intended to achieve equal energy performance levels, only the prescriptive level was evaluated. The glazing systems types and performance characteristics used for each case for each building type are noted in the individual building descriptions.

Use of daylighting systems (systems which take advantage of natural daylight to reduce electrical light load) is not required by ASHRAE 90.1, although the code does allow higher lighting and window levels when they are installed. Daylighting was considered only to a limited extent in the Resource Case as detailed in individual building descriptions in the work papers.

HVAC - DOE has had discretionary authority to add residential equipment to the list of NAECA-covered products, and has had a built-in process for updating minimum efficiency levels for residential heating and cooling equipment. However, development of minimum standards for commercial HVAC equipment required new legislation. Several sections of EPAct now establish minimum efficiency ratings and test procedures for several commercial HVAC systems:

- small commercial package air conditioning and heating equipment
- large commercial package air conditioning and heating equipment
- packaged terminal air conditioners
- packaged terminal heat pumps
- warm-air furnaces
- packaged boilers
- storage water heaters
- unfired hot water storage tanks
- electric motors
- general service fluorescent lamps
- incandescent reflector lamps
- ballasts

The requirements set in EPAct in general parallel, and in many cases are linked to, the ASHRAE/IES Standard 90.1-1989, although the latter covers some larger equipment not mentioned in EPAct. States are, with very limited exceptions, prohibited from adopting more stringent requirements for covered equipment. The requirement for states to adopt ASHRAE is therefore redundant with regard to covered equipment.

Lighting - The lighting power densities allowed under ASHRAE 90.1 are widely considered very high. This may be reflective of the rapid development of lighting technology since the standard was originally developed, although the need for case specific design flexibility is also a factor. The development and wide availability of high performance T-8 lamps, compact fluorescent lamps, high efficiency magnetic and electronic ballasts, motion and daylight sensors, and numerous other energy efficiency lighting technologies have become common only in the four years since Standard 90.1 was adopted.

The Current Practice values from the Union Electric Company study were consistently and substantially lower than allowed by ASHRAE 90.1, and were used for both the Current Practice case and the EPAct Case. As a result, substantial savings that are typically attributed to improvements in lighting were not captured since they have already been widely incorporated into the market. Commercial buildings with lighting power densities higher than ASHRAE values are, however, still being built in Missouri.

Water Heating - Equipment performance requirements for water heating systems contained in ASHRAE 90.1 parallel EPAct requirements. Additional design and installation requirements were incorporated in the analysis where applicable.

General Loads - Internal loads from people and various types of equipment were incorporated into each building, based on the appropriate values from the UE study. Since the intent was to look at building standards, these loads were held constant for all cases to provide consistent reference for comparison. Ventilation requirements were based on ASHRAE Standard 62-1989 and in several building types became a dominant factor in system operation. Methods of reducing the impact of higher ventilation requirements, such as air cleaning, sensor controlled ventilation rates, and ventilation air heat recovery are not covered by Standard 90.1 and are outside the scope of this study.

Commercial Efficiency Analysis

Building Descriptions and Economic Parameters - In order to place the performance of ASHRAE Standard 90.1-1989 (or its equivalent) in perspective, four energy efficiency levels were modeled:

- Current Practice
- EPAct Standard (ASHRAE Standard 90.1-1989)
- Enhanced Case
- Resource Case

Based on the review of the Dodge's Missouri building data sets, six commercial buildings representing approximately 60% of the forecasted new commercial construction activity (based on square feet) were assessed for impacts of the four energy efficiency levels:

- Small Office
- Large Office
- Retail Store
- School
- Nursing Home
- University Building

To determine energy performance, each combination of efficiency level and commercial building type were modeled for the two Missouri climate zones (north and south). Further, each of the buildings was modeled with two heating/cooling systems:

- Gas Heating/Electric Air Conditioning, and
- Electric Heating/Electric Air Conditioning.

Energy Efficiency Levels

Current Practice - Detailed definitions of representative new buildings typically required extensive surveys of recently built buildings. Union Electric Company (UE) of St. Louis, as part of its Integrated Resource Planning, was recently confronted with a similar need to identify a set of prototype buildings that represent the types and energy efficiency of buildings within their service territory. During the past year, UE conducted an extensive analysis of buildings they serve, including over 800 field audits of commercial buildings, of which 300 were of sufficient detail for comprehensive energy performance evaluation. UE has distilled this comprehensive survey into sixteen basic commercial building prototypes, with four distinct sets of energy systems for each, for both existing (over three years old) and recently constructed (less than three years old) buildings. Given the strong match of building categories between the Dodge data and the UE survey data, our assessment, with UE permission, uses UE building and equipment descriptions to a large degree to define the technical specifications of Current Practice level for the six commercial buildings.

EPAct Standard - To the extent possible, the prescriptive requirements of ASHRAE Standard 90.1 were used to define this level of efficiency for all six commercial buildings. Compliance of real buildings with ASHRAE Standard 90.1 may also be achieved by using two alternate compliance paths.

Enhanced Case - This efficiency level represents a package of upgrades above and beyond the EPAct Standard and is generally representative of "recommended practice" for commercial buildings.

Resource Case - This level is an aggressive set of energy efficiency measures that are not often found in commercial buildings but represent measures that may be justified when avoided capacity and environmental externality credits are considered.

Building Types and Mechanical Systems

The six buildings modeled in the commercial portion of this assessment are graphically shown in Figures in the commercial building section of the work papers. The buildings are simplified representations of new construction in their respective categories. In the case of the school building and nursing home, the buildings are based on construction documents from recently built buildings.

Small Office - The small office is a 9600 ft^2 (60' by 160') single story building with six office suites. Its long dimension faces north and south. The building has a slab-on-grade floor, frame wall with masonry veneer and a flat, built-up roof. Window area (for the base building) is 25% of wall area on all orientations. Each office suite in the building is individually conditioned with a roof top packaged electric air conditioner and either a gas furnace, electric resistance or an electric heat pump. The building is occupied from 6:00 A.M. to 7:00 P.M. during weekdays and 9:00 A.M. to 12:00 A.M. on Saturday.

Large Office - The large office is a 150,000 ft^2 (122' by 122') ten story building. The building has a basement with concrete slab, masonry walls and a flat, built-up roof. Window area (for the base building) is 30% of wall area on all orientations. The building is cooled by a water-cooled electric centrifugal chiller system with variable air volume and heated by a hot water baseboard system (with either a gas boiler or electric resistance). The building is occupied from 7:00 A.M. to 9:00 P.M. weekdays, 7:00 A.M. to 2:00 P.M. Saturday. Thermostat settings during occupied hours are set at 71°F heating, 75°F cooling. During unoccupied hours, heating is setback to 56°F and cooling system is set to off.

Retail Store - The retail store is a 25,200 ft^2 (180' by 140') single story building with one tenant.[21] Its long dimension faces east and west. The building has a slab-on-grade floor, precast concrete walls and a flat, built-up roof. Only the south wall (the storefront) has windows, where window area is 80% of the wall area. The storefront is partially shaded by a six foot awning. The store is conditioned by five single zone rooftop units with air-cooled electric air conditioning and either a gas furnace, electric resistance or electric heat pump. The store is occupied from 8:00 A.M. to 9:00 P.M. weekdays and Saturday, and 9:00 A.M. to 5:00 P.M. Sunday and holidays.

School - The school building is a 59,000 ft^2 one story building that is generally representative of elementary, middle and high schools built in Missouri. The school building includes classrooms, administrative offices, gymnasium, computer laboratory and cooking and dining spaces. The building has slab-on-grade floor, masonry walls and a flat, built-up roof. The building is cooled with 10 roof-top packaged air-cooled electric air conditioner units and heated with either gas furnaces, electric resistance or electric heat pumps. The school is occupied from 7:00 A.M. to 5:00 P.M. weekdays and is assumed to operate from Labor Day to Memorial Day. The heating setpoint is set to 60°F and the cooling setpoint to off when the building is unoccupied.

Nursing Home - The nursing home is a 31,000 ft^2 one story building based on the typical "X" configuration commonly used in nursing home design. The building includes sixty living units and also has cooking and dining facilities, recreational space, administrative offices, and nursing stations and examination rooms. The building has a slab-on-grade floor, masonry walls and flat ceiling with wood truss and attic. Window area is 29% of wall area. The nursing home is conditioned by 10 packaged systems (with zone control) with air-cooled electric air conditioning and heating from either gas furnaces, electric resistance or an electric heat pumps. Occupancy of the building is continuous. Thermostat settings are 73°F winter and 75°F summer. No thermostat setback or setup occurs.

[21] This building is representative of a Walmart, Blockbuster Video, or other relatively large retail store.

University Building (Library) - The library building is a 48,000 ft^2 three story building that may be built on a university campus or by a county or municipality.[22] The building has a slab-on-grade floor, masonry walls and a flat, built-up roof. Window area (for the base building) is 27% of wall area on all orientations. Perimeter spaces are dedicated to administrative or research offices, with interior spaces dedicated to services and resource stacks. The building is conditioned with 15 rooftop package units (5 per floor) with electric, air-cooled air conditioning and either gas furnaces, electric resistance, or electric heat pumps. The building is occupied from 6:00 A.M. to 10:00 P.M. weekdays, 6:00 A.M. to 5:00 P.M. Saturday, and 6:00 A.M. to 10:00 P.M. Sunday and holidays.

Economic Parameters

Commercial buildings are owned and operated quite differently than residential buildings. Many commercial buildings have multiple tenants whose energy consumption is submetered. Other buildings that do not submeter often charge (usually embedded in the lease rate) tenants for energy on a pro rated basis tied to square footage. In either case, there has historically been little incentive for commercial building owners or designers to incorporate energy efficiency measures as utility costs are "passed on" to tenants.[23]

In this analysis, two of the six buildings (small office, large office) fit this description. The other four buildings (school, library, retail store, nursing home) are owned and operated by either an educational institution or business where utility costs impact operating budgets or profits of the building owner. In order to simplify the economic evaluation of energy efficiency measures, all six commercial buildings are assessed according to net cash flow/affordability for the building owner, where PITIE values provide a basis for comparison. Table III-8, on the following page, provides a summary of economic parameters used to determine PITI. Table III-8 also provides a summary of a range of utility rates and escalation factors that were used in the assessment.

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[22] This building configuration is a prototype developed by the Pacific Northwest Laboratory for use in analyzing the energy performance of commercial buildings and the impact of commercial building energy standards. It has been modified for use in this assessment and uses load and occupancy profiles typical of a university library.

[23] In an increasingly competitive commercial real estate market, the ability to pass on high energy costs to tenants is becoming increasingly difficult for building owners.

Table III-8 Summary of Commercial Economic Parameters	
Mortgage	
Term	20 years
Rate	10% private, 6% public (tax-free bonds-school & university)
Down Payment	20%
Financing Fees	2%
Taxes	
Federal Income	0.2
State Income	0.03
Property (Energy Improvements)	1% (none for school and university)
Utility Rates *	
Electricity - *Small General Service* - Small Office, Retail, Nursing Home, School, University	
High Case	$0.095/kWh (Summer)
	$0.080/kWh (Winter)
Low Case	$0.065/kWh (Summer)
	$0.055/kWh (Winter)
Electricity - *Large General Service* - Large Office	
High Case	$4.0/kW and $0.085/kWh (Summer)
	$2.9/kW and $0.055/kWh (Winter)
Low Case	$3.6/kW and $0.065/kWh (Summer)
	$2.5/kW and $0.045/kWh (Winter)
Natural Gas	
High Case	$0.58/therm
Low Case	$0.50/therm
Escalators	
Inflation	3.5%/year
Natural Gas	4.4%/year
Electricity	0.0%/year

*Utility rates account for customer charges and 4% sales tax.

Energy and Demand Results (Building Level)

Table III-9, on the following three pages, provides a comparison of peak gas demand, annual gas demand, peak summer electrical demand, annual electricity use (electric and gas heat versions) and annual PITIE for all four cases and all six buildings, as well at PITIEC and PITIECE for the Resource Case. Figure III-5 on the next three pages, provides a summary of that information. The following points should be noted:

- Conclusions regarding this data should not be based solely on individual data points, but the overall pattern.
- Measures required by EPAct are generally cost effective (affordable), with annual PITIE being equal to or less than the Current Practice case in most cases.
- More aggressive energy efficiency may actually be more cost effective (affordable). This is primarily a result of substantial savings that can be achieved from down-sizing major HVAC equipment; providing savings that accrue even after accounting for the higher cost of more efficient equipment.
- Proper design and operation of HVAC and lighting control systems is absolutely essential if projected energy savings are to be achieved.
- There may be other technologies, such as heat recovery and thermal storage that are cost effective that could yield additional demand and energy savings.
- Basic building design features such as daylighting, form, orientation, beneficial solar gain and space organizing strategies may also yield additional savings.
- Office equipment was held constant for all four cases. Emerging improvements if energy performance of many types of office equipment are expected to reduce these loads, yielding additional net savings.

Commercial Buildings Performance Summary (cont'd)

Building Type							Examples are all for North Zone
Variable	Current Practive	EPAct Case	% change from C.P.	Enhanced Case	% change from C.P.	Resource Case	% change from C.P.
Elementary School							
Gas Heat							
Peak gas demand, Btu/SF	76.2	69.5	8.79%	61	19.95%	47.5	37.66%
Annual gas, Btu/SF	49000	36000	26.53%	30000	38.78%	22000	55.10%
Peak electrical demand, W/SF	3.86	3.95	-2.33%	3.20	17.10%	2.95	23.58%
Annual elec., kWh/SF	5.38	5.03	6.51%	4.56	15.24%	4.5	16.36%
PITIE, $/SF	$5.35	$5.34	0.19%	$5.32	0.56%	$5.33	0.37%
PITIEC, $/SF	na	na		na		$5.24	2.06%
PITIECE$/SF	na	na		na		$5.22	2.43%
Electric Heat							
Peak summer demand, W/SF	3.86	3.95	-2.33%	3.20	17.10%	2.95	23.58%
Annual elec., kWh/SF	15.55	12.71	18.26%	8.24	47.01%	7.53	51.58%
PITIE, $/SF	$5.78	$5.66	2.08%	$5.41	6.40%	$5.41	6.40%
PITIEC, $/SF	na	na		na		$5.33	7.79%
PITIECE$/SF	na	na		na		$5.21	9.86%
University Library							
Gas Heat							
Peak gas demand, Btu/SF	47.9	47.9	0.00%	41.7	12.94%	31.3	34.66%
Annual gas, Btu/SF	25000	22000	12.00%	22000	12.00%	17000	32.00%
Peak electrical demand, W/SF	6.15	5.75	6.50%	4.31	29.92%	3.92	36.26%
Annual elec., kWh/SF	17.14	16.2	5.48%	12.35	27.95%	11.93	30.40%
PITIE, $/SF	$6.91	$6.88	0.43%	$6.65	3.76%	$6.76	2.17%
PITIEC, $/SF	na	na		na		$6.65	3.76%
PITIECE$/SF	na	na		na		$6.57	4.92%
Electric Heat							
Peak summer demand, W/SF	6.15	5.75	6.50%	4.31	29.92%	3.92	36.26%
Annual elec., kWh/SF	22.04	20.58	6.62%	14.72	33.21%	13.94	36.75%
PITIE, $/SF	$7.10	$7.06	0.56%	$6.69	5.77%	$6.80	4.23%
PITIEC, $/SF	na	na		na		$6.69	5.77%
PITIECE$/SF	na	na		na		$6.58	7.32%

Commercial Buildings Performance Summary

Building Type							Examples are all for North Zone
Variable	Current Practive	EPAct Case	% change from C.P.	Enhanced Case	% change from C.P.	Resource Case	% change from C.P.
Small Office Building							
Gas Heat							
Peak gas demand, Btu/SF	52	42	19.23%	31	40.38%	21	59.62%
Annual gas, Btu/SF	32000	21000	34.38%	14000	56.25%	9000	71.88%
Peak electrical demand, W/SF	5.73	5.00	12.73%	3.75	34.55%	3.02	47.27%
Annual elec., kWh/SF	12.15	11.62	4.36%	9.88	18.68%	8.59	29.30%
PITIE, $/SF	$7.32	$7.37	-0.68%	$7.39	-0.96%	$7.57	-3.42%
PITIEC, $/SF	na	na		na		$7.43	-1.50%
PITIEC$/SF	na	na		na		$7.38	-0.82%
Electric Heat							
Peak summer demand, W/SF	5.73	5.00	12.73%	3.75	34.55%	3.02	47.27%
Annual elec., kWh/SF	18.78	16.08	14.38%	11.52	38.66%	9.87	47.44%
PITIE, $/SF	$7.60	$7.56	0.53%	$7.44	2.11%	$7.62	-0.26%
PITIEC, $/SF	na	na		na		$7.48	1.58%
PITIEC$/SF	na	na		na		$7.36	3.16%
Large Office Building							
Gas Heat							
Peak gas demand, Btu/SF	18.8	9.1	51.60%	7.27	61.33%	4.85	74.20%
Annual gas, Btu/SF	31000	13000	58.06%	8000	74.19%	7000	77.42%
Peak electrical demand, W/SF	4.99	3.51	29.66%	2.82	43.49%	2.45	50.90%
Annual elec., kWh/SF	13.28	12.08	9.04%	9.6	27.71%	8.47	36.22%
PITIE, $/SF	$8.13	$7.95	2.21%	$8.02	1.35%	$8.13	0.00%
PITIEC, $/SF	na	na		na		$7.99	1.72%
PITIEC$/SF	na	na		na		$7.92	2.58%
Electric Heat							
Peak summer demand, W/SF	4.99	3.51	29.66%	2.82	43.49%	2.45	50.90%
Annual elec., kWh/SF	21.06	19.92	5.41%	11.68	44.54%	10.33	50.95%
PITIE, $/SF	$8.46	$8.40	0.71%	$8.12	4.02%	$8.23	2.72%
PITIEC, $/SF	na	na		na		$8.09	4.37%
PITIEC$/SF	na	na		na		$7.94	6.15%

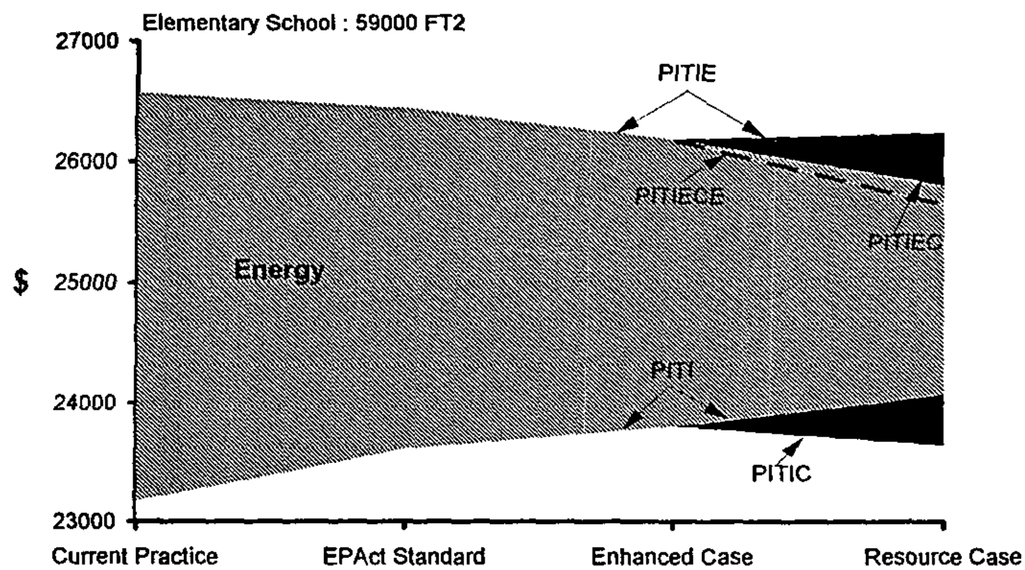
Table III-9
Page Three

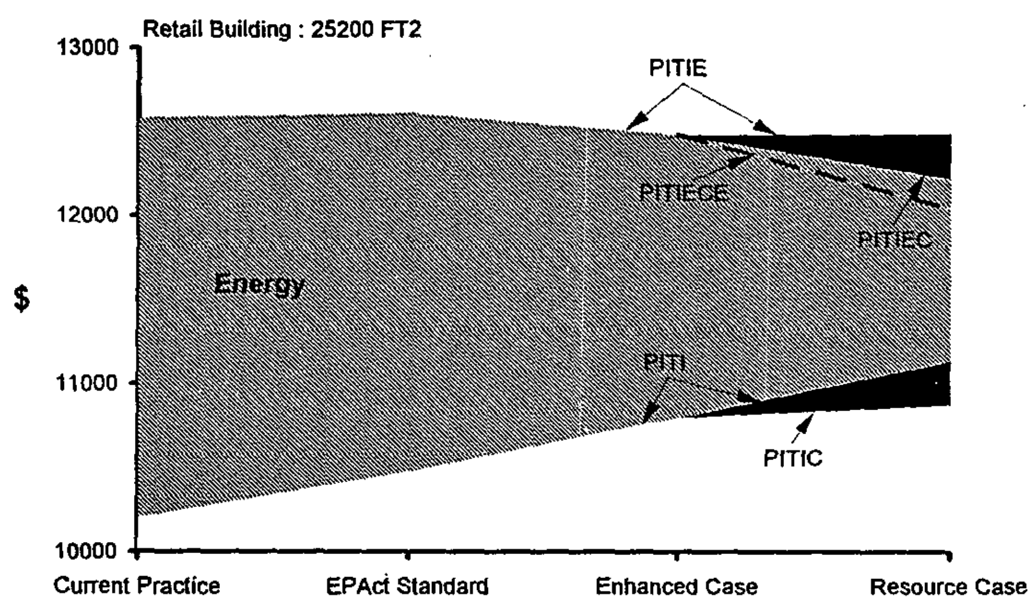
Commercial Buildings Performance Summary (cont'd)

Building Type							Examples are all for North Zone
Variable	Current Practive	EPAct Case	% change from C.P.	Enhanced Case	% change from C.P.	Resource Case	% change from C.P.
Retail Store							
Gas Heat							
Peak gas demand, Btu/SF	51.6	47.6	7.75%	39.7	23.06%	31.7	38.57%
Annual gas, Btu/SF	33000	22000	33.33%	18000	45.45%	15000	54.55%
Peak electrical demand, W/SF	6.11	5.71	6.55%	4.21	31.10%	3.17	48.12%
Annual elec., kWh/SF	12.33	11.77	4.54%	9.56	22.47%	7.58	38.52%
PITIE, $/SF	$5.94	$5.97	-0.51%	$5.94	0.00%	$5.94	0.00%
PITIEC, $/SF	na	na		na		$5.81	2.19%
PITIECE$/SF	na	na		na		$5.74	3.37%
Electric Heat							
Peak summer demand, W/SF	6.11	5.71	6.55%	4.21	31.10%	3.17	48.12%
Annual elec., kWh/SF	19.49	16.5	15.34%	11.79	39.51%	9.64	50.54%
PITIE, $/SF	$6.24	$6.16	1.28%	$5.97	4.33%	$5.98	4.17%
PITIEC, $/SF	na	na		na		$5.85	6.25%
PITIECE$/SF	na	na		na		$5.71	8.49%
Nursing Home							
Gas Heat							
Peak gas demand, Btu/SF	54.7	51.5	5.85%	48.2	11.88%	38.6	29.43%
Annual gas, Btu/SF	121000	114000	5.79%	106000	12.40%	89000	26.45%
Peak electrical demand, W/SF	5.27	4.86	7.78%	3.92	25.62%	3.34	36.62%
Annual elec., kWh/SF	13.5	12.9	4.44%	11.4	15.56%	10.26	24.00%
PITIE, $/SF	$8.12	$8.11	0.12%	$8.11	0.12%	$8.13	-0.12%
PITIEC, $/SF	na	na		na		$8.00	1.48%
PITIECE$/SF	na	na		na		$7.94	2.22%
Electric Heat							
Peak summer demand, W/SF	5.27	4.86	7.78%	3.92	25.62%	3.34	36.62%
Annual elec., kWh/SF	37.3	35.53	4.75%	25.87	30.64%	23.56	36.84%
PITIE, $/SF	$9.11	$9.05	0.66%	$8.49	6.81%	$8.60	5.60%
PITIEC, $/SF	na	na		na		$8.46	7.14%
PITIECE$/SF	na	na		na		$8.27	9.22%

Figure III-5
Page One

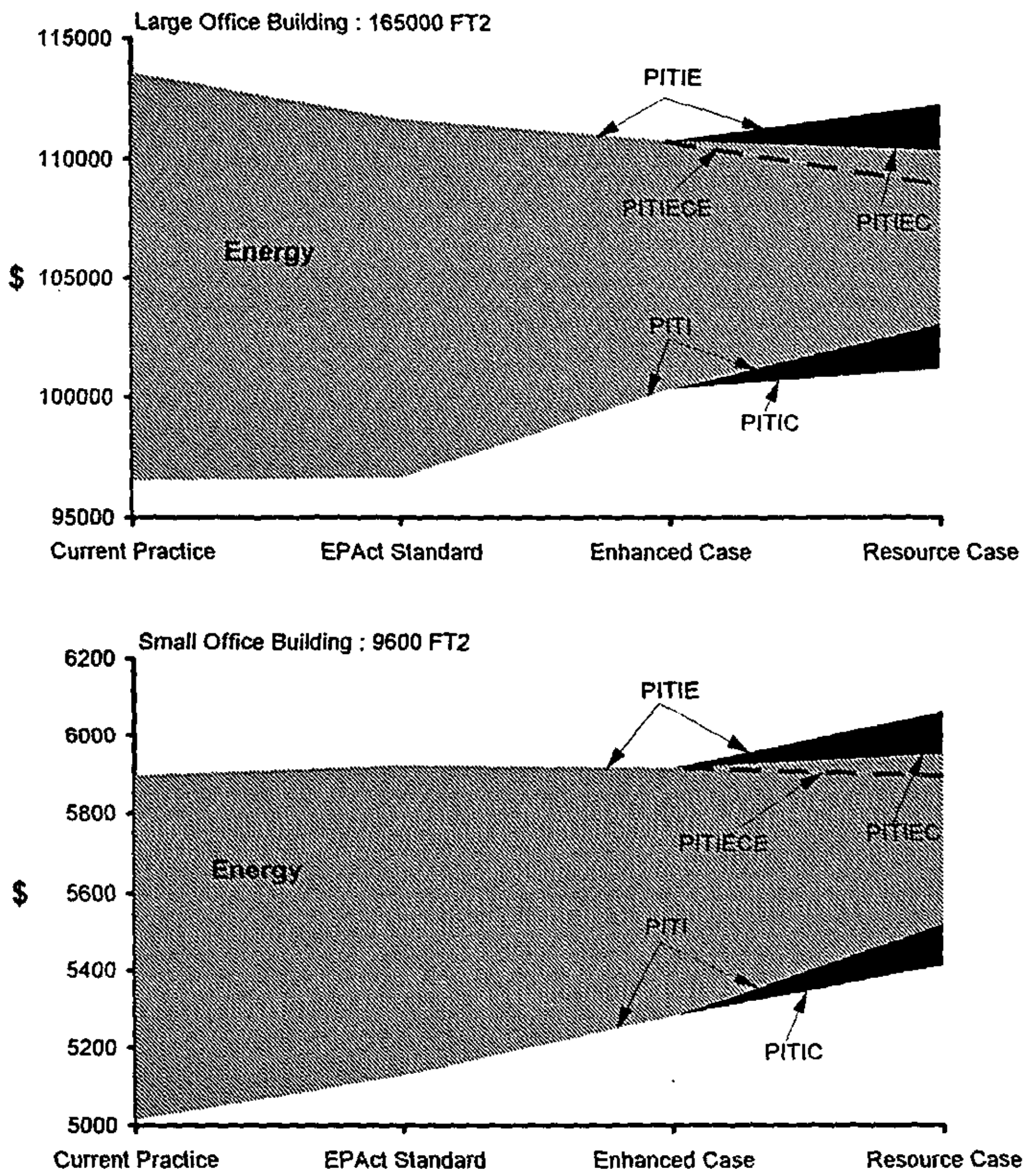
Average Monthly Ownership Costs





PITI = Principal, Interest, Taxes, Insurance
PITIE = Principal, Interest, Taxes, Insurance, and Energy
PITIC = PITI Capacity Credit
PITIEC = PITI with Energy with Capacity Credit
PITIECE= PITI with Energy with Capacity and Externality Credit

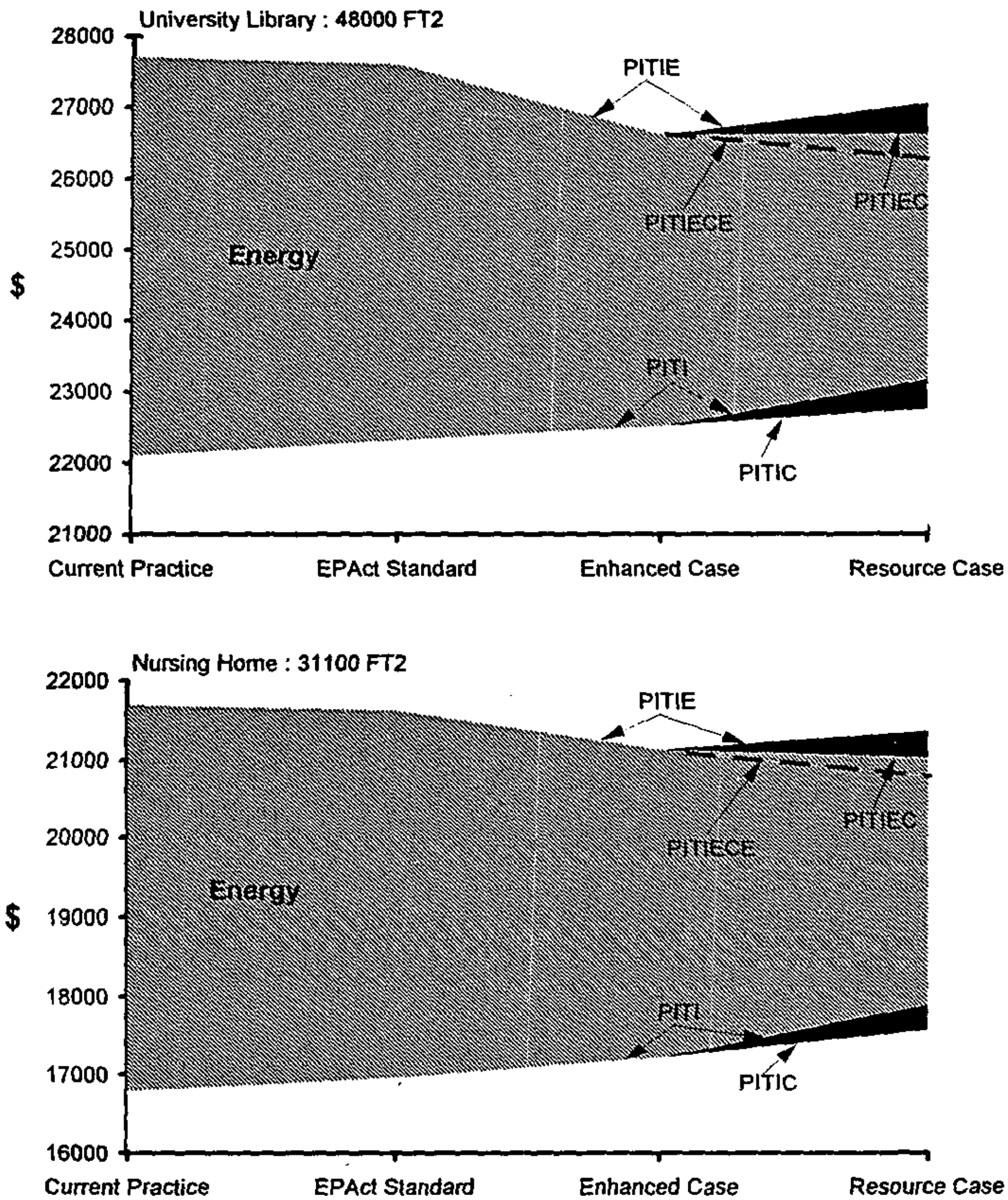
Figure III-5
Page Two
Average Monthly Ownership Costs



PITI = Principal, Interest, Taxes, Insurance
PITIE = Principal, Interest, Taxes, Insurance, and Energy
PITIC = PITI Capacity Credit
PITIEC = PITI with Energy with Capacity Credit
PITIECE= PITI with Energy with Capacity and Externality Credit

Figure III-5
Page Three

Average Monthly Ownership Costs



PITI = Principal, Interest, Taxes, Insurance
PITIE = Principal, Interest, Taxes, Insurance, and Energy
PITIC = PITI Capacity Credit
PITIEC = PITI with Energy with Capacity Credit
PITIECE = PITI with Energy with Capacity and Externality Credit

Energy and Demand Results (Macro Level)

By 1995, Missouri will have a standing stock of commercial buildings of nearly 1.25 billion square feet. All of this stock will have been constructed in absence of a state-wide energy standard. This 1995 standing stock will annually require 79 trillion Btus of energy (at the building boundary). The F.W. Dodge data forecasts a total of nearly 131 million square feet of new commercial buildings to be added between 1995 and 2000. In absence of a commercial energy efficiency standard, this new building stock is estimated to require 37 trillion Btus on a cumulative basis by the year 2000.

If Missouri were to meet its mandatory obligation set forth in EPAct to adopt a state-wide commercial standard, this block of construction would be affected by the new standards.[24] Adopting ASHRAE Standard 90.1-1989 or its equivalent would reduce the cumulative consumption of energy for new commercial buildings built between 1995 and 2000 by 4 trillion Btus, or 12%, compared to Current Practice, as shown in Figure III-6.[25] The Enhanced Case and the Resource Case -- which both represent more aggressive energy efficiency levels than ASHRAE 90.1-1989 -- yield savings of 24% and 32%, respectively, when compared to Current Practice. While Btu savings as a result of adopting ASHRAE Standard 90.1 - 1989 or an equivalent standard translate to cumulative operating cost savings for Missouri commercial building owners of nearly $68 million by the year 2000 (and other benefits as discussed below), its significance is dwarfed by the energy consumption of the pre-1995 standing commercial building stock.[26]

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[24] EPAct requires that states certify that they have reviewed energy standards for appropriateness by October, 1994. Assuming this date for a standard to be in place, it would begin to affect building efficiency in 1995. Although the benefits of energy standards continue far beyond the 1995-2000 period, the year 2000 represented a mid-term horizon for this evaluation.

[25] ASHRAE Standard 90.1-1989 does not apply to all commercial buildings (e.g. manufacturing facilities, refrigerated warehouses, arenas, etc.) Such buildings represent about 25% of projected building stock in the 1995-2000 time period. The results of the analysis, which are for <u>all</u> new and existing commercial buildings in Missouri, tend to underestimate the impact of ASHRAE Standard 90.1-1989 on the portion of the building stock to which the Standard does apply.

[26] While it was beyond the scope of this Report to assess the performance and efficiency improvement opportunities for existing commercial buildings in Missouri, it is evident that the opportunity is sizable and should be addressed in a coordinated manner with any new commercial building energy programs.

Energy Savings Impacts of Energy Efficiency Levels:
Commercial
(1995 - 2000 Cumulative)

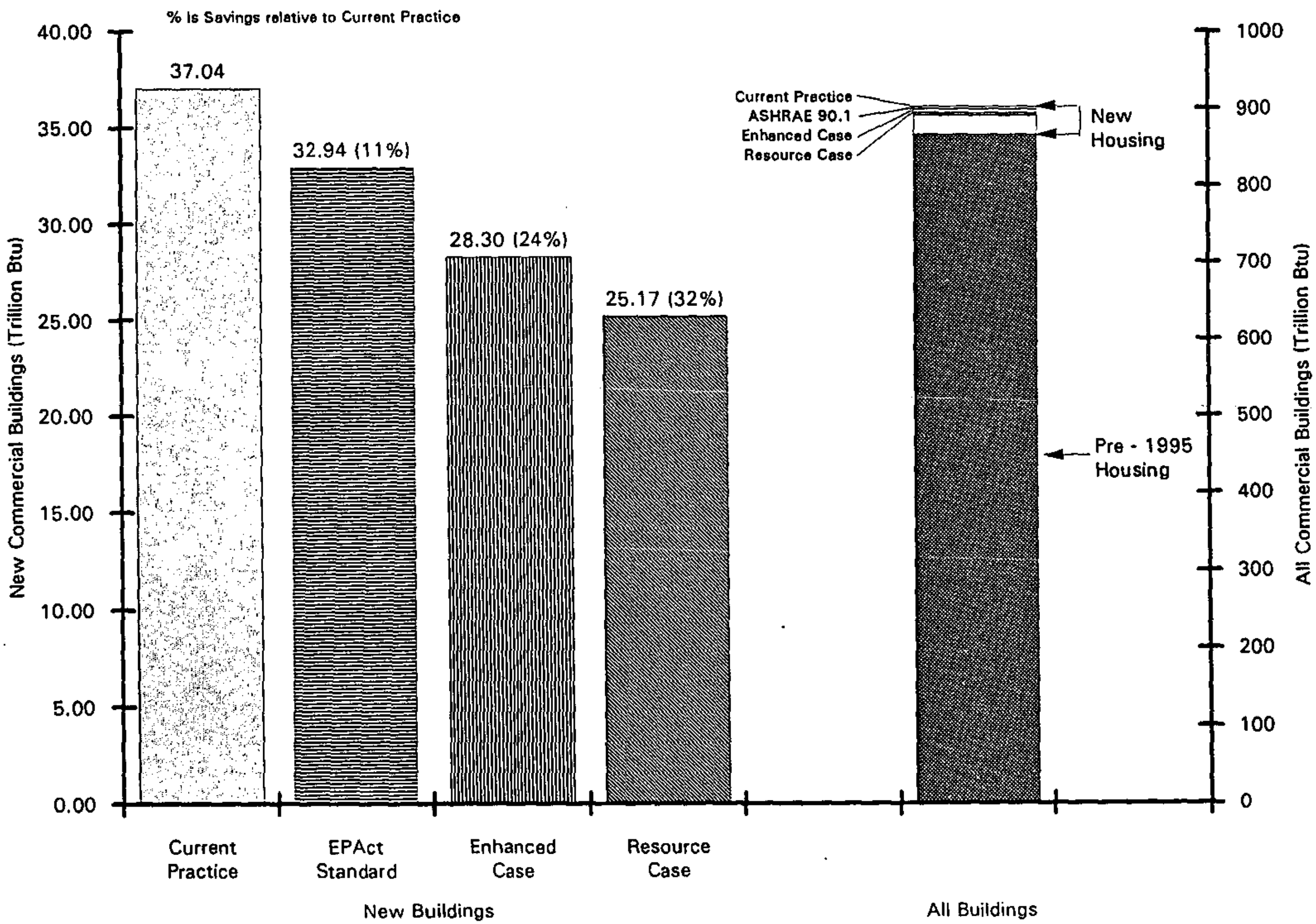

Figure III-6

Economic and Environmental Impact

Introduction

The likely state wide impacts from the energy efficiency building improvements that were modeled in the Residential Commercial Buildings analyses are evaluated in this section. The energy efficiency improvements were analyzed from the perspective of the building owner in previous sections. In other words, the level of energy efficiency improvements were designed so that any additional costs incurred by building owners would be offset by the benefits they received, that is, they would have reduced energy bills.

For the purpose of analyzing the *overall impacts* of the energy efficiency building improvements, the analysis in this section will take a broader perspective: that of society as a whole. To do this, the analysis shifts focus from customer energy bills, and instead evaluates how improved building efficiency will affect the costs and benefits associated with the overall production of electricity and natural gas. Also included are other impacts, such as the impact of using fossil fuels on the environment and on the economy in general. Finally, the analysis will compare the costs and benefits of building efficiency improvements using a societal discount rate, in order to reflect a societal perspective. We have assumed a societal discount rate of 3% real, roughly based on the cost of risk-free, long-term United States treasury bonds.

For the purpose of this discussion, we will refer to the efficiency improvements that are made on residential and commercial buildings as *building code improvements*. This is based on the analysis that identified the EPAct Standard as the base case above Current Practice that was used in analyzing energy efficiency options. The EPAct standard represented the minimum code requirements of the federal legislation for both residential and commercial buildings.

Building code improvements will reduce the consumption of electricity and natural gas, resulting in a variety of impacts in Missouri. First, energy savings from the code improvements will reduce the cost of producing and delivering electricity and natural gas. Second, energy savings will reduce the environmental impacts that typically result from the production and consumption of electricity and natural gas. Finally, energy savings will affect the economy in Missouri by lowering energy bills generally, thereby creating employment opportunities. These impacts are discussed and, to the extent possible, quantified in the following sections.

Direct Economic Benefits of Building Code Improvements

Electricity Generation - The direct economic benefits of electricity savings from the building code improvements will be in the form of (1) reduced costs of electricity generation, and (2) reduced costs of constructing electric generation capacity. The former are referred to as energy costs, while the latter are referred to as capacity costs. Improved building standards will allow electric utilities to avoid energy and capacity costs that they would otherwise have incurred. These are typically referred to as *avoided costs*.

To develop avoided costs for electricity, it is first necessary to determine two future electric system resource scenarios: one without the efficiency savings from the building codes, and one with the efficiency savings. The difference between these two scenarios will indicate what type of energy and capacity is avoided by the efficiency savings in each year.

It is assumed that, without the improved building codes, the state as a whole is likely to need additional combustion turbines by 1998 and a new combined cycle facility by 2000, both fueled by natural gas. This assumption is based on the future resource plans of the investor owned utilities in Missouri, as well as the most recent *Long-Range Planning Study* for the MOKAN power pool (Utility 1993 Cogeneration filings; CSA, 1992). While some utilities may plan to build facilities earlier than these dates, and others may plan to build facilities later than these dates, it has been assumed that these facilities are representative of capacity that is likely to be avoided in the state as a whole if buildings are constructed to higher efficiency standards.

This future resource scenario implies that avoided capacity costs will be zero through 1997, because no facilities will be displaced by the building code savings in these years. From 1998 through 1999, however, avoided capacity costs will be based on the costs of constructing a combustion turbine. Finally, from 2000 through the remainder of the planning horizon, the avoided capacity costs will be based on the costs of constructing a combined cycle facility. The assumptions used for the construction costs of combustion turbine and combined cycle units are taken from the *1993 EPRI Technical Assessment Guide* (EPRI TAG 1993). The avoided capacity costs also include the annual fixed operations and maintenance costs of the combustion turbine and combined cycle facilities (EPRI TAG 1993).

In order to represent the avoided capacity cost on an annual basis, the analysis has amortized the construction costs over the 30-year lives of the combustion turbine and combined cycle, using a nominal fixed charge factor. In order to represent the societal perspective, the analysis applied a fixed charge factor based on the societal discount rate. As a result, the annual avoided capacity costs are somewhat lower than those from a utility perspective, because they do not include costs such as finance costs and taxes, which are transfer payments between different entities within society. In addition, the estimates of the installed construction costs do not include allowance for funds used during construction (AFUDC), because these also are transfer payments.

Avoided energy costs have been estimated using the same approach. Prior to building new capacity, energy savings from the building code improvements would reduce the amount of generation from the existing *marginal* units (i.e., those with the highest variable cost) on the system. It is assumed, therefore, that avoided energy costs for the years 1995 through 1999 will be based on the marginal energy costs of the existing generating units in Missouri. The analysis adopted the avoided cost assumptions of the investor-owned utilities in Missouri as representing the marginal energy costs of existing units (Utility 1993 Cogeneration filings). The marginal energy generation during these years is forecast to be mostly from coal units, and therefore the avoided energy costs are roughly consistent with coal fuel costs.

Avoided energy costs from 2000 and beyond are based on the annual fuel costs of the avoided natural gas combined cycle.[27] The actual natural gas prices of $1.87 per million British Thermal Units (mmbtu) in 1992 were used, based on delivered prices in Missouri (DOE August 1993). Natural gas prices were then forecast beyond 1992 using escalation rates from the DOE Energy Information Agency (EIA), which forecasts average annual real escalation of 3.7% for wellhead natural gas prices through 2010 (DOE January 1993). Because natural gas prices are higher than the price of generation from existing coal facilities, there is a significant increase in the avoided energy costs in 2000.

In practice, the avoided energy cost will vary depending upon the time of day and time of year. Energy costs during peak periods can cost significantly more than during off-peak and shoulder periods. For those years when existing facilities are expected to make up the avoided costs (1995 through 1999), we have used avoided energy costs as the average across each year, for the purpose of simplicity. These average annual avoided energy costs are likely to be conservative (i.e., low) to the extent that the energy savings from the building code improvements are achieved more during peak and shoulder periods than off-peak periods.

For the later years when the avoided energy costs are represented by the production costs of a combined cycle facility (after 1999), we assume that the energy savings from the building code improvements will occur at approximately the same times as the combined cycle facility would operate. In other words, this methodology

[27] For 1998 and 1999 when a Combustion Turbine (CT) is assumed to be the avoided capacity, we assume that the CT would not generate much energy because it is a peaking unit. Therefore, the avoided energy in these years would continue to come from the existing units.

implies that the energy savings from the building code improvements would occur more during peak and shoulder periods than during off-peak periods. This is roughly consistent with our expectation of the energy savings from the code improvements, as described in the residential and commercial buildings analyses.

The resulting avoided capacity and energy costs are presented in Table III-10 for the years 1995 through 2014. These costs are in nominal dollars and represent the average avoided costs of the state of Missouri as a whole.

Table III-10
AVOIDED COSTS OF ELECTRICITY GENERATION IN MISSOURI
(in nominal dollars)

Year	Energy ($/mwh)	Capacity ($/kw-yr)
1995	14.0	0
1996	14.4	0
1997	15.0	0
1998	16.4	56
1999	17.3	56
2000	29.6	86
2001	32.0	88
2002	34.6	89
2003	37.4	90
2004	40.4	91
2005	43.7	93
2006	47.2	94
2007	51.1	96
2008	55.2	97
2009	59.7	99
2010	64.6	100
2011	69.9	102
2012	75.6	104
2013	81.8	106
2014	88.5	107

Natural Gas Supply - The direct economic benefits of natural gas savings from the building code enhancements could be in the form of (1) reduced cost of natural gas production, (2) reduced cost of natural gas transmission, and (3) reduced cost of natural gas distribution. Total of these reduced costs is referred to as avoided cost of natural gas. Component (3) is usually the smallest part, if any, of natural gas avoided cost and is ignored in this study. The sum of components (1) and (2) is a city-gate avoided cost which is used in this analysis to evaluate benefits of natural gas savings.

Since the actual natural gas savings are not known in advance, the commonly used approach is to calculate unit avoided cost which then could be applied to the particular physical gas savings in order to evaluate resulting benefits. However, one cannot simply calculate a single avoided cost and assume that it represents the value of all potential savings for two reasons: (1) Avoided gas costs vary according to the shape and load factor of the reduction in sendout. This is to be expected since the cost of providing service varies according to the shape of the load being served and the time of year (e.g. peak day, non-peak winter day, summer day). (2) Load reductions caused by building code enhancement will have different impacts on different end uses (e.g. space and water heating) and it may vary by the type of building. As a result, building code enhancement in different buildings will result in load reductions which differ in shape and load factor.

Thus, to estimate the value of potential natural gas savings, one needs to calculate individual avoided costs for a range of different types of load reductions, i.e. various shapes and load factors. One approach to these calculations would be to address each type of load reduction separately, calculating reduction-specific avoided costs for each possible type of load decrement. However, this would be very time-consuming.

A second approach, the one used here, is to estimate avoided costs for two basic types of load reduction:

- a peak day reduction/decrement case to estimate a **peak day avoided cost;**
- a non-peak day reduction/decrement case to estimate a **non-peak avoided cost**[28].

Peak day avoided costs are based on the assumption that load is reduced on the peak day only, while off-peak avoided cost is based on the assumption that load is evenly reduced in all days of the year excluding peak day. Basic avoided costs are presented in Table III-11, on the following page.

These estimates of the Missouri avoided gas costs were prepared based on the data from one of the largest Missouri utilities - Laclede Gas Company, which is serving Northeastern part of the state, including St. Louis City and County. Information on Laclede Gas Company was obtained from the Missouri Public Service

[28] Initially, the analysis considered winter non-peak and summer non-peak avoided costs separately. The differential between them was negligible in the original analysis, and we combined them into one category of non-peak avoided costs.

Commission. This information is representative for the whole state for the following reasons:

- Laclede Gas Company and Western Resources Company, which is serving the Kansas City area, account for almost 85% of total gas supply in Missouri;
- Average cost of gas supply for Laclede Gas and for Western Resources are very close (within 1%). Due to the lack of data, we were unable to calculate avoided costs for Western Resources directly, but we expect that results would not be significantly different.

Table III-11
BASIC AVOIDED COSTS OF NATURAL GAS
(Nominal $/MMbtu)

Year	Peak Day Type			Non-peak Type		
	Capacity Component	Commodity Component	Total Peak	Capacity Component	Commodity Component	Total Non-peak
1995	$74.38	$2.73	$77.10	$0.00	$2.73	$2.73
1996	$74.38	$2.78	$77.16	$0.00	$2.78	$2.78
1997	$74.38	$2.84	$77.21	$0.00	$2.84	$2.84
1998	$74.38	$2.89	$77.27	$0.00	$2.89	$2.89
1999	$74.38	$2.95	$77.33	$0.00	$2.95	$2.95
2000	$74.38	$3.01	$77.39	$0.00	$3.01	$3.01
2001	$74.38	$3.14	$77.52	$0.00	$3.14	$3.14
2002	$74.38	$3.28	$77.66	$0.00	$3.28	$3.28
2003	$74.38	$3.43	$77.80	$0.00	$3.43	$3.43
2004	$74.38	$3.58	$77.96	$0.00	$3.58	$3.58
2005	$74.38	$3.75	$78.12	$0.00	$3.75	$3.75
2006	$74.38	$3.85	$78.23	$0.00	$3.85	$3.85
2007	$74.38	$3.96	$78.33	$0.00	$3.96	$3.96
2008	$74.38	$4.07	$78.45	$0.00	$4.07	$4.07
2009	$74.38	$4.18	$78.56	$0.00	$4.18	$4.18
2010	$74.38	$4.30	$78.68	$0.00	$4.30	$4.30
2011	$74.38	$4.43	$78.80	$0.00	$4.43	$4.43
2012	$74.38	$4.55	$78.93	$0.00	$4.55	$4.55
2013	$74.38	$4.68	$79.06	$0.00	$4.68	$4.68
2014	$74.38	$4.82	$79.19	$0.00	$4.82	$4.82
Levelized Values (1993$/MMbtu) @ nominal discount rate of:						6.60%
95-14	$74.38	$3.43	$77.80	$0.00	$3.43	$3.43

Environmental Benefits of Building Code Improvements

Electricity - The consumption of electricity and natural gas results in a variety of environmental impacts. These impacts are sometimes referred to as environmental externalities, because they are not generally included in the prices paid for energy. In recent years, energy planners and regulators have begun to take account of environmental impacts in energy resource decisions. Monetary values of these environmental impacts have been developed to enable planners to compare environmental impacts with direct economic impacts, using dollars as a consistent unit of measurement. In this way, it is possible to compare options that have both different direct economic costs and different environmental impacts.

A variety of techniques have been developed to estimate monetary values of environmental impacts.[29] The two most frequently used techniques for estimating environmental externalities for electricity resources are the *direct cost* approach and the *control cost* approach. The direct cost approach assigns a monetary value to environmental *goods,* such as trees, fish and recreational parks, based on the market value of those goods. The control cost approach assigns a monetary value to pollutants, such as carbon dioxide (CO_2), sulphur dioxide (SO_2) and nitrous oxides (NO_X), based on the costs required to abate those pollutants. For pollutants such as SO_2 and NO_X, control technologies, such as scrubbers and selective catalytic reduction, are often used to represent the control costs. For CO_2, control costs are based on the costs of planting trees to act as carbon sinks, thereby offsetting the effects of CO_2 emissions. Both the control cost and direct techniques have resulted in a wide range of estimates of environmental externalities.

For the purposes of this analysis, the monetary values of environmental externalities are derived using the control cost technique. This approach is preferable to the damage cost approach, because of the many uncertainties inherent in the damage cost approach at this time. The control costs for non-greenhouse gases are based on analysis of existing and/or emerging air quality regulations. The costs for greenhouse gases were derived from estimates of the cost of planting trees as a carbon sink. The monetary values used in this analysis are presented in Table III-12, on the following page. These values were adopted by the Massachusetts Department of Public Utilities for electric utility integrated resource planning (MDPU 1993).

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[29] See EIERA, *Missouri Statewide Energy Study*, Volume IV, May 1992, for an overview of environmental impacts of energy consumption and monetary values for these impacts.

Table III-12 MONETARY VALUES OF AIR EMISSIONS	
Pollutant	**Monetary Values (1992-$/ton)**
Nitrogen Oxides (NO_x)	$7,200
Sulphur Dioxide (SO_2)	$1,700
Carbon Dioxide (CO_2)	$24
Methane (CH_4)	$240
Carbon (CO)	$960
Total Suspended Particulates (TSP)	$4,400
Volatile Organic Compounds (VOC)	$5,900

The air emissions presented in Table III-13 are primarily responsible for global warming, acid rain, ground-level ozone, and other impacts that affect the environment and human health. While there are a variety of additional environmental impacts associated with energy consumption, we have not included them in our analysis here.

The environmental impacts of the building improvements have been estimated using a similar approach as the direct economic impacts. *Monetized Environmental Costs* have been estimated by first applying the monetary values presented in Table III-13 to emission factors (in tons/mmbtu) which are representative of the avoided power plants in Missouri (UCS 1992). This results in avoided environmental costs, in $/mmbtu, which are then applied to heat rates which are also representative of the avoided power plants (EEI 1993; EPRI TAG 1993). This provides avoided environmental costs, in dollars per megawatt hour of electricity ($/mwh), which can be added to the avoided energy costs.

In developing avoided energy costs, the assumption is that certain marginal generation facilities would operate less, as a result of the building code standards. The avoided environmental costs used are based on those pollutants that would be avoided as a result of lower operation of these same facilities. Therefore, from 1995 through 1999, the code improvements are assumed to displace emissions from existing coal plants, and after 1999 the emissions from the new combined cycle are assumed to be displaced. As a result, there is a significant drop in the avoided externality costs in 2000, when the avoided emissions switch from existing coal facilities to a cleaner, more efficient combined cycle plant. This decrease in environmental externality costs coincides with the increase in capital and energy costs of the combined cycle plant.

The resulting avoided environmental costs of electricity generation in Missouri are presented in Table III-13, on the following page. These costs can then be added to the avoided energy and capacity costs to determine the total "societal" avoided costs per unit of electricity generation.

Table III-13
MONETIZED ENVIRONMENTAL COSTS
OF ELECTRICITY AND NATURAL GAS PRODUCTION IN MISSOURI

Year	Electricity ($/mwh)	Natural Gas ($/mmbtu)
1995	59.7	2.05
1996	61.8	2.12
1997	63.9	2.20
1998	66.2	2.27
1999	68.5	2.35
2000	19.5	2.43
2001	20.2	2.52
2002	20.9	2.61
2003	21.6	2.70
2004	22.3	2.79
2005	23.1	2.89
2006	23.9	2.99
2007	24.8	3.10
2008	25.6	3.21
2009	26.5	3.32
2010	27.5	3.43
2011	28.4	3.55
2012	29.4	3.68
2013	30.4	3.81
2014	31.5	3.94

Natural Gas End-Use Consumption - Consumption of natural gas in appliances also results in environmental impacts. The primary environmental impacts are due to emissions of the same pollutants that are released from fossil-fuel power plants.

Therefore, estimated avoided environmental costs of end-use natural gas consumption based on the same pollutants and monetary values presented in Table III-12. These values in ($/ton) are applied to emission factors (in lb/mmbtu) to determine an avoided cost (in $/mmbtu). The emission factors used in our analysis are based on average emission factors of residential and commercial space and water heating gas appliances (UCS 1992).

The resulting monetized environmental costs of natural gas end-use consumption in Missouri are presented in Table III-13. These costs can then be added to the direct avoided costs of natural gas, to determine the total "societal" avoided costs per unit of gas.

Net Economic and Environmental Impact

As described above, this analysis models the impact of building efficiency improvements implemented during the six years from 1995 through 2000. In order to capture the long-term benefits of the building efficiency improvements, it is necessary to account for the energy savings which will continue to accrue after 2000, from those measures that were implemented from 1995 through 2000. Therefore, it is assumed that the energy savings achieved in 2000 will continue to occur through the remainder of the study period. A twenty-year study period was selected for this impact analysis, even though much of the energy savings will continue to occur after twenty years. We see this as a conservative assumption in the methodology. The costs of implementing these measures, however, are incurred during the 1995 through 2000 period only.

The benefits of the building efficiency improvements can be derived by simply multiplying the avoided costs by the estimated electricity and gas savings. The results are provided in Table III-14, which presents the reduction in electricity and natural gas costs, in nominal dollars, for the twenty-year study period. The environmental benefits of the building code improvements are presented separately, and then are added to the direct economic benefits to determine the total benefits in terms of dollars. Table III-14, on the following 3 pages, provides a summary of results for the EPAct Standard, Enhanced Case and Resource Case.

Table III-14
ECONOMIC AND ENVIRONMENTAL BENEFITS OF EFFICIENCY IMPROVEMENTS
EPAct Standard Case
Page 1 of 3
Amounts are $Million. Annual figures are in nominal dollars. Cumulative Present Values (CPV) are in 1993 present value dollars. Discount Rate is 6.6%.

Year	Electric					Natural Gas End-Use			Electricity & gas
	Energy	Capacity	Energy & Capacity	Externality	Total Electric	Gas	Externality	Total Gas	Total Benefits
1995	$0.4	$0.0	$0.4	$1.7	$2.1	$1.5	$0.8	$2.3	$4.4
1996	$0.8	$0.0	$0.8	$3.5	$4.3	$3.1	$1.6	$4.8	$9.1
1997	$1.3	$0.0	$1.3	$5.4	$6.7	$4.9	$2.5	$7.5	$14.2
1998	$1.9	$2.3	$4.1	$7.5	$11.7	$6.9	$3.5	$10.4	$22.1
1999	$2.5	$2.9	$5.4	$9.8	$15.2	$9.1	$4.5	$13.7	$28.9
2000	$5.1	$5.4	$10.5	$3.4	$13.9	$11.6	$5.7	$17.3	$31.2
2001	$5.5	$5.5	$11.0	$3.5	$14.5	$12.4	$5.9	$18.3	$32.8
2002	$6.0	$5.6	$11.6	$3.6	$15.2	$13.3	$6.1	$19.4	$34.5
2003	$6.5	$5.6	$12.1	$3.7	$15.9	$14.2	$6.3	$20.5	$36.4
2004	$7.0	$5.7	$12.7	$3.9	$16.6	$15.2	$6.5	$21.8	$38.4
2005	$7.6	$5.8	$13.4	$4.0	$17.4	$16.4	$6.7	$23.1	$40.5
2006	$8.2	$5.9	$14.1	$4.2	$18.2	$17.3	$7.0	$24.3	$42.5
2007	$8.9	$6.0	$14.8	$4.3	$19.1	$18.3	$7.2	$25.5	$44.7
2008	$9.6	$6.1	$15.7	$4.4	$20.1	$19.4	$7.5	$26.9	$47.0
2009	$10.4	$6.2	$16.5	$4.6	$21.1	$20.5	$7.7	$28.3	$49.4
2010	$11.2	$6.3	$17.5	$4.8	$22.2	$21.8	$8.0	$29.8	$52.0
2011	$12.1	$6.4	$18.5	$4.9	$23.4	$23.0	$8.3	$31.3	$54.8
2012	$13.1	$6.5	$19.6	$5.1	$24.7	$24.4	$8.6	$33.0	$57.7
2013	$14.2	$6.6	$20.8	$5.3	$26.1	$25.9	$8.9	$34.8	$60.8
2014	$15.3	$6.7	$22.1	$5.5	$27.5	$27.4	$9.2	$36.6	$64.1
CPV	**$59.5**	**$41.2**	**$100.7**	**$47.3**	**$148**	**$130**	**$54.3**	**$184**	**$332.4**

Table III-14
ECONOMIC AND ENVIRONMENTAL BENEFITS OF EFFICIENCY IMPROVEMENTS
Enhanced Case
Page 2 of 3
Amounts are $Million. Annual figures are in nominal dollars. Cumulative Present Values (CPV) are in 1993 present value dollars. Discount Rate is 6.6%.

Year	Electric					Natural Gas End-Use			Electricity & gas
	Energy	Capacity	Energy & Capacity	Exter-nality	Total Electric	Gas	Exter-nality	Total Gas	Total Benefits
1995	$1.5	$0.0	$1.5	$6.6	$8.1	$3.3	$1.6	$4.9	$13.0
1996	$3.2	$0.0	$3.2	$13.6	$16.8	$6.7	$3.2	$9.9	$26.7
1997	$5.0	$0.0	$5.0	$21.2	$26.2	$10.6	$4.9	$15.5	$41.7
1998	$7.3	$11.8	$19.1	$29.5	$48.6	$14.9	$6.8	$21.7	$70.3
1999	$9.7	$15.0	$24.7	$38.4	$63.1	$19.6	$8.9	$28.5	$91.6
2000	$20.1	$27.8	$47.9	$13.2	$61.1	$24.7	$11.0	$35.7	$96.8
2001	$21.7	$28.2	$49.9	$13.7	$63.6	$26.4	$11.4	$37.8	$101.4
2002	$23.4	$28.6	$52.0	$14.1	$66.1	$28.2	$11.8	$40.0	$106.1
2003	$25.3	$29.0	$54.3	$14.6	$68.9	$30.1	$12.2	$42.3	$111.2
2004	$27.4	$29.4	$56.8	$15.1	$71.9	$32.2	$12.7	$44.9	$116.8
2005	$29.6	$29.8	$59.4	$15.7	$75.1	$34.4	$13.1	$47.5	$122.6
2006	$32.0	$30.3	$62.3	$16.2	$78.5	$36.4	$13.6	$50.0	$128.5
2007	$34.6	$30.8	$65.4	$16.8	$82.2	$38.4	$14.0	$52.4	$134.6
2008	$37.4	$31.2	$68.6	$17.4	$86.0	$40.6	$14.5	$55.1	$141.1
2009	$40.5	$31.7	$72.2	$18.0	$90.2	$42.9	$15.0	$57.9	$148.1
2010	$43.8	$32.3	$76.1	$18.6	$94.7	$45.4	$15.6	$61.0	$155.7
2011	$47.4	$32.8	$80.2	$19.3	$99.5	$48.0	$16.1	$64.1	$163.6
2012	$51.2	$33.3	$84.5	$19.9	$104.4	$50.8	$16.7	$67.5	$171.9
2013	$55.4	$33.9	$89.3	$20.6	$109.9	$53.8	$17.3	$71.1	$181.0
2014	$59.9	$34.5	$94.4	$21.4	$115.8	$56.9	$17.9	$74.8	$190.6
CPV	**$232.5**	**$212.0**	**$444.5**	**$184.8**	**$629.4**	**$274.0**	**$105.6**	**$379.6**	**$1,009.0**

Table III-14
ECONOMIC AND ENVIRONMENTAL BENEFITS OF EFFICIENCY IMPROVEMENTS
Resource Case
Page 3 of 3
Amounts are $Million. Annual figures are in nominal dollars. Cumulative Present Values (CPV) are in 1993 present value dollars. Discount Rate is 6.6%.

Year	Electric					Natural Gas End-Use			Electricity & gas
	Energy	Capacity	Energy & Capacity	Exter-nality	Total Electric	Gas	Exter-nality	Total Gas	Total Benefits
1995	$2.1	$0.0	$2.1	$9.1	$11.2	$4.2	$1.9	$6.1	$17.3
1996	$4.4	$0.0	$4.4	$18.8	$23.2	$8.8	$4.0	$12.8	$36.0
1997	$6.9	$0.0	$6.9	$29.2	$36.1	$13.8	$6.1	$19.9	$56.0
1998	$10.0	$18.1	$28.1	$40.5	$68.6	$19.3	$8.5	$27.8	$96.4
1999	$13.3	$22.9	$36.2	$52.7	$88.9	$25.4	$11.0	$36.4	$125.3
2000	$27.5	$42.6	$70.1	$18.1	$88.2	$32.1	$13.7	$45.8	$134.0
2001	$29.7	$43.2	$72.9	$18.7	$91.6	$34.2	$14.2	$48.4	$140.0
2002	$32.1	$43.8	$75.9	$19.4	$95.3	$36.5	$14.7	$51.2	$146.5
2003	$34.7	$44.4	$79.1	$20.1	$99.2	$38.9	$15.2	$54.1	$153.3
2004	$37.6	$45.0	$82.6	$20.8	$103.4	$41.5	$15.8	$57.3	$160.7
2005	$40.6	$45.7	$86.3	$21.5	$107.8	$44.4	$16.3	$60.7	$168.5
2006	$43.9	$46.4	$90.3	$22.2	$112.5	$46.9	$16.9	$63.8	$176.3
2007	$47.5	$47.1	$94.6	$23.0	$117.6	$49.5	$17.5	$67.0	$184.6
2008	$51.3	$47.9	$99.2	$23.8	$123.0	$52.3	$18.1	$70.4	$193.4
2009	$55.5	$48.6	$104.1	$24.7	$128.8	$55.2	$18.7	$73.9	$202.7
2010	$60.0	$49.4	$109.4	$25.5	$134.9	$58.4	$19.4	$77.8	$212.7
2011	$64.9	$50.2	$115.1	$26.4	$141.5	$61.7	$20.1	$81.8	$223.3
2012	$70.2	$51.1	$121.3	$27.3	$148.6	$65.2	$20.8	$86.0	$234.6
2013	$76.0	$52.0	$128.0	$28.3	$156.3	$69.0	$21.5	$90.5	$246.8
2014	$82.2	$52.9	$135.1	$29.3	$164.4	$73.0	$22.2	$95.2	$259.6
CPV	**$318.9**	**$324.9**	**$643.8**	**$253.7**	**$897.5**	**$353.6**	**$131.4**	**$485.0**	**$1,382.5**

The costs of the building efficiency improvements that were derived in the Residential and Commercial Buildings analyses include all of the costs that are incurred by building owners to purchase and install the additional measures required by the improved codes. These costs, are presented in Table III-15 below, for the EPAct Standard, Enhanced Case and Resource Case. Both the nominal costs, and the present value in 1993 dollars are shown.

Table III-15
COST OF BUILDING EFFICIENCY IMPROVEMENTS

YEAR	EPAct ($Million)		ENHANCED ($Million)		RESOURCE ($Million)	
	Nominal	Present Value	Nominal	Present Value	Nominal	Present Value
1995	$47.5	$41.8	$93.1	$81.9	$179.7	$158.1
1996	$47.7	$39.4	$94.5	$78.0	$183.6	$151.6
1997	$49.7	$38.5	$98.8	$76.5	$192.3	$148.9
1998	$52.1	$37.9	$103.7	$75.3	$202.6	$147.2
1999	$54.7	$37.3	$109.0	$74.3	$213.5	$145.5
2000	$57.3	$36.6	$114.6	$73.2	$224.2	$143.3
Cumulative	**$309**	**$231.5**	**$613.7**	**$459.2**	**$1195.9**	**$894.6**

Table III-16 summarizes the results of our impact analysis. It presents both the benefits and the costs of the building code improvements, in cumulative present value dollars using the 3% real societal discount rate. The difference between the two gives us the net benefit, for each of the three cases examined.

Table III-16
NET BENEFITS OF BUILDING EFFICIENCY IMPROVEMENTS
In Cumulative 1993 Present Dollars

	EPAct Standard	Enhanced Case	Resource Case
Benefits (Savings):	($Millions)	($Millions)	($Millions)
Electricity	$101.7	$444.5	$643.8
Natural Gas	$130.1	$274.0	$353.6
Environmental	$101.6	$290.5	$385.1
Total	$332.4	$1,009.0	$1,382.5
Costs	($231.4)	($459.2)	$894.6
Net Benefits	$101.0	$549.8	$487.9

Table III-16 indicates that there will be significant net benefits from the building efficiency improvements. The net benefits are expected to be $101.0 million in 1993 present value dollars for the EPACT standard, and $549.8 and $487.9 million for the Enhanced and Resource Cases, respectively.

In the EPACT Case, the benefits are obtained roughly evenly from electricity, gas and environmental impacts. In the latter two cases, however, the benefits are primarily obtained from electricity impacts. **It is interesting to note that if environmental externalities are not included in the benefits, there will still be positive net benefits from the building code improvements in all three cases.**

The Resource Case has lower net benefits than the Enhanced Case because the incremental costs necessary to achieve this higher level of savings exceed the incremental benefits. This suggests that **the optimal level of building efficiency improvements lies somewhere between the Enhanced and the Resource cases.**

Macroeconomic Effects

Estimating the economic impact of cost savings of energy efficiency investments in buildings is a straightforward but multi-step process. Given estimated cost savings for natural gas and electric usage for both residential and commercial buildings as provided by the residential and commercial buildings analyses, this part of the analysis now begins the step-by-step process of calculating the economic impacts based on a number of different indicators.

When completing any economic impact assessment, the analysis can never include all possible variables and must therefore select a finite number of variables for impact assessment. The variables selected for estimated impact in this analysis are income, employment, retail sales and state government revenue (e.g., state income tax, state sales tax, energy tax). Regardless of the variables selected in any analysis, all of the projections remain estimates and are contingent on the models presented and stated assumptions.

The process of estimating impact based on these variables started by analyzing net savings to residential and commercial buildings. Next, the economic impact of residential savings is calculated utilizing income multipliers. The net income effect is then translated into an equivalent employment effect. The new income is then transformed into a likely range of net retail sales impact and the sales are then extrapolated into likely sales tax effect for residential consumers. State income tax revenues are then calculated from the net income effect. The likely projected loss in state energy taxes are then subtracted from the combined increase in state income and sales tax to arrive at a net state government revenue impact assessment.

This analysis assumes that the construction related costs are neutral; that is, the stimulative effect of construction expenditures are equal to any contractionary effects of construction expenditures relative to the balance of the Missouri economy. This analysis does not attempt to calculate economic impacts of demand side management, avoided capacity payments and externality credits.

The process for calculating economic impacts of energy cost savings in commercial buildings is similar to the residential case except that it assumes a different disbursement of savings to factors other than pure income. It is assumed that corporations and other businesses will utilize new income from energy costs savings in the same manner that they will allocate sales revenue on their profit and loss statement in a given year. In other words, a large percentage will be allocated to cost of goods sold (e.g., payroll and other input purchases), overhead (e.g., sales and general administration) and the balance will be allocated to profits and retained earnings for new investment. Once these allocations are made, the income, employment and state government revenue projections can be made in a manner similar to the residential case. The residential and commercial savings can then be combined to give an overall picture of estimated economic impact of the energy cost savings.

Net Cost Savings Calculations - While the energy cost savings are of a benefit to most Missouri residents and businesses there is also a small category of economic *losers* from these savings. These are the businesses and employees within Missouri who derive their income directly from the energy payments of consumers. Their loss in income from decreased natural gas and electricity sales due to energy conservation programs must be calculated into the Net Cost Savings determination.

Because almost all of the raw inputs in energy generation are imported to Missouri from other states or nations only a small percentage of the consumers' energy dollar remains in the state as income. Therefore, the Net Cost Savings will be calculated with a discount factor to account for the loss of income to Missouri businesses and employees who benefit from energy sales.

Because a higher percentage of natural gas sales dollars leave the state the Net Cost Savings for natural gas -- NCS(ng) -- is calculated to be higher than the Net Cost Savings for electricity -- NCS(e). Based on our analysis and discussions with state energy officials these discounting values are assumed to be 0.80 for natural gas and 0.70 for electricity.

Net Residential Savings - Net Residential Savings (NRS) are calculated by adjusting for inflation by multiplying annual savings by a present value discount value (pvd), summing and then further discounting the data shown in the building energy savings (bes) by the NCS(ng) and NCS(e) values. The formulas for these calculations will be separate for natural gas and electricity. The net savings for natural gas are determined by the formula NRS(ng) = bes x pvd x NCS(ng). The net residential savings for electricity are calculated by the formula NRS(e) = bes x pvd x NCS(e). These Net Residential Savings values are shown in the Table III-17.

Table III-17
NET RESIDENTIAL SAVINGS
(Millions 1995 $)

	EPAct	ENHANCED	RESOURCE
Natural Gas (NG)	$32.145	$66.542	$80.181
Electric (EL)	$18.340	$68.147	$95.653
Total (NRS) (NG + EL)	**$50.485**	**$134.689**	**$175.834**

Residential Savings Economic Impact - All residential savings are treated as new marginal income and the assumption is that residential consumers will treat this as normal income. Obviously, different consumers will treat new income differently (i.e., some will spend or save more or less); however, for purposes of this analysis, we treat all residents equally. Because we are analyzing the economic impact the entire state of Missouri the economic multiplier is estimated to be rather large. Empirical studies on economic regions of various sizes suggest that a multiplier of 3.0 is a safe and conservative estimate as studies of metropolitan areas the size of St. Louis have yielded income multipliers of similar size. With that information, we then moved to estimating the net residential income effect.

Net Residential Income Effect: To determine the net residential income effect we start with the net residential savings and project its ultimate income increase for Missouri with what economists call an income multiplier. The formula for determining the net income effect is as follows:

Net New Income = Net Residential Savings X State Income Multiplier

This formula is applied to the three energy efficiency scenarios detailed earlier in this report, EPAct Standard, Enhanced Case and Resource Case, for all buildings using both natural gas and electricity to yield results as shown in the table III-18. The costs savings numbers detailed in the residential and commercial buildings analyses have been adjusted with the appropriate present value discount values (pvd) based on the 3.5% rate of inflation assumed in the earlier calculations.

Table III-18 RESIDENTIAL INCOME EFFECT/THREE SCENARIOS (Millions 1995 $)			
	EPAct	ENHANCED	RESOURCE
Natural Gas (NG)	$32.145	$66.542	$80.181
Electric (EL)	$18.340	$68.147	$95.653
Subtotal (NRS)	$50.485	$134.689	$175.834
Net New Income(NRS x 3)	$151.455	$404.067	$527.502

In summary the net new income to Missouri residential energy users for the six years of analysis, as derived from the three energy efficiency scenarios, will range from approximately $151.5 million for the EPAct Standard to $527.5 million in the Resource Case.

Employment Impact: Although this analysis makes no attempt to calculate new employment growth based on new investment and expanding production it does translate the new residential income into an equivalent *employment effect.* This is done by dividing the Net New Income by the average employee annual salary in Missouri for 1992. These are adjusted for inflation, at the same 3.5% rate, to 1995, the Present Value Year of these calculations. The 1992 average Missouri salary was $22,640; the 1995 inflation adjusted salary (1995 S) is projected to be $25,100.92. Because this calculation is based on summing all six analysis years, these employment numbers must be divided by six to give a full time employment equivalent average over the life of the analysis. The formula for determining employment equivalent impact of the new income is:
Employment Equivalent Impact = (Net New Income/1995 Average Salary)/Six Years

Application of this formula to the previously derived NNI numbers yields results as shown in Table III-19.

Table III-19 EMPLOYMENT EQUIVALENT IMPACT OF NET NEW INCOME		
Case:	NNI (Million $)	EEI
EPAct	$151,455	$1,006
Enhanced	$404,067	$2,683
Resource	$527,502	$3,503

Net Residential Savings Retail Impact: The net residential savings accumulates to consumers as income and a large portion of this is transformed into retail sales.

Historic data indicates that approximately 45% of income will become retail sales, with the balance going to taxes, housing, savings and other expenditures. It should be pointed out that the new income and employment *spinoffs* for retail sales are already accounted for in the previous calculations; still, calculations for retail sales are shown to give a general view of impact on retail sales and to specifically show a range of fiscal impact on state sales tax. The formula then for calculating increased retail sales and increased state sales tax is: NNI x 0.45 = Sales x 0.04725 = Sales Tax. The results of these calculations are shown in Table III-20.

Table III-20
RETAIL SALES/SALES TAX EFFECT

Case	NNI	X 0.045 = Sales	X 0.04725 = Sales Tax $
EPAct	$151,455	$68,155	$3,220,324
Enhanced	$404,067	$181,830	$8,591,468
Resource	$527,502	$237,379	$11,216,016

State Income Tax Effect: The Net New Income (NNI) flowing to the state's inhabitants becomes new marginal income subject to state taxation. For the purposes of this analysis it is assumed that this income will be taxed at the state rate of 6%. Utilizing this model the net increases in state income tax from residential users is shown in Table III-21.

Table III-21
STATE INCOME TAX EFFECT

Case	NNI	X 0.06 = New State Income Tax $
EPAct	$151,455	$9,087,300
Enhanced	$404,067	$24,244,020
Resource	$527,502	$31,650,120

Net Residential Savings Energy Tax Impact: While there will be gains from net savings to consumers in the form of increased sales and income taxes there will actually be losses in state energy taxes due to the losses in energy sales resulting from the energy conservation programs. While residential consumers are exempt from natural gas use taxes, they are subject to a 4.225% state electric energy tax (set) on electrical energy usage. It should be noted that many residential consumers are also subject to local energy taxes (e.g., city and county), but this model restricts itself to an analysis of state fiscal impacts. The residential savings energy tax impact (ETI) is calculated by taking the cost savings, for electricity (es) only, times the state electric tax (set). The formula for this calculation is ETI = (es) x (set). The estimated *loss of energy taxes resulting from conservation programs under the three scenarios* is shown in Table III-22.

Table III-22 STATE ENERGY TAX DECLINES FROM RESIDENTIAL SAVINGS		
Case	Cost Savings	Energy Tax Declines
EPAct	$22,295,000	$968,581
Enhanced	$85,184,000	$3,599,024
Resource	$119,566,000	$5,051,664

Commercial Savings Economic Impact - The estimation of the effect of commercial energy savings requires a different model and different assumptions than *the residential case. While this model treated all net residential savings as income,* businesses behave differently. Savings are equivalent to sales revenue and the assumption of this analysis is that this *revenue* will be treated the same as other revenue and will be allocated on the profit and loss statement in a manner similar to *revenue in past years. Therefore, this analysis makes the following assumptions* based on broad behavior patterns of all private firms in a large economy such as that of Missouri: 1) 60% will become Missouri payroll through expansion or new investment, 2) the balance (i.e., 40%) will flow out of the state for inputs. Based on these assumptions the net income effect of business savings is shown in Table III-23.

Table III-23 *NET BUSINESS SAVINGS (NBS) INCOME EFFECT:*			
Energy:	EPAct	ENHANCED	RESOURCE
Natural Gas	$9,633,000	$14,904,000	$20,483,000
Electric	$10,193,000	$37,996,000	$50,101,000
Sub-total (NBS)	$19,826,000	$52,900,000	$70,584,000
Total(NNBI)(NBSxSIM)	$59,478,000	$158,700,000	$211,757,000

Employment Impact of Business Savings: Employment impact is calculated in the same manner as the residential case and is shown in Table III-24.

Table VIII-24 EMPLOYMENT IMPACT OF BUSINESS INCOME		
Case:	**NNBI**	**EEIB (Jobs)**
EPAct	$59,478,000	395
ENHANCED	$158,700	1,054
RESOURCE	$211,752	802

Business Income Retail Sales/Sales Tax Effect: Retail sales/sales tax effect of the new income derived from business savings is calculated in the same manner as the residential savings impact and is shown in Table III-25.

Table III-25 BUSINESS INCOME RETAIL EFFECT			
Case:	**NNBI**	**x 0.45 = Sales**	**x 0.04725 = Sales Tax**
EPAct	$59,478,000	$26,765,000	$1,264,646
ENHANCED	$158,700,000	$71,415,000	$3,374,359
RESOURCE	$211,752,000	$95,288,000	$4,502,358

Business State Income Tax Effect: The state income tax effect from new income derived from business energy savings is calculated in the same manner as the residential savings and is shown in Table III-26.

Table III-26 BUSINESS STATE INCOME TAX EFFECT		
Case:	**NNBI**	**x 0.06 = New Income Tax $**
EPAct	$59,478,000	$3,568,680
ENHANCED	$158,700,000	$9,522,000
RESOURCE	$211,752,000	$12,705,120

State Energy Tax Effects: Calculations for state energy tax declines due to business energy conservation are shown in Table III-27 for the three cases.

Table III-27
STATE ENERGY TAX DECLINES FROM BUSINESS

Case:	ETL	NGTL	TETL
EPAct	$1,025,365	$1,204,140	$2,229,505
ENHANCED	$3,821,344	$1,862,940	$5,684,284
RESOURCE	$5,039,918	$2,560,320	$7,600,238

Combined Residential/Commercial Savings Economic Impact Summary - The total or combined economic impacts for the energy conservation scenarios are obtained by summing the residential and business impacts in the separate categories of income, employment, retail sales and tax effects. The combined data are shown in Tables III-28 to III-33. These combined effects are also summarized in the Conclusion.

Table III-28
COMBINED INCOME EFFECT

Case:	Residential	Business	Combined
EPAct	$151,145,000	$59,478,000	$210,623,000
Enhanced	$404,067,000	$158,700,000	$562,767,000
RESOURCE	$527,502,000	$211,752,000	$739,254,000

Table III-29
COMBINED EMPLOYMENT EFFECT

Case:	Residential	Business	Combined
EPAct	1,006	395	1,401
ENHANCED	2,683	1,054	3,737
RESOURCE	3,503	1,406	4,909

Table III-30
COMBINED RETAIL SALES EFFECT

Case:	Residential	Business	Combined
EPAct	$68,155	15,025	$94,920
ENHANCED	$181,830	40,913	$253,245
RESOURCE	$237,376	54,332	$332,664

Table III-31
COMBINED STATE INCOME TAX EFFECT

Case:	Residential	Business	Combined
EPAct	$9,087,300	$3,568,680	$12,655,980
ENHANCED	$24,244,020	$9,522,000	$33,766,020
RESOURCE	$31,650,120	$12,705,120	$44,355,240

Table III-32
COMBINED ENERGY TAX DECLINES

Case:	Residential	Business	Combined
EPAct	$968,581	$2,229,505	$3,198,086
ENHANCED	$3,599,024	$5,684,284	$9,283,308
RESOURCE	$5,051,664	$7,600,238	$12,651,902

Table III-33
STATE REVENUE SUMMARY

Case:	Sales Tax +	Income Tax -	Energy Tax =	Total
EPAct	$4,484,970	$12,655,980	$3,148,086	$13,992,864
ENHANCED	$11,965,827	$33,766,020	$9,283,308	$36,448,539
RESOURCE	$15,918,374	$44,355,240	$12,651,902	$47,421,712

Summary of Macro Economic Analysis - Based on the energy cost savings for residential and commercial buildings as presented in this report, the economic impacts for Missouri are considerable. This analysis is based on the combined residential and commercial building energy costs savings of the three scenarios, EPAct Standard, Enhanced Case and Resource Case, presented earlier in this report and is adjusted to 1995 dollars. Based on the models and assumptions presented, this analysis estimates the economic impacts over the six year period of 1995 - 2000 as follows:

Increased State Personal Income:

EPAct Standard	$210,623,000
Enhanced Case	$562,767,000
Resource Case	$737,254,000

Increased Employment (Full time positions for entire six years.):

EPAct Standard	1,401 jobs
Enhanced Case	3,737 jobs
Resource Case	4,409 jobs

Increased Retail Sales:

EPAct Standard	$ 94,920,000
Enhanced Case	$253,245,000
Resource Case	$332,644,000

Net Increases in State Revenue:

EPAct Standard	$13,992,864
Enhanced Case	$36,448,539
Resource Case	$47,421,712

Chapter IV
Program Review

Overview to Program Analysis

Introduction

In the 1992 *Missouri Statewide Energy Study* conducted by EIERA, an extensive analysis demonstrated that there is a substantial untapped potential for cost-effective energy efficiency improvement in the state's major energy-using sectors. A wide range of energy efficiency options were analyzed, in the following areas:

- Information and education
- Energy efficiency for residential buildings
- Residential energy efficiency equipment
- Energy efficiency for commercial buildings
- Commercial energy efficiency equipment
- Motor vehicle fuel efficiency
- Motor vehicle usage reduction/transit options
- Emerging energy technology options
- Integrated resource planning by utilities
- Traditional energy resource options
- Renewable energy resource options

Most, but not all, of these options were demand-side energy efficiency options. Interestingly, based on its analysis of demand-side options from an economic development perspective, the Study concluded as follows:[1]

> *Energy efficiency will sustain more employment opportunities than either the continued current level of energy use or the development of new energy supplies.* Therefore, investments in energy efficiency represent a significant economic development opportunity for the state.

However, the optimal level of investment in energy efficiency will not necessarily occur based on the operation of market forces alone. There are a number of barriers to investment in energy efficiency by households, businesses, and other parties -- barriers which thoughtfully designed policy and program initiatives can help to remove. The barriers fall into three general categories, which have been summarized as follows by a regional planning agency in the Pacific Northwest:[2]

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[1] Environmental Improvement and Energy Resources Authority, *Missouri Statewide Energy Study*, page I-33. Italics in original.

[2] Northwest Power Planning Council, Conservation Acquisition Program Design, Staff Issue Paper 89-32 (Portland, Oregon, Northwest Power Planning Council, 1989), page 3.

- Economic barriers - Inadequate access to capital at competitive terms, inaccurate price...signals; high rate-of-return/payback requirements; low priority investment relative to other uses of limited funds....
- Information barriers - Inadequate information on what to do; inaccurate perceptions, for example, the view that conservation means doing without;
- Institutional barriers - Arrangements that separate the benefits...from the costs...such as tenant/landlord relationship; political resistance to regulatory changes (e.g., codes, appliance standards).

Thus, energy efficiency will not be exploited just on account of being included in an analysis such as EIERA's 1992 Study. Rather, the *behavior* of thousands of individuals and firms must be altered, so that efficiency measures are actually adopted. Several types of potential programs can be developed to help energy users become more energy-efficient.

In this Report to the Legislature, the analysis up to now has focused on energy efficiency measures related to new or substantially renovated residential and commercial buildings; and on related policy options concerning buildings standards to help attain energy efficiency gains in those sectors. However, there are many program options besides building codes --programs which can:

- Encourage the construction of buildings even more energy-efficient than specified by any new building codes or standards that may be adopted; and
- Encourage energy efficiency in other areas besides new construction.

In general, an energy efficiency program's design should reflect the energy use behaviors it is intended to change. In this section of the Report, we focus more broadly on program options to encourage energy efficiency, especially demand-side energy efficiency. First, we review the range of types of programs that can be pursued. We then review concrete program options, first outside the energy utility sector, and then in the energy utility sector. In each sector (non-utility and utility), we first summarize existing programs, then identify promising options for consideration by Missouri citizens and policy makers concerned with investment in energy efficiency in the state. Building code options were discussed in Chapter III and are not included here.

Energy efficiency programs are designed to deliver *cost-effective* efficiency measures through *cost-effective* programs. Energy efficiency is not an end in itself. At the broadest level, energy efficiency programs are justified when the benefits to society -- direct economic cost savings, environmental impact mitigation, net job creation-- outweigh the costs of developing and implementing the energy efficiency programs. The main types of energy efficiency programs are described next.

Types of Energy Efficiency Programs[3]

Programmatic actions to advance energy efficiency may be grouped into four broad categories. These are:

- Education and Technical Assistance;
- Financing and Incentive Programs;
- Codes and Standards; and
- Pricing/Rate Design.

In developing a particular program, it is necessary to be aware of programs in other areas, so that the overall portfolio of energy efficiency programs will be integrated. The interconnectedness of the barriers to investment in energy efficiency is important when considering program options. For example, the lack of information about the costs of energy use and the benefits of energy efficiency may make energy users reluctant to invest in energy efficiency even when capital for the purpose is made available. Programs that *combine* technical information *and* investment capital to energy users may be more effective than programs that provide only one service or the other. Thus, successful programs often combine or coordinate more than one type of action.

Education and Technical Assistance

Information programs present energy efficiency concepts and techniques to present or future energy users or to those who may work for them. Broad educational programs may be sponsored by government agencies, universities, energy utilities, private businesses and community agencies, generally at no charge to users. Many kinds of broad educational programs have been offered, including but not limited to the following:

- Student and teacher education in schools and universities;
- Dissemination of printed and illustrated material on energy efficiency practices and measures to households and enterprises;
- Broadcast or television advertising on energy conservation;
- Centers where energy users can obtain technical information about a range of energy efficiency measures;
- Technical seminars for energy users (e.g. industrial plant managers) or professionals (e.g. building and building design professionals);
- Development of lists of vendors who specialize in various types of energy-efficient equipment or energy efficiency services;
- Information on financing institutions or programs that energy users can access to finance energy efficiency projects.

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[3] This discussion is adapted from: Natural Resources Defense Council, Empowering the World (New York: NRDC, 1993), chapter IV.

The above types of information may be more or less technical, but they are not site-specific. *Site-specific* information or technical assistance programs show energy users how to apply energy efficiency technologies in their particular facilities. The site-specific energy *survey* or energy *audit* involves the inspection of individual facilities by persons trained in energy analysis to identify energy efficiency improvements that can be taken by the energy users. In energy audit programs, estimates of the costs and expected energy savings for recommended efficiency measures are typically presented to the energy user, in conjunction with promotional incentives, such as low-cost loans or rebates, for specific technologies.

In the United States, many programs have provided on-site home energy audits. On-site audits assess savings opportunities relative to the chief end-uses in light of the building characteristics and its energy consumption records. They include a report to the householder on the costs and savings to be expected for recommended energy efficiency measures. Household audits generally cost about $100 when delivered on a routine basis across thousands of households. Computerized programs have been developed to allow reconciliation of engineering estimates of improvement savings with the history of energy bills for a particular house.

Energy audits or surveys for the Commercial and Industrial sectors are provided at varying degrees of technical sophistication and cost, owing in part to the great heterogeneity of the nonresidential sector. Audit costs in the Commercial sector, for example, can range from $0.05 to $0.15 per square foot depending on the complexity of the facility and the nature of the audit. Computerized on-site audits for enterprises that use small to medium amounts of energy may be performed on a routine basis for under $1,000. But audits for larger enterprises can easily be $1,000-10,000 or more, costing relatively more when the energy improvements are specified in enough detail that a contractor could be requested to quote his or her price for installing the specified measures for the energy user.

Another type of site-specific program is design assistance to new construction or renovation professionals. This involves review of building and facility plans to suggest specific modifications that could be made to improve the energy efficiency of the structure and its built-in energy-using equipment.

Information/technical assistance programs often involve subsidy of the costs of providing information, covered by a government agency or an energy utility. In an energy audit program, it is often the case that only a residual portion of the audit cost, as little as zero, is borne by the participating energy user. This type of program does not, when offered on a stand-alone basis, provide capital assistance toward the user implementing the recommended efficiency actions. Rather, it relies upon the program participant to undertake energy efficiency improvements from his or her own funds or from some other funding source. However, many types of financing and incentive programs (discussed below) do require that an audit be undertaken as a first step to identify cost-effective facility-specific savings opportunities.

Finally in the area of education, there are various kinds of training strategies. One type involves applied training, that is, training facilities operators to more effectively operate and maintain energy-using equipment. Another training strategy involves encouraging growth in the number of trained professionals capable of evaluating end-use energy consumption and of identifying cost-effective efficiency improvements in buildings, agriculture, manufacturing, etc. This is best done in response to a real demand for additional professionals as a result of government agencies and energy utilities gearing-up to pursue energy efficiency analysis and programs, and also a result of more energy users investing in energy efficiency. However, there is a "supply" component to training, which involves the introduction of energy engineering into the curricula for professional training of civil and industrial engineers, architects, urban planners, etc. Here, universities and technical institutes should take the initiative.

Financing and Incentive Programs

Government and Private Sources: Many means for financial assistance for energy efficiency improvements can come from government and private sources. Loans, grants, energy efficient mortgages and tax credits are typical means through which energy efficiency projects can be funded. Some of the money to fund these programs comes from federal sources, while other money is supplied through the oil overcharge funds, which have been recovered from oil companies that violated former federal petroleum pricing regulations between 1974 and 1981. Financing programs that exist on the federal, state and private levels, other than utility programs, include the following forms:

- *Federal and State Funded Grant and Incentive Programs:* These programs either provide free energy efficiency services, or they subsidize the installation of energy efficiency upgrades in qualifying homes and buildings. The Weatherization Assistance Program (WAP) is a federally funded program which installs weatherization measures, at no charge, in the homes of qualifying low-income residents. The Institutional Conservation Program is another federally funded program that provides grants to public and private, non-profit schools and hospitals so that energy efficiency upgrades can be installed.

  State governments also run programs that involve grants and incentives to encourage energy efficiency. The state of Illinois runs the Energy Conservation Interest Writedown Grant Program that helps pay the interest on a small business loan, provided the loan is for the installation of energy saving devices that have been given prior approval by the state through their small business audit program. The Iowa Department of Natural Resources has set up a program that makes loans to improve energy efficiency in Iowa's public buildings, private and public schools, educational agencies, hospitals, and nonprofit organizations. The energy efficiency upgrades must meet certain payback period requirements before they can qualify for loan assistance.

- *Federal and State Energy Efficient Mortgages:* This financing option allows individuals to include the installation of energy efficiency upgrades in the mortgage of the homes they are purchasing. This means of financing allows the individual to spread the cost of the upgrade over the life of the mortgage. The Department of Housing and Urban Development (HUD) has just begun a pilot program of this type that will be tested in five states in the U.S. Many states around the country already run energy efficient mortgage programs, including Arkansas and Nebraska.

- *Energy Service Companies (ESCOs):* These privately run organizations operate programs that encourage energy conservation as well. Shared savings or guaranteed savings is the financial mechanism that is used by these companies in order to make energy conservation profitable for both the participating customer and the company.

- *Federal and State Tax Credits:* Another means the federal government has used to encourage energy conservation measures is through a tax credit. The residential energy conservation tax credit, which expired in 1985, allowed a tax credit of 15% of the conservation measure cost to be taken as a tax credit. The tax credit could not exceed $300. There have also been a number of tax credits designed to encourage the implementation of alternatively fueled vehicles and supply resources. The state of California had a tax credit in place that encouraged the development of solar energy technologies.

- *Charitable Programs*: There are many privately funded programs around the nation which provide a variety of services for energy conservation. One example is the Metropolitan Energy Center in Kansas City, Missouri which provides energy services along with a revolving loan fund to help nonprofit agencies implement efficiency improvements. Another is the Interfaith Coalition for Energy, or ICE, in Philadelphia which provides energy information, audits and technical assistance for religious facilities.

Utility Sources: Programs to reduce or eliminate the costs of installing efficiency measures in buildings can directly address the access-to-capital barrier to energy efficiency. There has been extensive experience with financing and incentive programs in the United States, especially among electric utilities. Where integrated resource planning (IRP) has taken hold most strongly --California, the District of Columbia, New England, New York, Pacific Northwest states and Wisconsin-- the major utilities offer a wide range of incentive programs. Energy efficiency programs include all of the following incentive approaches, and combinations thereof.

- *Rebates to customers or dealers.* In this approach, the incremental cost of energy efficient equipment is reduced by the utility providing a rebate of some or all of that cost. Rebates may be available for a set of pre-specified equipment -- high-efficiency water heating, space conditioning equipment, building insulation, lighting systems, electrical motors, etc. -- or may be available on a "custom" basis for whatever equipment can be demonstrated to be high-efficiency and cost-effective. Rebates may be available to the retail customer (the energy user) who buys the equipment, to the dealers who sell the equipment or both.

- *Loans to finance investment in energy efficiency.* In this approach, the incremental cost of energy efficient equipment is financed through a loan arranged by the utility. The interest rate used for the loan may range from zero to the full cost of capital to the utility. Customers may be required to satisfy conventional credit criteria, or the utility may relax those criteria in extending loan financing. Loan payments are generally collected through the utility bill, though sometimes they are separately remitted. In some cases, the energy efficient equipment is leased to the customer over its lifetime, with the lease payments collected through the utility bill.

- *Cut-rate sales of efficiency measures.* In this approach, energy efficient equipment is sold directly to customer by the utility, which may make arrangements with a bulk-sales company to process customer orders. In some cases the utility charges customers its costs (which may be wholesale rather than retail, since bulk buying from suppliers is used), and in other cases, it charges customers only a portion of its costs for the equipment, thus subsidizing its costs.

- *Rate discounts and credits.* In this approach, customers who adopt certain energy efficiency measures receive a reduction to their rates for service, or credits to their electricity bills. This approach is most commonly used for load-management programs, wherein customers agree to reduce their on-peak demands (on their own, as through "interruptible rates,"[4] or through automatic control equipment installed by the utility) for specified periods of time, when required to do so by the utility. However, it has sometimes been used to reward energy conservation behaviors, such as building a house with high levels of insulation.

- *Direct installation of energy efficient equipment.* In this approach, the utility's agents perform the installation of efficiency measures in customer buildings. The customer avoids the "hassle" of procuring the measures from the marketplace on his or her own. Usually the costs of installation are subsidized, and in some cases, installation is free to the participant. Free installation is most common in direct installation programs aimed at low-income residential customers.

- *Payments to customers or third parties for delivered savings.* In this approach, the utility declares that it will pay up to certain amounts for reductions in energy consumption and/or peak demands. The savings may be generated directly by the customers, or through third-party contractors such as energy service companies (ESCOs). When the savings are generated by third-party contractors, those contractors in turn will provide various incentives to induce the utility's retail customers to conserve energy and/or demand. In this approach, the utility may conduct solicitations (*DSM bidding*) to secure a given quantity of savings, using competition among bidders to select projects that have the greatest chance of success, or which offer savings at lower prices to the utility. Payments for savings require agreed-upon methods to verify that savings from the efficiency measures have taken place, since payments are based upon realized savings.

Today, there are hundreds of utility operated energy efficiency programs that use the above incentives. The utility industry has begun to develop data-bases of program designs that enable utilities to share information on incentive (and other) efficiency program designs. When utility-operated incentive programs involve a subsidy to the participant, as they generally do, the utility's costs are collected through its rates charged to all customers.[5]

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[4] Interruptible rates are not standard rates, but rather special credits allowed to customers who agree to interrupt their use of energy to enable the utility to forego adding peak-period capacity resources. They must be carefully designed so that they are integrated with utility system needs; in some cases they have been ill-disguised subsidies to energy users who neither are nor expect to be interrupted.

[5] DSM program costs may be recovered using the same principles as are used to recover the costs of power plants, or they may be allocated to the broad customer classes (residential DSM program costs to the residential class, industrial to the industrial, etc.). The variety of approaches used by utilities to recover DSM costs is a subject all its own. See Paul A. Centolella, et al., *Cost Allocation for Electric Utility Conservation and Load Management Programs*. Washington, D.C.: National Association of Regulatory Utility Commissioners, February 1993.

Efficiency Standards

Efficiency standards are specifications applied to the manufacture or sale of energy-using equipment or to the energy-related aspects of the construction of new buildings. Standards may be voluntary, or they may be mandated by statute. The development of standards requires research into prevailing manufacturing and construction practices, and identification of technical options for more energy efficient products and building construction. Research also requires identification of the costs of various levels of efficiency that exceed prevailing practices, and analysis of the cost-effectiveness of efficiency standards programs.

Most states and several countries have enacted mandatory building standards that include requirements designed to ensure that buildings are more energy efficient than they would typically be in the absence of the standards. The efficiency provisions of building codes generally apply to renovated buildings as well as newly constructed ones. In the United States, buildings standards have traditionally been a sub-national (state and local) responsibility. Some states have no such standards, but most do. In a few states, such as California, whose efficiency standards are tighter than the average state's building efficiency requirements, building standards programs are accompanied by training manuals and software to assist builders in complying with the standards. Inspection of new buildings is conducted at the local (municipal) level in the United States, and local inspectors are charged with enforcing state code energy efficiency requirements. See the discussion on building codes in Chapter III of this Report.

Efficiency standards for manufactured products can cost-effectively reduce energy consumption. Beginning in the 1970s, some states, such as New York and California, established efficiency standards for various energy-using equipment. State standards were supplanted by federal standards beginning in 1990. The National Appliance Energy Conservation Act (NAECA) was passed in 1990. This bill established efficiency standards for furnaces and boilers, refrigerators and freezers, water heaters, air-conditioners and heat pumps, clothes washers, some lighting equipment and industrial motors. In 1992, EPAct increased some of the NAECA standards for such equipment as industrial motors, space heating, water heating, and lighting equipment, and added new standards for plumbing fixtures and electric motors.

Missouri failed to pass a minimum standard for refrigerator efficiency, at a time when many of the states in the surrounding area did. As a result, Missouri became a sort of dumping ground for the inefficient refrigerators in the area, and many of those refrigerators were installed in apartment buildings and homes in Missouri. This inability of Missouri to keep up with the neighboring states resulted in the installation of equipment that is inefficient and uneconomic for the residents of the state, since these refrigerators consume much more energy. In addition, since refrigerators have 15-20 year lifetimes, it will take many years before all of these inefficient refrigerators can be replaced by more efficient models.

Efficiency standards set an efficiency "floor." However, they do not set an efficiency "ceiling," since there are always techniques to exceed whatever efficiency level is mandated. For this reason, standards programs work well in tandem with other types of programs, such as education and incentive programs. The latter types of programs can encourage energy users to acquire buildings and equipment that are more energy efficient than is required by whatever mandatory efficiency standards may be in effect.

Pricing/Rate Design

When energy prices reflect the long-run societal costs of energy production, they help to promote long-run energy efficiency. Over the long period of time that energy production facility are in operation, they incur direct economic costs. Over that same period, they also incur costs not currently internalized by the utility or the economy, yet critically important, such as the impact on air quality or acid rain occurrence and damage.

Developing pricing systems for energy that bear a better resemblance to current resource costs is not enough, since the real issue from a planning perspective, is future costs --both economic costs and costs not currently internalized in the economy. The latter are sometimes called "externalities".

In the United States, electricity rates are set to recover the costs of existing ("embedded") plants and equipment as they are amortized over their useful life, the operating costs of the system (fuel and maintenance) plus the cost of capital to finance the system. Environmental costs are included only to the extent that the federal government's environmental regulations, such as its limits on air pollutants, require utilities to invest funds they would not spend otherwise. There has been a 20-year debate in the United States concerning whether electricity rates should reflect forward-looking resource planning considerations, and if so, how. Since the total revenues utilities collect are related to their current costs of production, this debate has focused on the *design* of the pricing structure through which these revenues are collected.

For example, two rate designs which collect the same amount of revenue today may send very different "signals" to energy users regarding consumption tomorrow. A declining block rate design charges a lower price per unit of energy consumed as the customer's consumption increases, thus signalling that marginal consumption is cheap. An inclining block rate design, on the other hand, charges a higher price per unit as energy consumption increases, thereby signalling that marginal consumption is costly.

Certain broad types of innovation in electricity pricing may, if properly implemented, help to capture the full, long-run societal costs of electricity production. Proper implementation relies on robust utility integrated resource plans having been developed, and a careful analysis of how customer electricity usage characteristics are related to the resource requirements in the IRPs to help design rate structure. These broad types of rate innovations include the following:

- Developing time-of-use rates, to reflect the time-varying costs of electricity production.
- Developing seasonal rates, to reflect the seasonally varying costs of electricity production.
- Reflecting long-run production costs in the marginal or "tail" energy charges of multi-block rate designs.
- Reflecting long-run externality costs (e.g., environmental impacts) in the marginal energy charges of multi-block rate designs.
- In general, considering whether the rate designs support the utility's IRP and adjusting designs if required to assure consistency.

There are a number of technical steps that must be taken in cost-of-service studies which are used to help design rate structure. These steps intervene between IRP development and the alignment of prices with IRP . These issues are beyond the scope of this Report. They are addressed, however, in a forthcoming white paper of the U.S. National Association of Regulatory Utilities Commissioners.[6]

[6] John Stutz, et al, Aligning Rate Design Policies with Integrated Resource Planning, A Report to NARUC (forthcoming 1993).

Existing Missouri Programs

The use of energy affects virtually every aspect of commerce and government in the state of Missouri. This section addresses those agencies and programs, public and private, which directly or indirectly impact energy use through their operations and/or responsibilities. For example, agencies and programs charged with financing the purchase or construction of buildings and housing, such as the Board of Public Buildings or the Missouri Housing Development Commission, can participate in new efforts to implement energy efficiency in the state's buildings and housing stock. Others have been charged with directly impacting energy use through their programs such as the Division of Energy of the Department of Natural Resources. Utility programs are addressed in another section of this chapter.

Division of Energy of the Department of Natural Resources

For the past decade, the majority of the Division's funding has been from oil overcharge funds. In the 1990's, at the same time that awareness of the connection between energy use, environmental improvement and economic stability has increased, the oil overcharge funds have been declining. Although other federal dollars may become available for environmental and energy initiatives, the amounts are very small compared to Missouri's past allocation of oil overcharge funds. However, if utility-based energy efficiency programs, also known as "demand-side management" (DSM) are expanded, this could provide a source of efficiency investment funds that would to some extent make up for a decline in oil overcharge (Petroleum Violation Escrow or PVE) funds.

The completion of the *Missouri Statewide Energy Study* in 1992 provided the Division a comprehensive study of the energy situation in the state and an extensive set of opportunities and recommendations for action. It is not the intent of this Report to summarize all of the findings and recommendations of that Study. However, one recommendation in particular holds significant promise for Missouri, the establishment of an Energy Futures Coalition. The Coalition would be a policy advisory committee from all sectors of the energy industry in Missouri, to advise the Governor's office and state government on energy policy and program implementation. This Coalition can provide the forum to facilitate the implementation of many of the programs that are recommended in the Energy Study and this Report.

Missouri has passed some important legislation in the past several years aimed at making a tremendous impact in reducing energy use in state government. These bills, SB80, HB195 and HB45 described below, give the Division much of the responsibility for implementation of these state efficiency programs. The bills also give the Division the opportunity to integrate its primary goal, to improve state energy efficiency, with the entire structure of state government. The Division also has the important responsibility of improving energy efficiency in almost all sectors of the state, private and public. Its many programs have a delivery system currently structured in five areas which include:

Director's Office/Administrative Services - The Division Director's Office is the link between the Legislature, and the services and staff of the Division. Administrative Services assists the Division Director in implementing the departmental and divisional policies and maintaining records. A few of the specific tasks include: payroll processing, purchasing, budget development, inventory, tracking and reporting of expenditures and personnel.

Weatherization - The Weatherization Assistance Program (WAP) provides funding for weatherization of eligible low-income households. This is a high demand program which has received supplemental funding in the past years from the now declining Petroleum Violation Escrow (PVE) funds. Services are provided by community action agencies, a non-profit agency and the City of Kansas City. The addition of the federal Weatherization Incentive Fund has provided opportunities for the state to investigate other funding avenues for Weatherization. This program is designed to help states encourage the addition of private funds to maintain the services normally funded by WAP and oil overcharge monies. $4.9 million have been allocated to the Division to operate the weatherization program, most of this as grants to the local providers.

Community/Education Services - This program covers the energy information needs of state and municipal governments, non-profit organizations and other sectors of the community. Typically it provides a variety of educational programs, information services, demonstration projects and other innovative programs to promote the efficient use of energy. Transportation and agricultural programs are also covered by this program. The current budget for these programs is $1.7 million.

Institutional Services - The Institutional Conservation Program, the Local Government Loan Program, the School Revolving Loan Program and the Industrial/Commercial Loan Program have all been merged under this program area for the purposes of efficiency and increased effectiveness.

- *Institutional Conservation Program (ICP):* This federally funded program provides 50% matching grants to public and private schools and non-profit hospitals for energy conservation improvements. Applicants submit a Technical Assistance Report (TAR) to the Division which is rated and reviewed by staff engineers. Money for ICP grants total just over $4.9 million with the majority of that coming from PVE funds. Administrative monies for ICP are currently budgeted at $198,000.

- *The Public School Loan Program:* The School Loan Program has awarded low interest loans to public elementary and secondary schools amounting to $5.9 million since it was begun in 1989. Payback periods of eligible measures must be between 6 months and 5 years. Savings estimates are over $2 million per year. The Public School program has $2 million in its revolving loan fund.

- *Local Government Loan Program:* This program has awarded over $3.3 million dollars in loans to local governments for implementation of a broad range of energy efficiency improvements having a payback between 6 months and 8 years. Projected savings are over $700,000 per year. This program has $3,000,000 in its revolving loan fund.

- *Industrial/Commercial Loan Program:* This new program began to accept applications in the fall of 1993. It promotes the implementation of energy efficiency measures in Missouri industries and provides low-cost financing for projects up to $150,000. This Program has $3,000,000 in its revolving loan fund.

Energy Services - Energy Services provides a wide variety of support for Division and state operations through five program functions which include Engineering Services, Field Monitoring, Energy Efficiency in State Facilities, Electronic Data Processing Coordination and the State Vehicle Fleet Conservation and Alternative Fuel Program. These programs provide the functions of both providing direct energy services and supporting existing energy services.

- *Engineering Services:* The Division's engineers are responsible for providing the engineering support to the project managers and the Director's office in general. Their most significant task at the present time is to review projects under the Institutional Service's programs.

- *Field Monitoring:* The major task of the monitoring section is to ensure that all state and federal procedures, rules and management requirements are followed.

- *Electronic Data Processing Coordination:* The "EDP" coordinator is responsible for managing the computer environment of the Division and developing systems and methods for data management.

- *State Vehicle Fleet Conservation and Alternative Fuel Program*: The passage of HB45 charged the state with implementing a program to reduce the fossil fuel use in government and evaluate the use of alternative fuels in vehicles. This program is entirely supported with oil overcharge funds allocated in FY1994. The bill charged the Division, in consultation with the Office of Administration, with developing and implementing the program. HB45 also charged the Division with assisting all state agencies in developing and implementing their own vehicle fleet energy conservation plans.

- *The Energy Efficient State Buildings Program*: This program is currently coordinating, with the Office of Administration, implementation of the Green Lights Program. However, the Energy Efficient State Buildings Program will expand dramatically over the upcoming years. Through the passage of HB195 and SB80 in 1993, a major state effort has been undertaken to make its facilities energy efficient. This effort involves many agencies of the state working in concert to implement it. Both bills address some of the same efficiency issues in their requirements, but each also have a unique focus. The unique thrust of HB195 is to create a self-supporting means to analyze state facilities and use a portion of the savings to fund future analyses. SB80 establishes an interagency advisory committee to assist the Office of Administration in implementing energy efficiency projects in state facilities.

In SB80, the Office of Administration has the responsibility of ranking proposed facility projects and deciding on the order of implementation of those projects. Responsibilities for carrying out other specific components of the bills are divided among several state agencies. Developing financing for facility projects is the responsibility of EIERA and the Board of Public Buildings.

The Division of Design and Construction is responsible for assisting the Division of Energy with development of design criteria, standards and analysis criteria and in enforcing and following through with implementation of requirements and standards. The bills specifically charge the Division of Energy with:

- developing minimum energy efficiency standards for state facilities (by 1/1/95 in HB195 and by 1/1/94 in SB80);
- establishing, with the Division of Design and Construction, a volunteer working group to assist with efficiency standards;
- establishing an efficiency rating system by 7/1/94;
- developing energy use baselines for state facilities;
- preparing and disseminating energy efficiency practices information for state facilities;
- establishing criteria for determining projected and actual energy savings in state facilities; and,
- administering the "Energy Analyses Account" to fund future energy analyses.

Environmental Improvement and Energy Resources Authority (EIERA)

The EIERA was created as a self-supporting agency to protect Missouri's environment, develop energy alternatives, and promote economic development. The means to accomplish this mandate include issuing low- and no-cost financing, some of which may be tax exempt, to businesses and local governments for environmental projects, providing technical assistance, and conducting studies and research. Environmental projects can range from pollution control/prevention activities to financing energy efficiency measures in state facilities. Among its research, the EIERA produced a thorough analysis of solid waste issues in Missouri and recently published the *Missouri Statewide Energy Study*.

The EIERA is involved in numerous educational activities across the state in the energy and environmental fields. These include the nationally recognized Household Hazardous Waste Program, the Missouri Energy Resources Project and past assistance in the development of a solar-powered car at Crowder College. EIERA also manages the Missouri Market Development Program, in coordination with Department of Natural Resources and the Department of Economic Development, to provide financial assistance helping develop and maintain a recycling infrastructure in the state.

Financing is one of the most important functions of EIERA. The authority to fund agency projects was set forth in RSMo §260.035.1(7). The EIERA issued its first bond package in December, 1973 and since then has issued over $1.9 billion in tax-exempt bonds, notes and commercial paper, primarily for pollution control and environmental improvement projects. In addition, the EIERA has been involved in a number of other significant efforts for improving the environment in the state.

In 1987, the EIERA, working with other agencies, established the Missouri State Revolving Fund (SRF). The SRF, in cooperation with the U.S. Environmental Protection Agency, provides low-cost loans to Missouri governments for the construction of water, wastewater and sewage treatment facilities. A companion program operated with the Missouri Public Service Commission provides financing to private water companies for the construction of new water systems in Missouri. The passage of SB80 and HB195 in 1993 added the responsibility of financing energy improvements for state buildings.

Office of Administration (OA)

The Office of Administration coordinates the central management functions of state government and is, therefore, a key agency in carrying out many of the efforts toward improving energy efficiency within state government. As mentioned earlier, SB80 and HB195 give the OA much of the responsibility for the implementation of the bill's requirements, often through its Division of Design and Construction and the Board of Public Buildings. In addition, this agency has significant responsibility in the purchase of vehicles, and is therefore involved in the implementation of HB45 regarding alternative fueled vehicles.

Board of Public Buildings - Chaired by the Governor, the Board of Public Buildings has the authority to initiate the construction of state office buildings and certain other facilities. It may issue revenue bonds for these capital improvement projects. The board works closely with the Division of Design and Construction and now, with the Division of Energy and EIERA in the Energy Efficient State Building program as required by SB80 and HB195. By focusing attention on energy efficiency in the design and construction of state buildings, the Board can provide an important leadership role of infusing a policy of energy efficiency in state operations.

Division of Design and Construction - This Division of the Office of Administration is responsible for building, operating and maintaining the state's buildings. One specific responsibility is to track and analyze the state's energy costs for operating its facilities. The Division of Design and Construction is also one of the agencies responsible for implementation of SB80 and HB195 and will work with the Division of Energy program for Energy Efficient State Buildings.

Missouri Health and Educational Facilities Authority (MOHEFA)

MOHEFA provides financing to the state's public and private, non-profit health and educational facilities. The goal of this financing authority is to provide low-cost financing for these institutions. It is governed by a seven member commission appointed by the Governor with the consent of the Senate. MOHEFA provides the means to improve the quality of medical and educational services to Missourians by assisting institutions to borrow money for improvement of their facilities, assisting public school districts and community colleges with loans to cover operating shortfalls, assisting with financing for organizations that provide services to the mentally disabled and operating a program to assist Missourians to invest in college bonds for their children. In the twelve years of actual operations, MOHEFA has issued financing of nearly $3.3 billion for 107 projects. The majority of the projects are for health care institutions, although a number of colleges and universities have taken part in the financing program.

The opportunities for expansion of the MOHEFA's financing programs can dovetail with statewide energy program development. Many of the state-owned buildings are in the University system and would therefore qualify for financing from MOHEFA. In addition, it appears that the majority of financing projects are in the St. Louis area, so further publicity and outreach to other parts of the state could also increase activity. Between MOHEFA and the Environmental Improvement and Energy

Resources Authority, it appears the infrastructure for financing many of the building improvements in the state are in place.

Public Service Commission (PSC)

The PSC is responsible for regulating the public services within the state including, energy utilities, commercial transit, telephone companies, manufactured housing and water and sewer systems. The PSC is also responsible for developing Integrated Resource Planning (IRP) which is discussed more fully in the Utility Program section, and governing implementation of IRP by the utilities in the state. EPAct requirements and opportunities have a direct influence on the way the PSC will operate in the next few years. Much of the detail of the EPAct effects on the PSC is discussed in the "Utility Programs" discussion of this section.

The Missouri Housing Development Commission (MHDC)

The Commission is responsible for providing financing for decent housing for low and moderate income Missourians. The Commission is authorized to issue and sell tax exempt notes and bonds which provide the funds for MHDC's mortgage financings. MHDC membership is made up of the Governor, Attorney General, Treasurer and six members appointed by the Governor with the advice of the Senate.

Past efforts of MHDC to include energy efficiency in financing programs have been only partially successful. In the mid-1980s, MHDC attempted to use $500,000 in oil overcharge money to buy down loans that would encourage energy efficiency in Missouri homes. This program achieved only limited success. One reason is that it focused on lenders, while providing little public information about the program. As a result, very little of the oil overcharge money was used to fund the resulting loan buy downs. However, this type of program could succeed if the delivery mechanism were focused more towards builders and buyers of new homes.

Although MHDC deals with multi-family buildings, its staff estimates that about 90% of financing provided through their programs is for single family homes. If Missouri carries out EPAct's recommendations in the area of implementing statewide residential building codes, an energy efficient mortgage program and a uniform home rating system, MHDC should be an important player in giving Missouri's homeowners access to the financing needed make their homes energy efficient.

Division of Family Services (DFS)

This Division is responsible for administering the Low-Income Home Energy Assistance (LIHEAP) program. This federal program has three components:

- the energy assistance program, which provides cash grants to the poor to help them meet their winter heating and energy needs;
- a weatherization program for low-income homes that allows the state to elect to spend up to 15% of the LIHEAP funding on low-income weatherization (DFS does not allocate anything for weatherization at this time); and,
- the LIHEAP emergency assistance program, which has the purpose of providing assistance to people with financial emergencies resulting in the loss of heat-related utility service or bulk fuel supply.

Future federal funding for LIHEAP is uncertain. There have been many battles in Congress recently that have revolved around attempts to lower the level of funding for this program. As a result, there is no assurance of federal monies for this program in the future. The advance appropriation for the fiscal year beginning July 1, 1994 is $1.475 billion which is an increase of about $27 million over last year. However, next year's appropriation request may be for no more than $1 billion. The termination of this program would exacerbate the plight of low-income customers attempting to meet their heating needs.

The University of Missouri Extension

The Extension Service disseminates energy education materials through centers located across the state. Information distributed covers a large variety of energy conservation subjects for children and adults. Much of the material developed and used by the Extension is aimed at helping homeowners manage energy efficient households in low-cost, common sense ways. The Extension also works in the area of youth education, such as the Junior Conserver program, and assists teachers with energy education efforts in Missouri's schools. The Extension works closely with the Division of Energy's Community/Education services and is and is a logical existing vehicle for the expansion of state energy education programs.

Community Based Programs

The Metropolitan Energy Center - The Energy Center, located in Kansas City, operates a wide variety of energy programs dealing with information, residential conservation, non-profit energy conservation and energy education. The Energy Center is also active in energy policy and program issues on a local, state and regional basis including transportation. Over the past several years the Energy Center has provided consulting services to the Environmental Improvement and Energy Resources Authority, the Division of Energy, the Kansas City Support Office of the U.S. Department of Energy and Kansas State University's Engineering Extension.

Missouri Energy Resources Project (MERP) - MERP provides training, resources and programs to support energy and environmental education in schools and businesses. Past projects have included mini-grants for classroom projects, the Energy Efficient Model Home, student leadership training for the environment, National Energy Education Day and other general services aimed at resources and support for teachers including maintaining a statewide network of teachers.

Neighborhood and Housing Organizations - There are many nonprofit organizations in Missouri which provide assistance to homeowners and neighborhoods to receive financing for home improvements, weatherization and so forth. A Kansas City organization, the Rehabilitation Loan Corporation (RLC) directly provides innovative, low cost financing for low- to moderate-income homeowners for a variety of purposes related to residential property. One program, the Seasonal Improvement Loan Program provides for heating, cooling and weatherization upgrades to a home at 3% interest. Other organizations throughout Missouri, such as the Urban League and ACORN in St. Louis, Neighborhood Housing Services in St. Joseph, the Affordable Housing Action Board in Springfield, to name only a few, can assist homeowners in gaining access to low cost financing and other assistance for energy efficiency upgrades.

Federal Programs

There are also federal programs available on the state and local level to provide technical assistance in promoting and carrying out energy efficiency. Both the U.S. Department of Energy and the Environmental Protection Agency have developed excellent programs in the area of efficiency. These are distinct from federal programs that provide grant funding to local and/or state government.

Department of Energy (DOE) - Although DOE has many programs which provide assistance to all sectors of the community, two programs are mentioned here as examples of their energy efficiency services that have relevance to this Report. The Energy Analysis and Diagnostic Center (EADC) is a national program which provides faculty and senior/graduate students from accredited engineering schools to analyze the plants of business and industry. The energy audits are provided at no cost to these companies. One EADC program is located at the University of Missouri - Rolla and another at the University of Kansas in Lawrence. Both provide services within 100 miles of their respective campus. DOE also has a program to promote efficient electric motors, a large potential energy saver. The Efficient Motors Program can provide technical assistance and product information to business and industry to help with motor retrofits.

The DOE has undertaken a significant effort to increase the acceptance and use of alternative fueled vehicles in federal and non-federal fleets. In response to EPAct, the Secretary of Energy has written to the mayors of the largest city in each of the major metropolitan areas in the nation to invite them to join the Clean Cities program. Atlanta was designated the first Clean City earlier this year. DOE is now attempting to institute this voluntary program throughout the country. They are bringing the various representatives of local government, utilities and private businesses together to work on developing an infrastructure for alternative fuels and speed up the process of conversion of existing vehicles and/or purchase of new alternative fueled vehicles. In Missouri, the St. Louis and Kansas City metropolitan areas are a high priority for inclusion in this program.

Environmental Protection Agency (EPA) - The best known EPA program working toward energy efficiency currently is the Green Lights Program. Green Lights is a comprehensive program that combines technical assistance, product development and review, financing information and promotion for a wide sector of energy users including industry, government and education. EPA is also offering extensive programs in efficiency in building HVAC systems and efficient computers (the Energy Star Program). The State of Missouri, several utilities, businesses, schools, and many others are now members of Green Lights and are, therefore, prime candidates for other upcoming EPA programs.

Missouri Program Options

As has been pointed out, the state of Missouri already operates several programs that target the residential sector, but there are additional possibilities for programs that can be implemented to further promote energy efficiency. This section provides an overview of specific programs that currently operate in other parts of the country. Some may be suitable for Missouri. The following discusses the opportunities, delivery systems and model programs that Missouri should consider.

Home Energy Rating System (HERS)

The energy efficiency of a home is often overlooked by home buyers. Lacking this information, home buyers often do not make the best decisions. A HERS program would provide home buyers this information and allow them to make an educated decision a home by understanding it's energy use and costs. A good HERS system will also give the buyer of an existing home the opportunity to evaluate its comparative efficiency level in making the purchase decision, as well as suggest potential of making energy efficiency improvements after purchase.

HERS programs involve collaboration between the state and the individuals involved in home financing, design and construction and marketing. The purpose is to encourage higher energy efficiency levels for both new and existing homes than is typical or is required by outdated building codes. A HERS program may include its own building standards that a home must meet in order to be certified. In purchasing existing housing, a HERS program can serve as the financial analysis tool for an energy efficient mortgage program. In designing a HERS program, an important point of consideration is if the HERS minimum rating requirements simply meet or exceed those put forth in ASHRAE 90.1-1989 and CABO Model Energy Code 1992.

HERS programs have become popular around the country. Many states have implemented these programs to educate consumers about the benefits of energy efficient homes. In Arkansas, there is an organization called Energy Rated Homes (ERH) of Arkansas. This non-profit organization provides a home HERS for the new and existing homes. The program was initially administered by the state energy office of Arkansas, but is now a separate entity that is funded through private means.

One of the diagnostic tools that is used to determine the efficiency of a home for a HERS is the CALRES model that was designed by the California Energy Commission. This computer model requires the input of certain information about the building shell performance, and with that data it can predict the annual energy use of the home and whether or not the home meets the building standards. The code that ERH uses to test the homes exceeds all of the current federal codes, so that if a home is found to be efficient by the ERH system, then it will be guaranteed to be efficient under federal building efficiency standards.

The rating system that ERH employs is a 0-100 point scale that indicates the efficiency level of a home. If a home receives a rating of 80, then it is 80% as energy efficient as possible. ERH also informs the home owner of how many Btu's of energy that the home might consume in a year, and what that energy might cost. The cost estimates consider average fuel costs, average consumption rates and the number of occupants in the home.

The New York State Energy Star Program (NYSE-Star) is another model HERS program. This program involves the New York State Energy Office, the New York State Builders Association, and the New York State Energy Research and Development Authority. These groups work with the investor-owned utilities of New York to certify homes that exceed the New York state building codes. NYSE-Star has a standard which requires that a home must be at least 25% more efficient than indicated in the New York state building code standards. This allows buyers to make an informed evaluation of the value of the a home by reviewing its relative energy efficiency.

Title I, Section 102 of EPAct requires the DOE to develop voluntary home energy rating guidelines. EPAct also mandates that the DOE must develop a set of national, uniform guidelines for State and local authorities, utilities and others involved in the residential housing community to use in assigning energy efficiency ratings to residential buildings.

Energy Efficient Home Mortgage Program

Energy efficient homes may be more expensive owing to the cost of the energy efficiency measures incorporated. This can create a barrier for home buyers, even though the savings that result from these measures over the life of the home will far outweigh the initial costs. An energy efficient mortgage (EEM) program can help to overcome this problem by allowing the home buyer to qualify for a larger mortgage. The fact that the home buyer could be spending less money each month on energy bills allows a larger mortgage which, in turn, allows the energy efficiency measures. It also allows the home buyer to spread the cost of the efficiency measures over the life of the mortgage.

The program would work in such a way that once an individual is interested in purchasing a home that has qualified under a HERS program, then he or she would apply for an energy efficient mortgage through a state agency and a qualifying lending institution within Missouri. The lending institution and the interested individual would then work out the specifics of the energy efficient loan, which would include the interest rate, the payment schedule, and the length of the financing agreement. The federal government also operates several energy efficient mortgage programs such as the VA, FHA, Fannie Mae, and Freddie Mac programs. It would appear to be to Missourian's benefit if the state financing programs and lending institutions participated in these programs.

The Energy Saver Loan program that was started by the Bank of New England (BNE) in 1983 is a specific example of an energy efficient mortgage program. This program was for individuals who wished to either purchase a new home, or refinance an old one. The individual qualified for the loan if energy conservation improvements were to be made on the home. An audit was performed on the home to appraise the value of the proposed upgrades. Once the upgrade had been appraised, the funds to cover the cost of the upgrade were placed in an escrow account. The amount in the escrow account could be no more than 15% of the value of the loan if it was a FNMA loan, and no more than 10% of the value of the loan if it was a FHLMC loan. The energy upgrade also had to be completed within 120 days of the closing.

This program allows participants to spread the cost of the energy upgrades over the life of the mortgage. The other benefits that result from a program of this kind are lower energy bills and a higher resale value owing to a higher energy rating of the home.

The marketing of an energy efficient loan program is a key element for a successful program. The institutions that operate the program must be sure that parties involved in the construction, sale and purchase of new homes are aware of the program. The more people that are involved from the beginning of the building process, the more likely the program is to succeed.

EPAct sets up a pilot energy efficient mortgage (EEM) program through the Department of Housing and Urban Development (HUD). The five states that qualified to take part in this pilot program are Alaska, Arkansas, California, Vermont, and Virginia. This pilot program only targets the retrofit market. It does allow the borrower to finance the mortgage 100 percent of the cost of the eligible energy efficient improvements without the need for appraisals. Eligible improvements are those that are cost-effective. That is, the total cost of the improvements must be less than the energy savings that occurs over the useful life of the improvements. The borrower must use a HERS to estimate the energy savings that will be achieved by the improvements.

Public Sector Efficiency Improvement Funding Program

The promotion of energy efficiency in schools and other public buildings would demonstrate to the people of Missouri that the state is serious about conserving energy. However, since public monies would be used to finance efficiency upgrades in public buildings, the state must first draft legislation that would make the funding of these projects a more straight forward process. The state must then administer the a comprehensive program that would result in improved efficiency in the public buildings of Missouri, which would be a major task.

The appropriation of funds for improvements to public schools and other municipal buildings are strictly controlled by capital budgeting laws. If a jurisdiction wants to upgrade a public school, municipal leases must contain an executory clause under which payments are subject to annual appropriations. Otherwise, the leases would be general obligations and subject to voter approval and strict underwriting requirements. To address this, the Iowa Legislature, for example, passed a law in 1987 that authorized school districts to enter into financial arrangements "obligating the school district area school to make payments on the loans beyond the current budget year." This authorization applies only for energy-related improvements effected through the Iowa Department of Natural Resources (Iowa-DNR) programs.

A bill that would allow the public sector to finance the loans in the same fashion as is now done in Iowa, would give jurisdictions more freedom to implement energy-related upgrades. The investment would be recovered over the payback period of the upgrade (no longer than five years, for example). In this manner, the money would be available for the upgrade, and the amount that the institution pays out to finance the loan would be recovered each year in the form of lower energy costs.

Having addressed these legal questions, the state would then need to set up a program that provides assistance to cities, counties and local governments that wish to identify energy efficiency improvements qualifying under this program. Qualifying projects would be those that improve the energy efficiency of the building, or in some way reduce the overall energy consumption of the building. The project would be proven to have a reasonable payback period (such as 5 years) in order to qualify for financial assistance.

Subsidized energy audits for interested jurisdictions would be the first step in the delivery of such a program. Once an audit is complete, and the energy-related improvements have been identified, then the participating financial institution would sign a municipal lease with the jurisdiction under which the jurisdiction repays principal and interest over the fixed term. Interest payments on municipal leases are tax exempt, so long as the transaction meets certain conditions. The other aspects of the financing agreement (interest rate, length of financing, payment schedule, processing time and fees) could all be flexible and negotiable between the jurisdiction and the lending institution.

As noted above, the state of Iowa passed a law to facilitate the successful operation of a public sector energy efficiency improvement loan program. The Iowa program, described earlier and run by the Iowa Department of Natural Resources (Iowa-DNR), has set up a group of state-funded lending organizations such as the School Energy Bank Program and the Local Government Energy Bank Program. The Iowa-DNR provides financial assistance for all project costs incurred prior to installation of the improvements and the initiation of the lease. These costs include the costs of the audit, design engineer's fees, Iowa-DNR's project management fees and fees for financial and legal consultants assisting in the preparation of the financing documents. These funds are advanced through a Promissory Note contained in a Memorandum of Agreement that the Iowa-DNR signs with each client. In Iowa, Norwest Investment Services has an informal agreement with Iowa-DNR through which it offers a standard project financing package to all jurisdictions that wish to participate in the Iowa school program. Specific terms of the long-term financing agreement (interest rate, length of financing, payment schedule) are determined on a case by case basis.

The Iowa Building Energy Management Program[7] makes loans to finance energy efficiency projects in public buildings, private and public schools, educational agencies, hospitals, and nonprofit organizations. The program is operated by the Iowa-DNR and has a $2 million funding level. Funds are used to leverage additional financing from other sources such as businesses and utilities. The program has four main components that target different areas, as follows:

- The Local Government Energy Bank Program assists counties, and local governments with energy efficiency projects. Eligible projects include improvements to buildings, street lighting, water and wastewater-treatment plants. Power generating plants also qualify. Northwest Investment Services, an Iowa financial institution, helps provide financing.

- Another of the Iowa-DNR programs aims to improve energy efficiency in Iowa's private colleges and universities. In conjunction with the Higher Education Loan Authority, Iowa-DNR's energy conservation efforts involve the members of the Iowa Association of Independent Colleges and Universities and the Iowa College Foundation. Accredited private schools also are part of Iowa-DNR's energy management efforts. Technical analysis to determine what improvements are possible precedes the creation of affordable financing for energy improvements.

[7] The following program description is summarized from Charles Bartsch and Diane DeVaul, *op. cit.*

- The School Energy Bank Program assists public school districts with energy-saving improvements. Two hundred and twelve jurisdictions participate with a total of 691 buildings involved. All facilities in the program have received energy audits. Program officials have scheduled engineering analyses for about half of these buildings. The program has provided more than $3.1 million in loans, which is expected to produce over $4.6 million in energy savings over a five-year period.

- The Iowa Facilities Improvement Corporation (IFIC) funds energy improvements for state government facilities. Set up in 1986, this program has saved the Departments of Corrections, General Services and Human Services more than $1 million annually through energy efficiency improvements. Those savings are used to fund projects in other departments. The Department of the Blind received $64,000, the Department of Public Safety $45,000, and the Department of Transportation $1.3 million. IFIC outlined $35.5 million in energy-management improvements for the Board of Regents facilities, with a projected annual savings of $7.2 million. Program officials plan to implement these measures by fiscal 1994.

Missouri already has two programs in place that promote energy efficiency projects in public buildings. The Local Government Loan program allows local governments to install energy saving devices, and the loans to pay for the approved improvements are low-interest (2% simple interest). The energy savings achieved with the upgrade will also pay off the interest of the loan. The Institutional Conservation Grants program provides matching grants to eligible public and private, non-profit schools and hospitals. To qualify for the grant, the upgrade must be a retrofit operation, it must have a payback period of between 2 and 10 years, a Technical Assistance Report must be completed by an engineer, and the building must have a heating or cooling system, or both. Both of the programs listed above are funded by a combination of federal and state funds.

EPAct Section 141 of Title 1 establishes a State Building Energy Incentive Fund of up to $1 million per state for financing energy efficiency improvements in state and local government buildings. Missouri must adopt the ASHRAE 90.1-1989 standards or its equivalent for commercial building, and the CABO Model Energy Code 1992 or its equivalent for residential buildings in order to be eligible for these funds.

Small to Medium Sized Commercial/Industrial Program

The small- to medium-sized commercial and industrial markets tend to be more difficult for the utilities to target than large customers because the benefits, while still cost-effective, do not tend to be as large as in the large industrial sector. State government could fill this gap by providing technical and financing services. In addition, a $250,000 grant, authorized by EPAct, is available to industrial associations to promote industrial energy efficiency through workshops, training seminars, handbooks, newsletters and databases. The State could examine how to work in partnership with these associations to develop such a program and access these funds.

A successful program in this area could convince the utilities that the small- to medium-sized businesses are a market sector worth pursuing to promote DSM. Once the state can get a program up and running in a cost-effective manner, the utilities may be able to take over the program and run it within the scope of their own DSM programs.

In such a program, initial contact with the businesses is through an energy audit. This audit is performed by efficiency experts for the interested businesses. The opportunities for energy savings are determined during a free walk-through audit. Once the audit has been completed, it is then up to the business to install the energy saving devices. Qualifying businesses, which must meet certain criteria regarding number of employees, annual revenues and certain stipulations regarding the installation and monitoring of the efficiency upgrades, would then pursue a conventional small business loan approved by a Missouri lending institution to finance the identified efficiency upgrades. The second phase of the program subsidizes the financing of the loan by prepaying the interest costs.

The Small Business Energy Management Program, along with the Energy Conservation Interest Writedown Grant Program, run by the state of Illinois, are examples of model programs that promote energy efficiency in small businesses through energy audits or financial assistance. The two programs, which provide audits and financial assistance respectively, are housed within the Department of Commerce and Community Affairs (DCCA) and the Department of Energy and Natural Resources respectively.

The basic purpose of the programs is the same as that outlined above. Efficiency experts perform energy audits for interested businesses, and then financial assistance is provided by the Energy Conservation Interest Writedown Grant Program. In order to qualify for financial assistance in Illinois, the businesses have to meet the following criteria:

- the business is a for-profit, non-farm commercial or industrial business;
- it has a net worth of less than $6 million and average after-tax profits of less than $2 million in the last two years;
- it does not operate in a home, residence or apartment building;
- it provides the DCCA with copies of all energy bills for the 24 months following the completion of the energy-conservation project;

- it certifies that the project applied for is a retrofit or replacement of an existing structure and/or equipment;
- it will complete the project within six months of approval; and,
- it agrees to allow DCCA or its representatives to inspect the facilities and improvements at any time before, during, or after a project is approved and to conduct a free energy audit if DCCA determines that one is necessary prior to the start of the project.

The U.S. Department of Energy also funds a program that is administered by engineering schools around the country. Energy Analysis and Diagnostic Centers (EADC) have been set up with the purpose of providing free energy audits to industrial facilities. The result of an audit is a report that contains recommended upgrades that can improve the energy efficiency of the facility. The EADC schools are available to provide audits to facilities within a 100 mile radius of the center. An EADC school is located at the University of Missouri-Rolla and at the University of Kansas in Lawrence, which has analyzed buildings in the western side of Missouri.

Opportunities Created by EPAct for Industrial Efficiency

The passage of EPAct gives the state an opportunity to expand its existing programs, while also creating an opportunity to broaden their scope. A $250,000 grant is available to industry associations. The Division of Energy could work with Missouri industry associations to assist them to obtain funding. This would allow the Division to expand its programs by promoting industrial energy efficiency through workshops, training seminars, handbooks, newsletters and databases in cooperation with industry associations.

Transportation

EPAct mandates that an increasing percentage of state vehicles must operate on alternative fuels starting in 1995. It will become more and more critical for the Office of Administration and other vehicle-purchasing agencies to be aware of the state of the art of alternatively fueled vehicles.

Through EPAct, DOE is providing grants to states for the accelerated introduction of alternatively fueled vehicles. States must develop a plan that includes provisions designed to result in progress toward the goal of introducing substantial numbers of alternative fueled vehicles in each state by the year 2000 as well as a detailed description of the requirements, including the estimated cost of implementing such a plan. The plan must also describe how the State, Federal, and local government entities would coordinate in implementing the plan. This plan must be submitted to the DOE for approval before it can qualify for the grant. A grant creates an opportunity for gas utilities and state organizations to work together for the promotion of alternatively fueled vehicles. The grants can aid in the implementation of the state plan, as well as help in the establishment of an alternative fuel bus program.

The states must provide at least a 20 percent match as part of the grant program. The state should approach the electric and gas utilities of Missouri to see if they would be interested in providing at least a portion of the 20 percent matching funds.

Existing Missouri Utility Programs

Introduction

Natural gas and electric utilities can play an important role in helping to overcome the economic, informational and institutional barriers that deter utility customers from investing in energy efficiency options. Utility customers, who consider energy efficiency investments, compare the up-front costs of the investment with the flow of benefits it produces over time. Benefits in future years are devalued at a rate reflecting the explicit or implicit "discount rate" the customer applies to income (and expenses) realized in future years. In empirical studies, various groups of customers have been found to have effective discount rates above those used by utility planners. When evaluating resource planning options, utilities will typically apply a discount rate of five to six percent (real) per year. While customer discount rates vary substantially, they tend to be significantly higher than the discount rates used for utility resource planning.[8]

Utilities can respond to customers' high discount rates by offering Demand Side Management (DSM) programs. DSM programs offer information, technical assistance, financing programs, and financial incentives designed to spur energy efficiency actions beyond those customers would implement based on utility rates and other market forces alone.

Other advantages of utility-based DSM programs have been summarized as follows by Eric Hirst at Oak Ridge National Laboratory:[9]

> *[Utilities'] monopoly franchise, active participation in their communities, and promotion of economic development all speak to their sense of public responsibility. More important, demand-side programs offer resources that are often less expensive...than supply resources. Thus, aggressive utility programs save money for customers by lowering overall energy-service costs. In addition, these programs provide environmental-quality and risk-reduction benefits not available with power plants. Also, electric utilities have long-standing relationships and monthly contacts...with their customers. Utilities are generally highly regarded as sources of reliable and credible information on efficiency options.*

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[8] See Prefiled Direct Testimony of Dr. John Stutz, Ohio Public Utilities Commission Case No. 91-410-EL-AIR (Boston, The Tellus Institute, December 1991), Exhibit JS-11.

[9] Eric Hirst, Electric-Utility Energy Efficiency and Load-Management Programs (Oak Ridge, Tennessee: Oak Ridge National Laboratory, Report ORNL/CON-285), pages 16-17.

The realization of the potential contribution of investor-owned utility (IOU) DSM to the overall level of investment in energy efficiency usually follows the establishment of an integrated resource planning (IRP) process. IRP processes require the identification of mixes of demand-side and supply-side resources that can minimize the total costs of energy services over a long-range planning period. Missouri established its first IRP process for electric utilities in March, 1993, but is just beginning to consider a parallel process for natural gas IOUs. For a publicly owned utility system, DSM emerges when the governing board establishes energy efficiency as a strategic priority of the utility.

The electric utilities that serve the majority of electricity customers in the state operate DSM programs. Not all of the utilities listed below are investor-owned, an example is Columbia Water and Light. Those utilities that are not investor-owned are not required to take part in the IRP process. Missouri electric utilities are also considering developing additional DSM programs, in the context of the 1993 IRP rule adopted by the Public Service Commission. As the utility filings under the IRP rule are only just beginning, their long-term goals are uncertain at the moment.

Kansas City Power and Light

Kansas City Power and Light (KCPL) included DSM programs in its KCPLAN for the first time in 1991. It now has full-scale programs that cover the following areas:

- Load Curtailment: Large customers sign up for load curtailment during peak load periods in return for rate reduction.
- Residential Air Conditioner Load Control: Install devices on individual A/C compressors to limit operation during peak load periods. Can be temperature activated or radio controlled.

KCPL also has several programs that are still in the planning phase. Action will not be taken on these programs until after the July 1994 filing date for KCPL's next IRP filing. The programs that are still in the planning phase are as follows.

- Industrial Process: Assist industrial customers in adopting higher-efficiency technologies in areas such as pumps, motors, refrigeration, compressors and lighting.
- Residential High-Efficiency Air Conditioner: Promotion of selection of high-efficiency air conditioning equipment at the time of replacement.
- Home Energy Audit: Promote Residential use of compact fluorescent lights and hot water insulation wraps.
- Commercial Air Conditioning: Promotion of high-efficiency cooling equipment in the Commercial sector.
- Residential High-Efficiency Refrigeration: Promotion of selection of high-efficiency refrigerators at the time of replacement.

- Residential Water Heater Load Control: Install devices on individual water heaters to limit operation during peak load periods.
- Energy Efficient Commercial & Industrial Lighting: Replacement of fluorescent lamps, ballasts or fixtures with higher-efficiency units.
- Commercial/Industrial Motors: Promote the purchase of efficient motors in Commercial/Industrial sector.
- Residential Insulation Program: Promote higher levels of insulation in homes that use electric space heating.

Union Electric Company

Union Electric Company (UE) is also fairly new to the DSM arena. It currently runs four programs, mainly focusing on information dissemination and load control. Its full scale programs are as follows:

- Energy Plus: Community Services to support individual customer energy needs (elderly and low income)
- Information Literature: This literature focuses on ways to reduce energy usage.
- Primary Service Interruptible Rate: Curtailable service rate offered to Primary Service customers.
- Short-Term Interruptible "Additional Energy" Rider: Curtailable service rate offered to customers willing to accept interruptions while increasing their energy usage.

UE, which also operates outside of Missouri, has several pilot or test programs listed in its 1992 report to the Illinois Commission. These programs focus more on conservation of energy than on load management. These pilot or test programs are as follows:

- Cold Cash Appliance Recycling Program: Pickup and recycling of spare, operating refrigerators and freezers for residential customers.
- Commercial End-Use Data Project: On-site surveys of 800 commercial customers, in order to gain more detailed knowledge of end-use loads for forecasting and demand-side planning.
- Energy Savings Partnership Program: Energy efficiency auditing and project management support for large commercial customers.
- Energy Efficient Residential Construction: New and rehab building envelope and appliance efficiency improvements.
- *In Concert with the Environment*®: An educational program for high school students, focusing on the linkages between personal energy efficiency and environmental quality.
- Industrial Market Research Project: A survey of electric loads and services needs among 150 key industrial customers.

- Industrial Process Audit Pilot Program: Provides nationally recognized consulting on process efficiencies to large industrial customers.
- Interruptible Pilot Program: Curtailable service with remote interruption feature (for smaller primary customers).
- MotorMiser Information Program: Distributing software for analyzing the economics of high efficiency motors.
- No Sweat Residential Energy Management Program: Direct load control experiment for residential central air conditioners and heat pumps.
- Residential Market Segmentation Study: A survey to quantify customer attitudes about energy efficiency, identify opportunities to provide energy services and develop geographically-specified market segments.

Some of these programs appear to belong in marketing and not DSM. Further, some of these programs are studies which, while critical to future success in the area of DSM, do not qualify as DSM while they are in the study phase.

Columbia Water and Light

Columbia Water and Light (CW&L) has been recognized in the past for its energy service and demand management programs. CW&L currently runs the following full scale programs:

- Residential Energy Audits: A "walkthrough" type of audit, an air infiltration test and infra red thermal scan is performed for residential customers.
- Commercial Energy Audits: Provide business customers with expert information regarding potential efficiency improvements to their operations.
- Residential Load Management: Radio controlled switches are installed on central air conditioners to cycle operation during peak load periods.
- Efficiency Upgrade Loans (Residential): Low interest loans are provided to qualifying customers who want to perform energy efficiency improvements. Air conditioner replacements, heat pump installations, and ceiling insulation are covered by this program.
- *Lighten Up!*: Residential and Commercial customers are given incentives to purchase compact fluorescent lamps by contributing $7.50 toward the purchase of a compact fluorescent lamp.

CW&L is also considering several new programs that are currently in the pilot phase. These are as follows:

- Restaurant Seminar to Promote Efficiency: Seminar conducted in the summer of 1993 aimed at providing energy efficiency ideas to managers of restaurants and other cooking establishments.

- Second Refrigerator Turn-in Program: Old, inefficient second refrigerators will be removed from residential dwellings. Incentives will be offered to the participating customers.
- Good Cents New Construction Building Evaluation Program: Promote energy efficient construction and design through a construction scorecard that will be based on the current Columbia building codes. These codes already promote very high thermal integrity for new construction.

Other Electric Utilities

The rest of the electric utilities in Missouri are still in the early stages of developing a full complement of DSM programs. The City Utilities of Springfield have hired the consulting firm, Stone and Webster, to help them decide how to shave 16 MW off of their peak load through DSM, but as yet no active programs. Empire District Electric Company has one active program that was started in 1990, an Interruptible Service program focused on commercial/industrial customers. The Missouri Public Service Company has no active programs, but has several programs under serious consideration. These programs under consideration cover all sectors and focus on energy conservation rather than load control.

Natural Gas Utilities

At the time of our survey of Missouri's natural gas utilities, we found very little DSM activity. Although the IRP rule adopted in Missouri does not currently cover natural gas utilities, this situation is likely to change as the Public Service Commission starts the development and implementation of IRP for natural gas utilities.

Missouri Utility Program Options

DSM Information Sharing Workshops

There is interest among the electric utilities in Missouri to set up an information sharing system for DSM program ideas. A series of workshops that would gather DSM professionals from all of the state's electric utilities (and, if possible, gas utilities) would afford a way to provide this system. This could help some of the more inexperienced utilities over initial hesitation about setting up an array of DSM programs. The more experienced utilities could also benefit from the workshops, since it would provide them with a forum in which they could discuss new program concepts, as well as ideas on how to improve their existing programs. The state of New York has implemented such a program, which brings together national experts and in-state utility DSM personnel. Wisconsin has set up the Center for Demand-Side Research which has a somewhat similar objective. Various approaches to collective information sharing are also occurring in other parts of the country, and such a system can only help Missouri utilities to run more effective DSM programs.

Natural Gas Utility IRP Process

In our survey of the gas utilities of Missouri, as noted above, we found virtually no DSM activity in the state. This lack of activity provides a huge opportunity for the Missouri PSC to promote DSM on the part of gas utilities by initiating a gas Integrated Resource Planning (IRP) process in the state. Kansas has recently drafted gas IRP rules, and New Jersey drafted a gas DSM rule in November of 1991. The amount of energy that can be conserved in the state through DSM by the gas utilities is likely to be very significant. Natural gas IRP would allow the gas utilities to begin to play a significant role in the promotion of natural gas conservation in the state.

Opportunities in EPAct to Promote Natural Gas Vehicles

The proliferation of natural gas vehicles is something that the natural gas utilities of Missouri should keep a close eye on. There is potential for an increase in natural gas sales if natural gas vehicles can gain a share of the vehicle market. That is why the natural gas utilities should be paying close attention to the fleet guidelines, found in EPAct, with regard to the percentage of alternatively fueled vehicles.

EPAct includes an opportunity for the gas utilities of Missouri to be at the forefront of technology with the promotion of natural gas vehicles. EPAct has stringent guidelines concerning the percent of fleet vehicles that will have to be powered by alternative fuels by the late 1990s. The Act also authorizes the Federal Energy Regulatory Commission to allow advance recovery of research, development and demonstration costs by the Gas Research Institute for transportation-related and emissions-related natural gas projects. This legislation provides an excellent opportunity for the gas utilities to begin to develop natural gas vehicles in Missouri.

Become Green Light Partners

At the time of this report, Kansas City Power and Light, City Utilities of Springfield, Graybar Electric Company, Missouri Valley Electric Company, and Union Electric Company are partners in the EPA's Green Lights program. Other utilities should consider joining the program since it could serve a dual purpose for them. First, it could save them money on their own energy expenditures, and second, it could let their customers know that the utility is serious about conserving electricity.

Once a contract is signed between the EPA and a new "Green Lights Partner" a survey of all of the facilities is conducted with consideration of a full set of lighting options to maximize energy savings. These savings will provide an annualized internal rate of return equivalent to the prime interest rate plus six percentage points. Ninety percent of the square footage for which retrofits are appropriate must be retrofit within five years of signing the contract. The facilities will be re-surveyed no later than five years after completing the retrofit. The contract also calls for an agreement to educate employees on the benefits of energy efficient lighting products and to encourage employees to purchase them.

Develop Comprehensive New Construction Programs

New construction is one of the most important markets to reach as far as DSM is concerned. Once a home is built and occupied, it is much more difficult to install conservation measures. An opportunity exists for electric utilities in Missouri to develop comprehensive programs for new construction. New construction is one of the programs that UE is looking at for possible future opportunities, but there needs to be a solid commitment.

The adoption of an energy efficiency building code as the standard for Missouri would be a positive first step, that the legislature can take, to encourage the development of new construction programs. These building codes would provide a baseline from which the utilities could work in their analysis of the energy efficiency of new homes.

An important aspect of a successful new construction program is the inclusion of all parties involved in the new home market. This should include builders, lenders, and buyers. The development of such a program also provides an opportunity for the utility new construction programs to work in concert with a state home energy rating system.

New construction programs need to concentrate a significant amount of effort before construction begins. Designers and builders must be convinced that installing energy efficient products will help and not hinder the marketability of a house. If these groups are convinced that the utility program will sufficiently offset the incremental costs of the efficiency measures, then they will be more likely to install the measures in the first place. Home buyers must also be a key target for the new construction program. These individuals need to be assured that the savings that will result from lower energy bills will outweigh the initial incremental costs of building an energy efficient home.

The typical delivery mechanisms for new construction programs is through financial incentives, design assistance and training for builders, and marketing to potential home buyers. The builders must install measures that exceed the program standards in order to qualify for the incentives. The builders also attend a training workshop on the techniques of energy efficient construction. The plans for the home are submitted to the utility for approval, and inspections are made throughout the construction process to ensure that the home will live up to the design standards. Once a qualifying home is complete, it is certified by the utility, and the builder is certified as able to construct energy efficient homes.

There are a number of effective new construction programs that are run by utilities all across North America. New England Electric Systems (NEES) offers their Energy Crafted Home program to target the new construction market in New England. The program goal is to encourage the construction of homes that exceed the current building code standards in New England. Incentives and training for builders along with marketing the program to prospective home buyers are the primary means of ensuring that energy efficient homes are built. NEES provides the incentives to the builders for equipment that meets the efficiency standards of the program. The utility also pays the support services if the builder is a first time builder of an Energy Crafted Home. The utility analyzes the plans for the home to make sure that it conforms to the program requirements. Once that plans have been approved, the utility does on-site audits during construction to ensure that the home is being built in accordance with the plans.

When the home is completed, it is certified. The builder also becomes a certified Energy Crafted Home Builder. One example of the success of this program is an Energy Crafted Home that was built in Southbridge, MA. The utility paid out $1,800 in builder incentives and $665 for support services for the first-time Energy Crafted Home Builder. The estimated customer benefit is $208/year in lower energy bills. The utility benefits are that 3.6 kW of winter peak demand have been saved, along with 2,227 kWh of annual energy savings.