Report to the Missouri Legislature
Pursuant to House Concurrent Resolution 16

Economic Opportunities
Through
Energy Efficiency
And The Energy Policy Act of 1992

EIERA
Environmental Improvement and Energy Resources Authority

December, 1993

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Economic Opportunities Through Energy Efficiency And The Energy Policy Act of 1992

December, 1993

Environmental Improvement and Energy Resources Authority

State of Missouri Department of Natural Resources

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Consultants:
Metropolitan Energy Center
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Missouri House of Representatives

Resolution

WHEREAS, it is in the interest of the State of Missouri to meet the requirements contained in Title I of the federal "Energy Policy Act of 1992", which provides that the state review its building code regarding energy efficiency in relationship to the requirements contained in the Council of American Building Officials Model Energy Code, 1992, and to update its commercial building code to meet or exceed the American Society of Heating, Refrigerating, and Air Conditioning Engineers Standard 90.1-1989:

NOW, THEREFORE, BE IT RESOLVED that the members of the Missouri House of Representatives of the Eighty-seventh General Assembly, the Senate concurring therein, hereby direct the Environmental Improvement and Energy Resources Authority, in cooperation with the Commissioner of Administration, the Division of Energy and other appropriate organizations as determined by the authority, to determine the state's obligations under the federal Energy Policy Act of 1992 and to review energy efficiency standards for residential and commercial buildings in view of the state's projected long-range energy needs, the effect of efficiency programs on those needs, and advances in technology with respect to weatherization and energy efficiency; and

BE IT FURTHER RESOLVED that the Authority's review be in accord with the requirements contained in Title I of the federal "Energy Policy Act of 1992" (P.L. 102-486, 106 Stat. 2776); and

BE IT FURTHER RESOLVED that the Authority prepare a report on its review for presentation to the House of Representatives and the Senate by January 1, 1994, and that said report include:

(1) Any recommendations for energy efficiency standards which will reduce energy consumption or increase the productivity or effectiveness of energy resources use;

(2) The direct effect of implementing the changes on the cost of construction and remodeling and lending practices; and

(3) An estimate of energy savings that would result from the changes, including an estimate of net costs when savings are deducted from any increased construction and remodeling costs; and

BE IT FURTHER RESOLVED that the Chief Clerk of the Missouri House of Representatives be instructed to prepare a properly inscribed copy of this resolution for the Director of the Environmental Improvement and Energy Resources Authority.

Offered by Representative Patrick Dougherty

Douglas Burnett, Chief Clerk of the House, and Terry L. Spieler, Secretary of the Senate, do hereby certify that the aforementioned is a true and correct copy of House Concurrent Resolution No. 16, adopted by the House on April 1, 1993, and concurred in by the Senate on April 27, 1993.

CHIEF CLERK OF THE HOUSE

SECRETARY OF THE SENATE

"Salus Populi Suprema Lex Esto"

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CHAPTER I
REPORT SUMMARY

Introduction

Missouri was an early leader in the development of a statewide analysis of the link between economic, energy and environmental issues, when, in 1992, the Environmental Improvement and Energy Resources Authority (EIERA) released the *Missouri Statewide Energy Study*. This Study documented that in 1990, Missourians spent $9.7 billion on all of their energy needs which represented nearly 11% of total income for the state. Since Missouri must import most of the energy it uses, over $7 billion of the $9.7 billion leaves the state's economy. The Study convincingly makes the case that efficiency in our energy consumption allows more of our incomes to remain in the state and reduces pollution.

With the findings of the *Missouri Statewide Energy Study* as a foundation and the impetus from Congress in the form of The Energy Policy Act of 1992 (EPAct), the First Regular Session of the 87th Missouri General Assembly passed House Concurrent Resolution 16 (HCR16). This Resolution directs the EIERA, the Division of Energy of the Department of Natural Resources and the Office of Administration to analyze the obligations of EPAct on Missouri and to further analyze energy efficiency standards for buildings in Missouri and the opportunities for improving the efficiency of those buildings.

This Report to the Legislature specifically analyzes how to make Missouri buildings more energy efficient through compliance with higher construction standards and emerging technologies. It also details Missouri's obligations and opportunities under EPAct. And finally, it ties together an analysis of the state's building stock with the EPAct analysis and a review of existing programs that affect energy efficiency, in order to provide recommendations.

In the process of developing a comprehensive set of recommendations for the state of Missouri, there are two dominant considerations. First is that historically, we have measured success of our energy efficiency programs in terms of number of contacts made, number of technical studies initiated, number of audits completed or number of dollars spent. These can not be the measures of success for the future; energy saved should be the key measure of success of any of our recommendations. Second, all of our programs should rest on a foundation of partnerships among all of the various stakeholders. This will ensure the greatest potential for success.

The recently published book, *Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector*, authored by David Osborn and Ted Gaebler, has been widely discussed as a model for the new partnerships for the nineteen-nineties. The authors established a strong framework for their observations and recommendations. They included four points about government in their introduction:

*First we believe deeply in government....Second, we believe that civilized society cannot function **effectively** without **effective** government....Third, we believe that the people who work in government are not the problem; the systems in which they work are the problem....Fourth, we believe that neither traditional liberalism nor traditional conservatism has much relevance to the problems governments face today.*

This section was restated in the introduction to *Creating A Government That Works Better and Costs Less*, the Report of the National Performance Review by Vice President Al Gore released in the fall of 1993. In both books, the authors were making the case that the critical issue for our future success is not just *what* government does but also *how* it does it. It is in this context we are recommending a change in how the state of Missouri promotes energy efficiency and how it delivers services to the residents of the state.

Our recommendations are divided into three parts. The first part deals with specific recommendations regarding how to make buildings more energy efficient through the use of codes, standards and rating systems. Second is a structure for creating partnerships around the state including both the public and private sectors. And third are specific energy efficiency program opportunities.

Our technical analysis reveals the cost-effectiveness of investing in the energy efficiency of Missouri's buildings. We believe that taking the opportunities that now present themselves can help to make Missouri a leader in energy efficiency.

The National Performance Review indicated some important benefits of making government more effective and efficient that could complement Missouri's efforts to increase the efficiency of the state. Although all of the details are not yet developed and some require legislation, some of the recommendations of the National Performance Review include:

- *Congress should allow states and localities to consolidate separate grant programs from the bottom up.* - Depending on how this is implemented, some of the various categorical grants could be combined, such as Weatherization Assistance and Low Income Home Energy Assistance.
- *Give all cabinet secretaries and agency heads authority to grant states and localities selective waivers from federal regulations or mandates.* - Many of the categorical grant programs come with extensive federal requirements. As innovative programs are developed, this might provide the opportunity to test new program approaches.
- *Strengthen the Federal Energy Management programs.* - Although this is primarily directed at federal facilities, the focus on buildings in Missouri and the lessons learned from improved efficiency at these facilities may be useful to Missouri.

- *Redirect Federal Energy Laboratories to post cold war priorities.* - As the national laboratory system changes, Missouri should prepare itself to work with them. For example, the National Renewable Energy Laboratory operated by Midwest Research Institute in Kansas City is developing more programs to assist state and local governments to reduce energy use and increase the use of renewable energy resources.

Integral to this Report is the basic assumption that making the most efficient use of energy while also improving both the economy and the environment will be the measure of our success. Saving energy is the foundation of all the program recommendations. It is our conviction that key to improving the energy efficiency of buildings and reducing the amount of energy consumed within the state, is a reordering of the way we develop and provide services. It is the reorganization of programs and our philosophical base, that will provide for the creation of new opportunities for energy efficiency in Missouri.

Energy Policy Act of 1992

On October 24, 1992, then President George Bush signed into law the Energy Policy Act of 1992 (EPAct). EPAct is arguably the most comprehensive piece of energy-related legislation ever enacted in the United States. EPAct creates and expands national programs in energy efficiency, renewable energy, and alternative motor vehicle fuels. EPAct also amends the Public Utilities Holding Company Act of 1935 (PUHCA), as well as provides a framework for increased electricity transmission access. For Missouri, under this law, there are both requirements and opportunities that would necessitate state action. Missouri requirements mandated by EPAct as well as opportunities provided to the State are summarized below.

The thrust of EPAct is to promote energy efficiency. It requires stricter energy efficiency standards for new commercial buildings and recommends higher standards for residential buildings. EPAct also requires stricter energy efficiency standards for lighting, appliances, motors, heating and cooling systems, and other products; sets water conservation standards; requires the Federal government to use energy more efficiently; encourages utilities and industries to invest in energy efficiency; and exempts from taxation energy efficiency rebates from utilities to residential consumers. EPAct fosters renewable energy by increasing Federal support for research and development on renewable energy technology; by indefinitely extending a 10% tax credit for business investments in renewable energy; and by establishing a 1.5 cent per kwh tax credit for electricity generated from renewable sources.

EPAct amends the Public Utility Holding Company Act of 1935 to encourage competition in the electric utility generation and wholesale power market, and amends PURPA to encourage the use of Integrated Resource Planning techniques and demand-side management by utilities. In addition, EPAct promotes the use of alternative motor vehicle fuels by establishing minimum alternative-fuel vehicle percentages for commercial and government motor vehicle fleets. EPAct streamlines the licensing of nuclear power plants and establishes a uranium enrichment corporation.

This Report identifies all mandatory requirements of states established by EPAct as well as the opportunities created by the Act for action by the State of Missouri. We define opportunities as instances where states or local governments are specifically mentioned by the Act and where, in our judgment, opportunities are created by its mandatory requirements.

Although our analysis under HCR16 is aimed primarily at state government, many of the requirements and opportunities go far beyond state government alone. In some instances, the Report notes opportunities for state government in Missouri to assist others in implementing requirements contained within EPAct. As the federal

government and the Department of Energy have begun the process of *reinventing* how they provide programs and services, many of their specific activities will change over time. Indications are that this will only serve to assist state and local governments to become more efficient within a more flexible framework.

Requirements

- By October 24, 1994 Implement a minimum commercial building energy code that meets or exceeds ASHRAE standards either through state legislation or by having a majority of municipal and local governments adopt such a code.
- By October 24, 1994 Certify (after public hearing) to DOE that Missouri has reviewed its residential building codes and decided whether or not to adopt the CABO Model Energy Code or an equivalent.
- By October 24, 1994, The Public Service Commission must begin hearings and make a determination on whether to adopt new PURPA standards for Integrated Resource Planning (IRP) for gas utilities.
- Purchase new alternative fueled. State vehicles that meet the percentage requirements in EPAct.

Opportunities

- Update residential building code to meet or exceed CABO standards through state legislation or local ordinances to enable new residential buildings to be eligible for Federal mortgages (VA, FHA, etc.)
- Work with DOE to develop and promote a home energy ratings program
- Support the development of a regional Energy Efficiency Center
- Establish energy efficiency standards for manufactured housing
- Promote HUD's energy efficient mortgage program
- Apply for up to $250,000 grant to implement new PURPA standards
- Assist industry organizations to apply for up to $250,000 grant for industrial energy efficiency programs
- Establish building codes as stringent as ASHRAE/CABO in order to apply for $1 million grant for efficiency improvements for State buildings
- Promote and coordinate private sector involvement in the Low-Income Weatherization Program
- Develop State plan for alternative fuels and alternatively-fueled vehicles in order to apply for DOE grants and assistance
- Establish agreement with USDOT to conduct alternative fuel bus program in order to apply for USDOT grants
- Participate in electric utility electric motor vehicle battery study
- Participate in study of rate treatment of renewable energy projects
- Encourage municipalities, cooperatives or other agencies involved in the generation, transmission, and distribution of electricity to take advantage of 1.5 cent/kWh credit for renewable energy production
- Exercise authority to regulate disposal of low-level radioactive waste

Technical Analysis

Methodology

The first step in analyzing the potential impact of improved energy efficiency in Missouri buildings was to develop a profile of existing buildings as well as projections for new construction in the state. For this analysis, a group of representative building models was developed. Using data bases maintained by the F.W. Dodge division of McGraw-Hill, a residential and commercial building profile was developed. When compared with models prepared by Union Electric Company (UE) and other sources, three residential and six commercial building models were identified that collectively represent 79% of the total projected building activity in the state. This is summarized in Table I-1. Detailed descriptions of each model are included in the appendices to the full report.

Table I-1
Missouri Building Inventory Additions 1995-2000 (New Construction)

Building Types Modeled	Building Area (sq. ft. x 1,000)	Percent of Total
Small Office Building	13,424	4
Large Office Building	6,196	2
Retail Building	13,349	4
Nursing Home	8,064	2
Elementary School	18,925	6
University Buildings	3,357	1
Single Family Housing - 1 Story Detached	128,969	39
Single Family Housing - 2 Story Detached	42,989	13
Multi Family Housing - Units	26,520	8
Other (Not Modeled)	68,161	21
TOTAL	329,955	100

The next step in the analysis was a review of residential and commercial building codes that are in use. In the residential sector, four major building codes are in use: the National Building Code, the Uniform Building Code, the Standard Building Code and the Model Energy Code. The Model Energy Code is developed cooperatively by the organizations that develop and update the first three codes and is updated every three years. The current version will be updated in 1995.

On the commercial side, the primary standard is the American Society of Heating, Refrigeration, and Air Conditioning Engineers' Standard 90.1-1989 (ASHRAE 90.1-1989). Compliance, after meeting the technical requirements for all buildings, such as minimum efficiency for equipment, is determined in one of three ways. The first is prescriptive compliance where a building designer follows the list contained in the standard. This is the simplest, yet most stringent and least flexible method. Second is system performance compliance that is an alternative to the prescriptive path and allows tradeoffs between different envelope and lighting systems based on an overall power allowance. The third is the energy cost budget compliance that is based on modeling a hypothetical building that meets either the prescriptive or system performance compliance path. The energy budget of the proposed building must be equal to or less than the energy budget of the hypothetical model. This is the most complex approach, but it offers the greatest flexibility.

A review of both residential and commercial technology was the next step in the process. Although this Report was not intended to provide a complete review of all emerging building technologies in both the residential and commercial sectors, there are significant advances in building components and applications that are reviewed. The analysis included building shell improvements such as improved insulation, windows and doors. Also analyzed were equipment improvements including heating and air conditioning, lighting and water heating equipment.

The analysis of emerging technologies, when coupled with the review of building codes, was the basis for determining the actual insulation levels, equipment installed and other efficiency measures in each of four scenarios for the nine buildings types modeled. In addition, for each of the modeled types, there were two heating approaches analyzed, electric and natural gas.

To analyze the potential efficiency of the nine model building types in light of the codes that are in use and technologies available, four efficiency scenarios were developed. They each represent a progressive step on a ladder of efficiency.

Current Practice - This scenario is an estimation of what the actual practice is in Missouri today.

EPAct Standard - This scenario uses the prescriptive requirements of the CABO Model Energy Code and the ASHRAE Standard 90.1-1989 and represents the minimum recommendations of the Energy Policy Act. It is modeled based on improvements over Current Practice.

Enhanced Case - This scenario incorporates a cost-effective package of energy efficiency measures that exceeds the performance of the EPAct Standard scenario, yet does not increase the total cost of ownership of the building.

Resource Case - This scenario includes additional measures added to the Enhanced Case. It also accounts for utility avoided capacity and environmental externality offsets. In this scenario, the building owner is assumed to receive,

in addition to the utility bill savings, additional payments reflecting utility avoided-cost benefits and some compensation for the environmental benefits of reduced energy use.

To ensure that the analysis reflected Missouri's climate, which in fact varies from the northern to the southern boarder of the state, the analysis divided the state into two climatological zones. The northern zone uses weather data from the Columbia airport and the southern zone used data from Springfield, national weather data collection locations. In addition, a survey of utilities in the state was completed to determine a range of utility rates for each of the building types modeled.

For residential buildings, the analysis was completed using ESPRE 2.1, a modeling tool developed by the Electric Power Research Institute. For commercial buildings, the modeling was completed using DOE 2.1d, a modeling tool developed by the U.S. Department of Energy. The hour-by-hour computer modeling provided natural gas and electric consumption information on a monthly and annual basis and electric and natural gas peak demand on an hourly basis.

The final step in analyzing the models was to determine the actual cost of improvements associated with each of the four scenarios for each of the nine buildings. A professional cost estimating firm went through the specifications for each building and developed cost scenarios for each level of improvement. In this manner, the costs, for example, for adding additional insulation or a higher efficiency air conditioner, were based on real market conditions. This then provided the information for the overall economic modeling of the buildings and the basis for the net cash flow and affordability test of the various scenarios.

In this section of the full Report, the analysis focused on the economic benefit to the building owner. This involved calculating the total cost of ownership with and without the energy efficiency improvements represented by the four scenarios from the Current Practice to the Resource Case. From the owners point of view, it is assumed energy efficiency improvements make economic sense if the cost of the added improvements are equal to or less than the overall costs without the improvements.

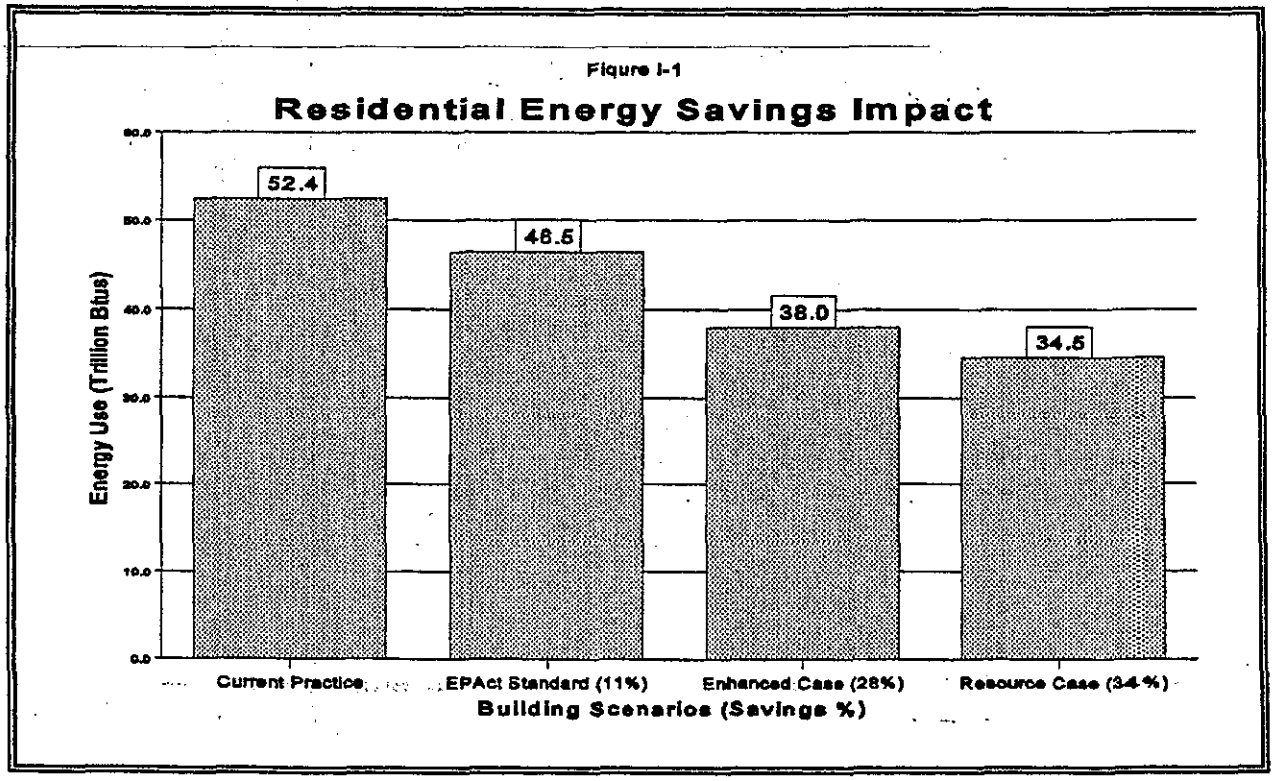
In the mortgage markets, the affordability equation is principal, interest, taxes and insurance or *PITI*. In this analysis, energy or *E* was added to the equation in all of the scenarios. In the Resource Case, as stated earlier, credits for reducing the need for additional energy supply capacity or for reduced environmental costs were also added. The economic analysis is based on the assumption that the total cost of ownership, including energy costs, *PITI+E* is a better indicator of affordability than the traditional *PITI* formula.

Residential Analysis

In the residential sector, our analysis has found that the EPAct Standard slightly increases the annual cost of ownership compared to Current Practice because of the addition of basement insulation that represents an over investment in unheated basements in Missouri. The Enhanced Case, which has a more aggressive level of efficiency measures, has approximately the same affordability for the owner as does Current Practice. The Resource Case, with an even more aggressive level of measures, including capacity and environmental credits, has an affordability equal to or greater than Current Practice.

On a statewide basis, nearly 200 million square feet of new residential buildings are projected to be constructed between 1995 and 2000. They would use significantly less energy by increasing the efficiency to any of the three scenarios over the level of Current Practice. In the EPAct Standard case, energy savings for these buildings are projected to amount to 11% over Current Practice. In the Enhanced Case, the amount of savings is 28%. In the Resource Case, energy savings are projected to amount to 34% over Current Practice. Figure I-1 details those savings.

Figure I-1

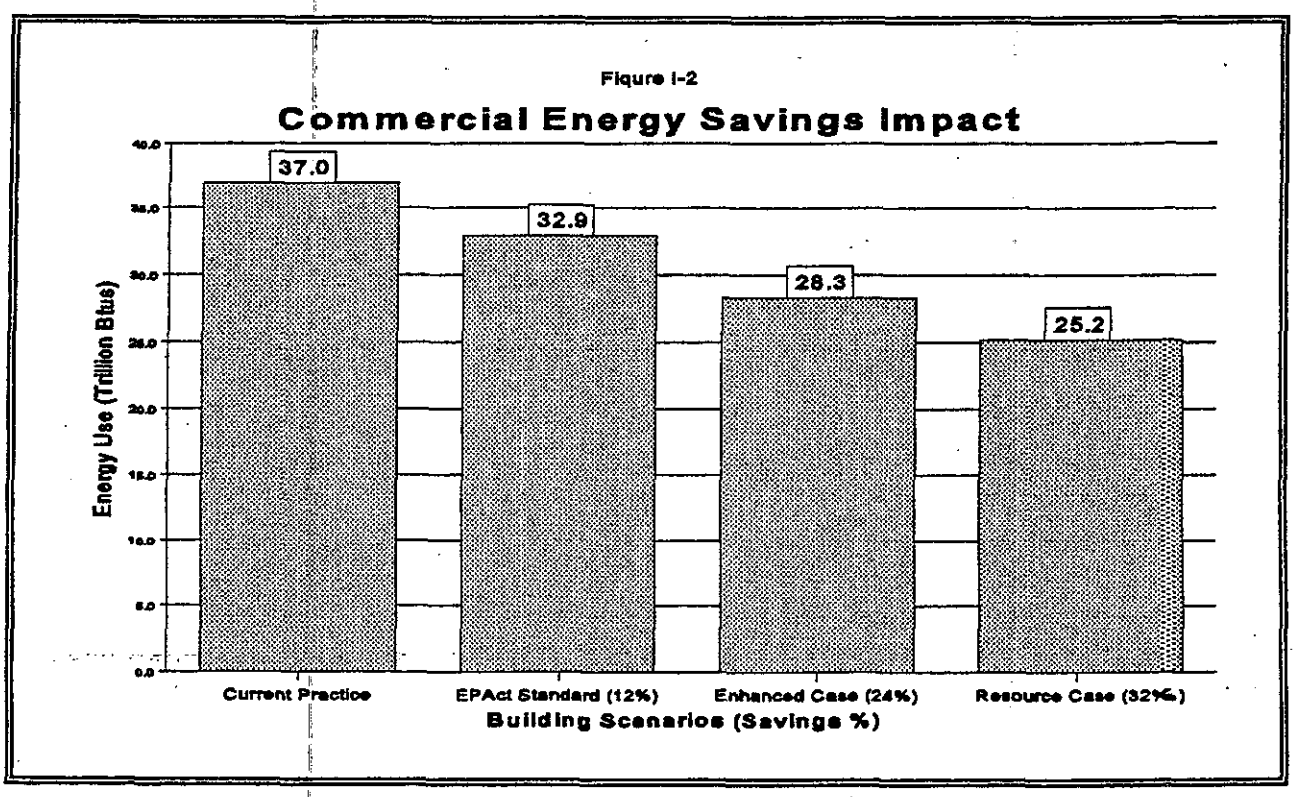


Commercial Analysis

In the commercial sector, our analysis has found that investment in energy efficiency is economically advantageous to most building owners. Upgrading to the EPAct Standard generally is economically beneficial to the owner and the more aggressive levels represented by the Enhanced and Resource Cases are also cost effective, primarily due to the down-sizing of the HVAC equipment. Although not treated in this analysis, significant additional savings may be achieved by improved building design incorporating aspects such as daylighting and passive solar. In addition, in the commercial sector, improved efficiency of office equipment would reduce energy loads and would offer significant savings to the building owner.

On a statewide basis, our analysis projects that an additional 131 million square feet of commercial buildings will be constructed between 1995 and 2000. The six commercial buildings types analyzed represent approximately fifty percent of the total of over two hundred building types in the state. The statewide analysis of building to higher standards indicates that energy consumption could be reduced from the Current Practice by 12% in the EPAct Standard, 24% in the Enhanced Case and up to 32% in the Resource Case by use of more efficient equipment and applications. Figure I-2 details the energy savings for the commercial sector.

Figure I-2



Economic and Environmental Impacts

To provide a further analysis of the impact of more efficient buildings in Missouri, the Report examined three other benefits of improving energy efficiency. The first two, (1) the economic benefit to the state of reducing the need for additional energy supply or capacity and (2) reducing the environmental impact of the use of fossil fuels, were examined from the benefits point of view for a 20-year period to 2015. A third benefit, the economic impact of energy cost savings in terms of employment, income, retail sales and government revenue, was analyzed for a six year period of 1995 through 2000.

There are direct economic benefits to Missouri in reducing the need for additional energy supply. Since most of the energy used in the state is produced from fossil fuels that are not extracted in Missouri, a reduction in use represents a reduction in the potential future importation of energy resources. In addition, in the electric industry, enough reduction in use could mean a complete avoidance of the need for additional generating capacity over the next twenty years. In this section of the Report, our analysis looked at the overall societal benefit of efficient energy use. For the electric industry, that meant reducing the need for building additional electrical generating capacity; for the natural gas industry, it meant reducing the amount of gas imported to the state.

The environmental benefits of improving the efficiency of buildings in Missouri are grounded in the most efficient use of energy generated from fossil fuels. Many states are now developing control cost scenarios for the pollutants that are produced from the use of fossil fuels. The costs are based on the strategies necessary to *control* the impact of the pollutants produced. Although Missouri does not currently have a set of such values, the Report utilized a comprehensive set of values established for the Massachusetts Department of Public Utilities for electric utility Integrated Resource Planning. Should Missouri develop its own set of values, they could be used for a more specific analysis of the Missouri environmental costs.

The analysis of the four building scenarios for the nine building types suggests there are significant benefits from improving the energy efficiency of Missouri buildings. The net benefits are projected as $101.0 million for the EPAct Standard, $549.8 million for the Enhanced Case and $487.9 million for the Resource Case. In all cases, even if there were no credits given for environmental costs of energy, there would still be a positive net economic benefit to Missouri and the individual building owner from improved building efficiency. Table I-2, on the following page, provides a summary of these findings:

Table I-2 Net Benefits of Building Efficiency Improvements *In Cumulative 1993 Present Value Dollars ($Million)*			
	EPAct Standard	**Enhanced Case**	**Resource Case**
Benefits (Savings):			
Electricity	$100.7	$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**

Finally, an analysis was conducted on the overall economic impact of the improvement in building efficiency using employment, income, retail sales and state government revenues as measures. Using a Missouri specific computer model, the analysis examined how the investment in energy efficiency, the additional costs and the resulting savings, would affect the Missouri economy. This analysis was done on the basis of direct investment in energy efficient buildings and does not include an economic analysis of the environmental and supply credits detailed in Table I-2.

Based on this buildings analysis, there is a substantial net benefit to the state and its citizens in all three of the scenarios when compared to the Current Practice. Table I-3 provides a summary of these findings:

Table I-3 Summary of Macro Economic Analysis 1995-2000 in 1995$				
	Increased State Personal Income	**Increased Employment** *Full time positions for entire six years*	**Increased Retail Sales**	**Net Increases in State Revenue**
EPAct Standard	$210,623,000	1,401	$94,920,000	$13,992,864
Enhanced Case	$562,767,000	3,737	$253,245,000	$36,448,539
Resource Case	$739,254,000	4,909	$332,644,000	$47,421,712

Program Review

In this Report to the Legislature, the analysis up to now has focussed on energy efficiency measures related to new or substantially renovated residential and commercial buildings; and on policy options concerning building 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.

This section focuses on program options to encourage energy efficiency, especially utility demand-side energy efficiency options. Major existing programs are summarized and promising options for consideration are identified. This section is divided between government and private programs and utility programs.

Government and Private Programs

Some of the most visible, existing programs analyzed in the Report, are outlined below. Within state government, the **Division of Energy** of the Department of Natural Resources is the focal point of most of the State's efforts, with the responsibility of improving energy efficiency in almost all sectors of the state - private and public. Some of its current programs include low-income weatherization, educational services, institutional assistance including grant and loan programs for schools, local governments and industry, vehicle efficiency programs and the Energy Efficient State Buildings Program, recently expanded by HB195 and SB80.

In addition, the Office of Administration's **Division of Design and Construction** and **Board of Public Buildings** have significant responsibility for state building's energy efficiency. They have the opportunity to work in partnership with the Division of Energy on efficiency programs. Another state agency, the **Division of Family Services** is responsible for administering the federal Low-Income Home Energy Assistance (LIHEAP) program. In Missouri, LIHEAP funds now are currently used only for utility assistance, though 15% of these funds could be used for weatherization.

An important component of energy efficiency programs is financing. The **Environmental Improvement and Energy Resources Authority (EIERA)** provides financial and technical assistance to businesses, local governments and not-for-profit organizations for energy and environmental projects. The EIERA also conducts studies and research in these areas. The **Missouri Health and Educational Facilities Authority** provides financing, usually for programs or administration, to the state's public and private, non-profit health and educational facilities. The **Missouri Housing**

Development Commission is responsible for providing financing for affordable, quality housing for low and moderate income Missourians. These three financing authorities provide resources to the residential, commercial, industrial and institutional sectors of the state.

The **Public Service Commission** is responsible for regulating the investor-owned energy utilities within Missouri. They are also responsible for regulating the development of Integrated Resource Plans by these utilities to ensure that future investments are economically balanced between both supply- and demand-side options. As utilities invest more in demand side management approaches, the PSC will play a very significant role in improving the energy efficiency of Missouri.

As Missouri develops and enhances the infrastructure to promote energy efficiency within the state, there are a number of non-state programs that can provide services. Examples include the Metropolitan Energy Center in Kansas City, the Missouri Energy Resources Project and Earthways in St. Louis and various neighborhood, housing and community development organizations throughout the state. In addition, at the federal level, the Department of Energy (DOE) and the Environmental Protection Agency (EPA) have developed many non-grant type programs that promote energy efficiency and often provide technical assistance such as the EPA's Green Lights and Green Buildings programs.

Energy Efficiency Program Options

A **Home Energy Rating System** (HERS) program would evaluate the comparative energy efficiency of a home and give the buyer of a new or existing home the opportunity to use this information in making decisions about the purchase and, in the case of an existing home, look at the potential of making energy efficiency improvements after purchase. A HERS is an energy analysis tool which can help to qualify a buyer for an Energy Efficient Mortgage.

An **Energy-Efficient Mortgage Program** (EEM) would assist a home buyer to either qualify for a larger mortgage to purchase a more efficient home or to make the home they want to purchase more efficient. It is based on adding energy costs to the traditional equation of principal, interest, taxes and insurance to evaluate the economics of the potential mortgage.

In the public sector, 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. Missouri already has several programs in place that

promote energy-efficiency projects in public buildings, and these new funds could enhance the financing available through these programs.

The small and 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 for the large industrial customers. State government could fill this gap by providing technical and financing services. In addition, a $250,000 grant, authorized by EPAct, is available to industry 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.

Utility Programs

Natural gas and electric utilities can play an important role in helping overcome the economic, informational and institutional barriers that deter utility customers from investing in energy efficiency options. Integrated Resource Planning (IRP) has just begun in earnest in Missouri with Union Electric's filing of their plan in early December. The following is a brief overview of some current utility activities and potential programs.

At the time of this Report, **Union Electric Company** (UE) was operating four programs, mainly focusing on information dissemination and load control. These included an information program, a low-income and elderly service program and two interruptible rate programs. UE also has several pilot or test programs for all customer classes, which are expected to be included in their IRP that was filed.

Kansas City Power and Light (KCPL) currently offers full-scale programs that cover load curtailment and residential air conditioner load control. KCPL also has several programs that are still in the planning phase including, industrial process energy management, commercial air conditioning, motors, and lighting, and residential air conditioning, refrigeration, insulation and audits.

Columbia Water and Light, a municipal utility, currently provides residential and commercial energy audits, home efficiency upgrade loans, a compact fluorescent lamps program. They are currently considering additional residential and commercial efficiency programs.

The rest of the electric utilities in Missouri are still in the early stages of developing a full complement of DSM programs. **Empire District Electric Company** has one active program at the moment, an Interruptible Service program. And, although

Missouri Public Service Company and **City Utilities of Springfield** have no active programs at this time, they indicate they have several programs under consideration.

Based on a review of successful utility programs in other parts of the country, there are a number of new program options available for Missouri. They include:

Promote Demand Side Management (DSM) Information Sharing Workshops - A series of workshops that would gather DSM professionals from all of the state's energy utilities would afford a way to respond to interest among the electric utilities in Missouri to set up an information sharing system for DSM program ideas.

Initiate Natural Gas Utility IRP Process - At the present time, gas utilities in Missouri are not actively involved in DSM activity, so there is opportunity for the Missouri PSC to promote DSM on the part of gas utilities by initiating a gas Integrated Resource Planning process in the state.

Develop Comprehensive New Construction Programs - An opportunity exists for electric utilities in Missouri to develop comprehensive programs for new construction to promote energy efficient buildings.

Target Industrial Customers - Currently, Kansas City Power and Light is the only utility in Missouri that is offering a full scale industrial DSM program. Opportunity exists for the other Missouri electric utilities to increase their efforts to target industry for DSM.

Promote Natural Gas Vehicles - With EPAct requiring the conversion of both public and private fleets to alternative fuels, a significant number of fleet operators will consider conversion to natural gas. The natural gas utilities of Missouri, no doubt, will examine the potential for an increase in natural gas sales if natural gas vehicles can gain a share of the vehicle market.

Recommendations

The investment in energy efficiency is an excellent economic opportunity for Missouri, as it is for other states. With the information base and analyses provided by the *Missouri Statewide Energy Study* of 1992, the requirements and opportunities of the Energy Policy Act of 1992, this Report and with the experiences of other states, Missouri is now well-positioned to make sound energy decisions. Unforeseen situations and opportunities for the state will arise which this Report cannot predict. ***However, the recommendations contained in this Report provide a timely, solid basis from which Missouri can actively move forward in a responsible manner.***

The recommendations are aimed at achieving actual, cost-effective savings while encouraging partnerships among the many public and private participants. The first part of the recommendations addresses the use of rating systems, standards and codes to achieve energy efficiency. The second part recognizes the opportunity for partnerships to develop strategies and programs for the long-term economic and environmental benefit of the state. The last part of the recommendations outlines specific programmatic opportunities that can and should be immediately pursued.

Energy Efficiency Through Rating Systems, Standards and Codes

✔Adopt a state-specific *residential energy standard,* equivalent to MEC 92, that provides two alternatives for compliance: a prescriptive path and a "points-based" path.

✔Adopt a state-wide *home energy rating system based on the* residential energy standard, and use the standard as an equivalent substitute for MEC 92 for builders, home buyers, and lenders participating in HUD/DoA-backed mortgage programs.

✔Adopt a state-specific *commercial energy standard* based on ASHRAE Standard 90.1-1989 that provides two alternatives for compliance: a prescriptive path and a "trade-off" path.

✔Develop *energy efficiency standards for manufactured housing.*

Partnerships for Developing and Implementing Energy Strategies

✔The Energy Futures Coalition should work closely with state governmental entities, utilities, private business, design, development and construction professionals, nonprofit and citizens groups and other interested parties to develop cooperative methods for the delivery of energy efficiency services in Missouri.

Energy Efficiency Program Opportunities for Action

✔Develop effective strategies to give Missourians from all sectors access to *reliable and usable energy information*, including a method to assure *access to reliable building energy audits and analysis* for all building owners or tenants.

✔Develop an effective variety of specific *financing mechanisms* for energy efficiency investments.

✔Support and encourage *programs that promote energy efficiency* such as the Home Energy Rating Systems (HERS), Green Builder Councils and training and certification programs. Encourage the *transfer of successful experiences* by recognizing and promoting effective local and regional programs.

✔Assure continued, improved and cost-effective delivery of *energy efficiency services to low income households*, leveraging federal funding with utility and private sector participation.

✔Promote the development and implementation of comprehensive *Integrated Resource Planning* including demand side management strategies.

✔Ensure the development of an *alternative fuels infrastructure* that significantly contributes to the economic and environmental betterment of Missouri and support the *conversion of vehicles to alternative fuels*.

CHAPTER II
ENERGY POLICY ACT OF 1992

Introduction and Background

After nearly two years of study by the executive branch and a year and a half of debate in Congress, then President George Bush signed House bill H.R. 776, the Energy Policy Act of 1992 into law as P.L. 102-486 on October 24, 1992. H.R. 776 was the result of a Senate-House conference committee's efforts to reconcile the differences between separate House and Senate bills introduced to implement the Bush administration's National Energy Strategy.

In July 1989, President Bush directed the U.S. Department of Energy (DOE) to develop a National Energy Strategy to reduce foreign oil imports, improve national security, reduce the trade deficit, and improve the competitiveness of U.S. companies at home and abroad. DOE held 15 hearings throughout the country to determine which issues should be addressed by the strategy. DOE turned the thousands of pages of the hearings' testimony from consumers, environmental groups, and industry into more than 100 legislative and administrative proposals, which were presented to the White House for review in December 1990.

Based on DOE's proposals, President Bush released the first edition of the National Energy Strategy in February 1991. The strategy represented the first sustained energy policy effort since the Carter administration. Although initiated more than a year before the Iraqi invasion of Kuwait and the subsequent U.S.-led military campaign in the Persian Gulf, the Bush Administration's National Energy Strategy efforts were clearly accelerated by these events.

In response to the National Energy Strategy and the Persian Gulf crisis, Congress quickly drafted legislation to implement key features of the strategy, but it took 19 months of debate in 17 congressional committees before the House and Senate agreed to a final version of the bill. The debate was extremely divisive, and passage of the Act was referred to as a "legislative miracle" by Senate Energy Committee Chairman and sponsor of the Senate version of the bill, J. Bennett Johnston (D-La.).

Much of the congressional debate centered on two of the bill's measures, which were ultimately dropped in order to ensure passage of the final version. Conservation advocates and environmentalists agreed to remove provisions establishing higher Corporate Average Fuel Economy (CAFE) mileage standards for automobiles; in return, oil and gas industry advocates dropped a provision to allow exploration and test drilling in Alaska's Arctic National Wildlife Refuge. In addition, most of the bill's natural gas provisions (Title II) were dropped to resolve a deadlock over provisions prohibiting States from restricting natural gas production to boost prices ("pro-rationing"), streamlining the permitting process for construction of natural gas pipelines, and preventing transition costs from the Federal Energy Regulatory

Commission's (FERC) interstate natural gas pipeline restructuring efforts (FERC Order 636) from being passed on to ratepayers.

Nevertheless, EPAct is perhaps the most comprehensive energy legislation ever enacted in the United States, being more extensive than the last "package" of energy legislation enacted during the Carter administration. EPAct amends portions of the legislation in that package, including the National Energy Conservation Policy Act of 1977, the Public Utilities Regulatory Policies Act of 1978 (PURPA), and the Natural Gas Policy Act of 1978. EPAct encompasses virtually all areas of energy policy: energy efficiency and conservation, oil and gas production and transportation, coal, electricity transmission and generation, renewable energy, alternative motor vehicle fuels, hydro-electric power, nuclear energy and radioactive waste, and global climate warming and greenhouse gas emissions.

The thrust of EPAct is to promote energy efficiency. It requires stricter energy efficiency standards for new commercial buildings and recommends higher standards for residential buildings. EPAct also requires stricter energy efficiency standards for lighting, appliances, motors, heating and cooling systems, and other products; sets water conservation standards; requires the Federal government to use energy more efficiently; encourages utilities and industries to invest in energy efficiency; and exempts from taxation energy efficiency rebates from utilities to residential consumers. EPAct fosters renewable energy by: increasing Federal support for research and development on renewable energy technology; indefinitely extending a 10% tax credit for business investments in renewable energy; and establishing a 1.5 cent per kwh tax credit for electricity generated from renewable sources.

EPAct amends the Public Utility Holding Company Act of 1935 to encourage competition in the electric utility generation and wholesale power market, and amends PURPA to encourage the use of Integrated Resource Planning techniques and demand-side management by utilities. In addition, EPAct promotes the use of alternative motor vehicle fuels by establishing minimum alternative fuel vehicle percentages for commercial and government motor vehicle fleets. EPAct also streamlines the licensing of nuclear power plants and establishes an uranium enrichment corporation.

EPAct has thirty separate Titles and over three hundred sections addressing how we manage our energy use and ultimately aiming to increase energy efficiency. It requires action by virtually all branches of the federal government, by the various power administrations operated by the government and by every state, territory and Indian Tribe. The following is a brief summary of some of the significant sections of EPAct that relate to this Report:

- **Title I** - Energy Efficiency. It contains sections on improving the efficiency of buildings and equipment, requires utilities to develop

Integrated Resources Plans to ensure the efficient use of energy and sets into place various incentives and requirements to ensure that efficiency improves in the residential, commercial, industrial and utility sectors.

- **Titles III - VI** deal with alternative motor fuels and requirements for vehicle fleet operators to convert their fleets to these domestic and less polluting fuels. There are requirements for federal state and private fleets contained within these sections.
- **Title VII** restructures electricity regulations to increase the competition of the electricity generation market as well as increasing access for transmission.
- **Title XII** expands the government's focus on renewable energy resources from research and development to commercialization and the establishment of a 1.5 cent per kwh tax credit for electricity generated from renewable sources.
- **Title XVI** establishes a least-cost energy strategy and a concurrent effort to reduce greenhouse gas emissions.
- **Title XIX** amends the Internal Revenue Code to provide a variety of tax deductions and incentives.

This Report identifies all mandatory requirements to states established by EPAct as well as the opportunities for action created by the Act for the State of Missouri. We define opportunities as instances where states or local governments are specifically mentioned by the Act and where, in our judgment, opportunities are created by its mandatory requirements.

Although our analysis is aimed primarily at state government, many of the requirements and opportunities go far beyond state government alone. In some instances, the report notes opportunities for state government in Missouri to assist other groups and entities in implementing requirements contained within EPAct. As the federal government and the Department of Energy have begun the process of *reinventing* how they provide programs and services, many of the specific activities will change over time. Indications are that this *reinventing* will serve to assist state and local governments to become more efficient within a more flexible framework.

This summary was prepared by relying on the final version of EPAct published with the Conference Report from the House-Senate committee. In addition, we have relied on various summaries of EPAct prepared by the following entities: the National Association of Regulatory Utility Commissioners; the National Regulatory Research Institute; the Association of Energy Engineers; the National Association of State Energy Officials; Foster Associates; Electric Utility Week; the Denver Regional Office of the U.S. DOE and the Ohio Office of Consumers' Counsel.

Title I - Energy Efficiency

Introduction

The energy efficiency improvements required in Title I will arguably result in the most significant benefits from EPAct. The provisions of Title I improve energy efficiency standards in building codes, set strong lighting, heating, ventilating and air conditioning (HVAC), and appliance energy and water efficiency standards, promote Integrated Resource Planning and energy efficiency incentives for utilities, increase federal funding and assistance for industrial energy efficiency, and set strict energy efficiency mandates and programs for reducing the federal government's energy consumption.

Subtitle A - Buildings

Section 101 - Building Energy Efficiency Standards

Section 101 requires states to establish a minimum commercial building energy code based on current voluntary codes developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for commercial buildings. States need to certify to the Secretary of DOE that they have reviewed and updated commercial building codes to meet or exceed ASHRAE standards by **October 24, 1994.**

States are required to review and encouraged, but not required, to update residential building codes to meet or exceed current voluntary codes developed by the Council of American Building Officials (CABO) for residential buildings. However, states must certify to DOE that they have reviewed and made a determination as to whether to adopt revised residential building codes by **October 24, 1994.**

A state can decide not to revise its residential building codes, but must submit to DOE the reasons for such determination by this date. Each states' determination on this issue must be made in writing and after a public notice and hearing. The availability of federal mortgage assistance (FHA, FMHA, VA) for new residential buildings is tied to compliance with minimum energy efficiency codes based on the current CABO voluntary residential building codes.

If ASHRAE or CABO standards are revised in the future, and if DOE determines that these revisions will save additional energy, each state has two years after the DOE's determination to further upgrade its standards to meet the new standards. DOE can grant extensions to any of the certification deadlines in § 101, if good faith efforts have been attempted. In addition, DOE can provide technical assistance and

funding (the amount, however, is unspecified) to help States implement the requirements of § 101.

OPTIONS:	•	Requires implementation of commercial building codes standards and certification to DOE by 10/24/94. If existing commercial codes are not up to standard, they must be updated.
	•	Requires (after public hearing) certification to DOE that Missouri has reviewed its residential building codes and decided whether or not to change them.
	•	Option of updating residential code; state can either: (a) do nothing or (b) update residential code, if needed.
RESPONSIBLE AGENCIES:		Since Missouri has "home rule" for setting building codes, local municipal and county governments would have to implement these. However, the most effective way to implement building standards (and meet the commercial building code requirement) would be through legislation. Division of Energy would be responsible for certification of residential building code review to DOE.

Section 102 - Residential Energy Efficiency Ratings

This section requires DOE to develop voluntary home energy rating guidelines by April, 1994 to be used by state and local governments, utilities, builders, real estate agents, mortgage lenders, and others to assist consumers in residential home purchasing decisions as well as to promote the use of energy efficient mortgages. By October, 1995, a report on the feasibility of a mandatory rating system for all federally insured mortgages must be completed by DOE.

OPTIONS:	•	do nothing;
	•	work with DOE to promote these standards
RESPONSIBLE AGENCIES:		Division of Energy, Missouri Housing Development Commission

Section 103 - Energy Efficient Lighting and Building Centers

Section 103 authorizes the establishment of Energy Efficient Lighting and Building Centers in each of the 10 federal regions in order to demonstrate building energy efficient technologies and to provide technical assistance to building professionals. To establish these centers, DOE is required to make grants to non-profit institutions or consortia which may consist of state and local governments, non-profit institutions, universities, and utilities. Section 103 specifies several activities and functions for these centers.

Funding for the Building Efficiency and Lighting Centers has been eliminated by Congress in FY 1994. Funding in FY 1995 is uncertain, at best. Establishment of a "Housing Technology Center" has been included in the just-released White House global climate change document entitled: The Climate Change Action Plan. These centers are very similar to those called for under EPAct. Funding may be provided for these centers in FY 1995 as part of this new initiative.

OPTIONS:	• do nothing; • support and/or assist in organizing a consortium and apply for grant
RESPONSIBLE AGENCIES:	Division of Energy, Department of Economic Development, EIERA, University System, Governor's Office

Section 104 - Manufactured Housing Energy Efficiency

This section requires the Secretary of Housing and Urban Development (HUD) to establish new energy efficiency standards for manufactured housing. States are allowed to establish their own standards at or above new HUD standards and current voluntary standards developed by ASHRAE.

OPTIONS:	• do nothing; • establish standards at or above new HUD standards
RESPONSIBLE AGENCIES:	Division of Energy, Public Service Commission

Sections 105 and 106 - Energy Efficient Mortgages and Pilot Program

Sections 105 defines energy efficient mortgages as mortgages that provide "financing incentives for the purchase of energy efficient homes, or for making energy efficiency improvements in existing homes by incorporating the cost of such

improvements in the mortgage." Section 106 establishes a pilot program for these mortgages to be run by HUD in five states. HUD has since announced that the five pilot states will include Alaska, Arkansas, California, Vermont and Virginia. HUD is required to expand the pilot program nationally by mid-1995 and make new housing eligible for the program.

OPTIONS:	•	do nothing;
	•	Monitor the HUD pilot program
RESPONSIBLE AGENCIES:		Division of Energy; Missouri housing agencies

Subtitle B - Utilities

Section 111 - Encouragement of Investments in Conservation and Energy Efficiency by Electric Utilities

Section 111 amends Section 111 of the Public Utilities Regulatory Policies Act of 1978 (PURPA) to include three additional PURPA regulatory standards: PURPA § 111(d)(7) - Integrated Resource Planning, PURPA § 111(d)(8) - Investments in Conservation and Demand Management and PURPA § 111(d)(9) - Energy Efficiency Investments in Power Generation and Supply. As with other PURPA standards, State public utilities commissions are directed to consider and make a determination as to whether adoption of these standards fulfills the purposes of PURPA (i.e., the encouragement of conservation, the efficient use of utility resources and equity in rates). EPAct also amended PURPA to require state public utilities commissions to begin their consideration of these new standards no later than **October 24, 1994**, and to make a determination by **October 24, 1995.**

PURPA § 111(d)(7) - Integrated Resource Planning requires electric utilities to use Integrated Resource Planning in their resource acquisition process.

PURPA § 111(d)(8) - Investments in Conservation and Demand Management requires that utility investments in DSM resources be at least as profitable as utility investments in new generation, transmission and distribution plant. This standard also requires appropriate consideration to income lost from reduced sales as a result of DSM investments, and for DSM measures to be appropriately monitored and evaluated.

PURPA § 111(d)(9) - Energy Efficiency Investments in Power Generation and Supply requires that utility rates be set in a manner that encourages investments in all cost-effective improvements in the energy efficiency of power generation, transmission and distribution. This standard also requires state commissions to consider the disincentives caused by existing ratemaking policies and any incentives to encourage better maintenance and investment in more efficient power generation, transmission and distribution equipment.

EPAct § 111 further amended PURPA to add PURPA § 111(c)(3) - *Protection for Small Business*. This section requires state commissions that adopt PURPA § 111(d)(7) (Integrated Resource Planning) or § 111(d)(8) (Investments in DSM) to consider the impact of implementation of such standards on small energy-conservation-related businesses. This section also provides that these small companies shall be protected from unfair competition by utilities.

OPTIONS:	• *Requires hearings to consider whether to adopt these standards; after hearings, can decide not to adopt*
RESPONSIBLE AGENCIES:	Public Service Commission
The Public Service Commission has fulfilled this requirement, by approving on April 9, 1993 a settlement agreement in Docket No. EO-93-222. In the agreement, various utilities, Commission staff, consumer advocates, and other parties agreed that the PSC has already satisfied these standards in its existing IRP rules (Docket Nos. EX-92-299 and OX-92-300).	

Section 112 - Energy Efficiency Grants to State Regulatory Authorities

Section 112 provides grants of up to $250,000 to state regulatory authorities for planning and program development activities to implement the new PURPA standards promulgated in Section 111. The grants can also be used to provide financial assistance to nonprofit subgrantees of DOE's Weatherization Program in state commission proceedings to examine energy efficiency of DSM programs.

OPTIONS:	• do nothing; • apply for grant
RESPONSIBLE AGENCIES:	Public Service Commission, Division of Energy

Sections 113 and 114 require the Tennessee Valley Authority and the Western Area Power Administration to develop and implement integrated resource plans. These sections contain no direct requirements or other suggestions to states.

Section 115 - Encouragement of Investments in Conservation and Energy Efficiency by Gas Utilities

Section 115 amends Section 303 of PURPA to include two additional PURPA regulatory standards for gas utilities: PURPA § 303(b)(3) - Integrated Resource Planning, and PURPA § 303(b)(4) - Investments in Conservation and Demand Management. As with other PURPA standards, state public utilities commissions are

directed to consider and make a determination as to whether adoption of these standards fulfills the purposes of PURPA (i.e., the encouragement of conservation, the efficient use of utility resources and equity in rates). EPAct also amended PURPA to require state public utilities commissions to consider and make a determination as to the adoption of these new standards no later than **October 24, 1994.**

PURPA § 303(b)(3) - Integrated Resource Planning requires gas utilities to use Integrated Resource Planning in their resource acquisition process.

PURPA § 303(b)(4) - Investments in Conservation and Demand Management requires that utility investments in DSM resources be at least as profitable as utility investments in new gas supplies and facilities. This standard also requires appropriate consideration to income lost from reduced sales as a result of DSM investments, and for utility revenues to be linked with the utility's performance in implementing DSM programs.

EPAct § 115 further amended PURPA to add PURPA § 303(d) - Small Business Impacts. This section requires state commissions that adopt PURPA § 303(b)(3) (Integrated Resource Planning) or § 303(b)(4) (Investments in DSM) to consider the impact of implementation of such standards on small energy-conservation-related businesses. This section also provides that these small companies shall be protected from unfair competition by utilities.

OPTIONS:	• Requires hearings to consider whether to adopt these standards; after hearings, can decide not to adopt
RESPONSIBLE AGENCIES:	Public Service Commission
The Commission has not yet promulgated an IRP rule for gas utilities. On 12/7/93, it opened a docket on gas IRP and on EPAct § 115 with a Prehearing Conference scheduled for 1/14/94. The published timetable is for the rules to be developed by the summer of 1994 and for them to go into effect, after appropriate hearings and approval, in July, 1995.	

Subtitle C - Appliance and Equipment Energy Efficiency Standards

Section 121 requires DOE to develop (in conjunction with industry) an energy efficiency rating and labeling program for windows and window systems. Section 122 requires test procedures and labeling rules and establishes minimum efficiency standards for commercial heating and air-conditioning equipment and electric motors. Section 123 requires DOE to establish test procedures and labeling rules for common types of fluorescent and incandescent reflector lamps. Section 123 also establishes minimum efficiency standards for fluorescent and incandescent reflector lamps. This

section also sets maximum flow rates for toilets, shower heads, faucets and other plumbing products.

Section 124 requires DOE to establish technologically feasible and economically justified efficiency standards for small electric motors, utility distribution transformers, and high-intensity discharge lamps. Sections 125 and 126 provides industry with the opportunity to establish voluntary energy efficiency information and/or labeling programs for commercial office equipment and luminaries. DOE can decide to establish such programs if it finds that industry's progress in these programs is insufficient. Sections 127 and 128 direct DOE to evaluate and report on the potential for the development and commercialization of high-efficiency appliances, and on utility early replacement programs for appliances.

The standards set in these sections will affect products sold and manufactured in Missouri, but do not require any direct action or provide any opportunities for state agencies.

Subtitle D - Industrial

Sections 131 - Energy Efficiency in Industrial Facilities

This section establishes an industrial energy efficiency grant program to encourage industry organizations to establish or strengthen their energy efficiency programs, including energy reporting and efficiency target requirements. The grants of up to $250,000 will fund industry organizations to foster industrial energy efficiency at up to a 75% federal cost share. Grants may be renewed at the discretion of the Secretary of Energy. In addition, the Secretary of Energy will establish an annual awards program to recognize improvements in energy efficiency.

OPTIONS:	• do nothing; • assist organizations to apply for grants
RESPONSIBLE AGENCIES:	Division of Energy

Section 132 - Process-Oriented Industrial Energy Efficiency

This section establishes a program of grants to states to encourage utilities and state governments to cooperate with local industries in assessing industrial energy efficiency opportunities in production processes, building operations and the use of renewable energy technology. The purpose of this section is to increase cooperation between utilities, government and industry through a variety of means. No specific funds, however, were appropriated for this section.

Section 133 - Industrial Insulation and Audit Guidelines

This section requires DOE to develop voluntary guidelines for industrial energy audits and for insulation levels in industrial equipment. This section does not require direct action or provide opportunities for action by state agencies.

Subtitle E - State and Local Assistance

Section 141 - Amendments to State Energy Conservation Program

Section 141 establishes a State Buildings Energy Incentive Fund of up to $1 million per state to establish a revolving fund for financing energy efficiency improvements in state and local government buildings. The funding is leverage capital that can be used for debt service or to encourage additional private investment. For a state to be eligible for this fund, the state (or a majority of local governments in the case of "home rule" for establishing building codes) must adopt building energy efficiency codes as stringent as ASHRAE Standard 90.1-1989 for commercial buildings and CABO Model Energy Code 1992 for residential buildings.

Section 141 also expands the existing federally-financed State Energy Conservation Program to include training and education of building designers and contractors in energy efficiency, programs for the development of building retrofit standards and programs to encourage renewable energy.

Congress has eliminated the Energy Extension Service and added many of its mandates to the State Energy Conservation Program to consolidate program administration and direction. The development of many of the components of this section have been deferred until FY 1994. It is anticipated that a full program will be initiated in FY 1995.

OPTIONS:	• do nothing; • establish building codes as stringent as ASHRAE/CABO codes and apply for $1 million fund • include new programs in State Energy Conservation Program
RESPONSIBLE AGENCIES:	Legislature and/or local governments for building codes, Office of Administration for fund application

Section 142 - Amendments to Low-Income Weatherization Assistance Program

Section 142 expands the existing federally-financed Low-Income Weatherization Assistance Program to: (a) allow utilities and other private sector investments, cost-sharing, and funds to support federal and state weatherization assistance programs for low-income housing; and, (b) include the use of solar thermal water heaters and wood-burning heating appliances in the program.

OPTIONS:	• do nothing; • coordinate private sector involvement in Low-Income Weatherization Program
RESPONSIBLE AGENCIES:	Division of Energy

Subtitle F - Federal Energy Management

The sections in this subtitle update and expand the existing Federal Energy Management Program to establish new energy goals and procedures and also, to integrate the efforts of the General Services Administration and the Office of Management and Budget with those of DOE and other agencies. The goal for all federal facilities is to reduce energy consumption by twenty percent per square foot by 2000 with the additional requirement that all measures with a ten year payback be installed by 2005.

This subtitle also requires DOE to establish regulations for the use of energy savings performance contracts to enable federal agencies to use private sector funding for federal energy efficiency improvements. The subtitle also expands coverage of federal energy management requirements to Congress and the U.S. Postal Service. This subtitle does not require direct action or provide opportunities for action by state agencies.

Subtitle G - Miscellaneous

The sections in this subtitle expand the scope and frequency of DOE energy data collection on energy efficiency and renewable energy, and require DOE to study district heating and cooling and vibration reduction technologies. This subtitle does not require direct action or provide opportunities for action by state agencies.

Title II - Natural Gas

Most of Title II was removed by the House-Senate conference committee during intense negotiations over the compromise bill. Provisions dropped included clauses prohibiting states from restricting natural gas production to boost prices ("pro-rationing"), streamlining the permitting process for construction of natural gas pipelines and preventing transition costs from FERC's interstate natural gas pipeline restructuring efforts (FERC Order 636) from being passed on to ratepayers.

The resulting Title II consists of only two sections. Section 201 prevents price discrimination, surcharges, or other preferential treatment for imported natural gas. This provision is aimed at enforcing upon domestic production, the same straight fixed variable rate design used for Canadian supplies. Section 202 states that Congress believes gas consumers and producers, as well as the national economy, are best served by a competitive natural gas wellhead market. This section is interpreted as Congress stating that the federal government can preempt or take action against state natural gas prorationing laws and practices done for the purpose of artificially raising gas prices.

Title II contains no requirements or opportunities for action by state agencies. However, Section 202 can be interpreted as a warning to states engaging in the prorationing of gas supplies.

It is important to note that other sections in EPAct encourage the use of natural gas and further research and development efforts, especially in buildings, utilities and alternative fuel vehicles. DOE is currently developing a comprehensive Natural Gas Strategic Plan that will likely be released by mid-1994.

Title III - Alternative Fuels - General

Title III requires the federal government to focus its automobile, light truck and other vehicle fleet purchases on alternative-fueled and dual-fueled vehicles. The qualifying alternative fuels include methanol, denatured ethanol, other alcohols and mixes (85% or greater by volume) of these fuels with gasoline or other fuels; natural gas and liquified petroleum gas; hydrogen; coal-derived liquid fuels, fuels derived from biological materials and electricity (including solar). This Title sets minimum federal fleet percentage requirements for alternative-fueled vehicles, encourages public refueling stations by requiring federal alternative-fueled vehicles to refuel at public stations to the maximum extent practicable and establishes incentives for agencies to exceed the program requirements.

Section 303 contains the following required minimum alternative-fueled vehicle purchases by **federal fleets.** By fiscal year:

- 1993, 5,000 vehicles must be purchased;
- 1994, 7,500 vehicles must be purchased;
- 1995, 10,000 vehicles must be purchased;
- 1996, 25% of vehicles purchased must be alternative-fueled;
- 1997, 33% of vehicles purchased must be alternative-fueled;
- 1998, 50% of vehicles purchased must be alternative-fueled;
- 1999 and thereafter, 75% of vehicles purchased must be alternative-fueled.

On April 21, 1993, President Clinton signed Executive Order 12844, which accelerates the introduction of alternative fueled vehicles (AFV) into the federal fleet by increasing the federal AFV purchase requirements by 50% over those outlined in EPAct. At present, it is unclear if sufficient funding is available to meet these increased purchase requirements fully, but EPAct purchase levels will be exceeded in all likelihood.

Title III contains no requirements or opportunities for action by state agencies. However, the federal fleet requirements create significant business opportunities for public refueling stations for alternative fuels.

Title IV - Alternative Fuels - Non Federal Programs

Title IV encourages the development of natural gas and electric vehicles, establishes public information programs, labeling requirements and data collection programs for alternative fuels, promotes incentives for state and local government alternative fuels programs and establishes a low-interest loan program for alternative fuel vehicles.

Sections 401-403 primarily expand the definition of alternative fuels for certain motor-vehicle-related legislation. Section 404 amends the Natural Gas Act by exempting from the provisions of this Act any seller or transporter of vehicular natural gas (VNG) who (1) is not otherwise a natural gas company, or (2) is subject primarily to regulation by a state commission (whether or not the state is exercising such jurisdiction). This section also exempts VNG from the Public Utility Holding Company Act (PUHCA). Thus, a company will not be considered a gas utility company under PUHCA solely because it owns or operates facilities distributing VNG for transportation purposes. Sections 405 through 407 establish public information programs, labeling requirements, and data collection programs for alternative fuels.

Section 408 authorizes the FERC to allow cost recovery of expenses in advance by natural gas companies for research, development and demonstration activities by the Gas Research Institute (GRI) for transportation-related and emissions-related natural gas projects. This section also gives FERC the authority to allow cost recovery of expenses by electric utilities in advance for the same activities by the Electric Power Institute (EPRI) for projects on electric motor vehicles.

Sections 401-408 contain no requirements or opportunities for action by state agencies. However, the Public Service Commission should be aware of the cost recovery treatment of GRI and EPRI expenses in its review of GRI and EPRI dues paid by natural gas and electric utilities.

Section 409 - State and Local Incentives Programs

Section 409 requires DOE to issue regulations by October 24, 1993 that establish guidelines for comprehensive state alternative fuels and alternative fuel vehicle incentives as well as establish program plans designed to accelerate the introduction and use of such fuels and vehicles. This section also requires DOE to "invite" each Governor to submit a state plan to DOE within one year of the effective date of the DOE regulations discussed above, and makes federal funding and assistance available to states that submit plans and are approved by DOE.

The state plan must include provisions designed to result in progress toward and achievement of, the goal of introducing substantial numbers of alternative fuel

vehicles in such state by the year 2000, and a detailed description of the requirements, including the estimated cost of implementation of such a plan. In order for States to be eligible for federal assistance under Section 409, the plan would have to describe how state, federal and local governmental entities would coordinate in implementing the plan.

If the Governor requests further assistance (after the state plan has been approved by DOE), DOE may provide information and technical assistance, grants to assist states in implementing any part of the plan, and grants for acquisition of alternative fuel vehicles. DOE must also assist states in procuring alternative fuel vehicles, including coordination with similar federal procurement programs. States must provide at least a 20 percent match as part of the grant program.

Congress authorized $10 million per year for five years (1993-1997) to implement this section. The issuance of regulations by DOE is delayed until at least June, 1994. Current plans call for the program to be underway in FY 1995.

OPTIONS:	• do nothing; • develop state plan for alternative fuels and alternatively-fueled vehicles, and apply for DOE grants and assistance.
RESPONSIBLE AGENCIES:	Division of Energy, Office of Administration

Section 410 - Alternative Fuel Bus Program

The U.S. Department of Transportation may enter into cooperative agreements and joint ventures with municipal, county, or regional governments in urban areas with over 100,000 population for commercial demonstration programs of alternative fueled vehicles used in mass transit. To be eligible for federal assistance, the agreements and joint ventures must require the local government to provide at least 20 percent of the costs of the program. School buses may also be included in this program. Congress authorized $30 million per year for 1993-95 for this program.

OPTIONS:	• do nothing; • establish agreement or joint venture with USDOT to conduct program, and apply for USDOT grants and assistance
RESPONSIBLE AGENCIES:	Division of Energy, municipal and county governments and mass transit authorities

Sections 411-413 require DOE to establish programs for the certification of training programs for motor-vehicle alternative fuel conversions technicians; to study the use of alternative fuels in off-road industrial and commercial vehicles (including airports), marine engines, and railroad vehicles; and report to Congress on topics related to alternative fuel vehicles. Sections 411-413 contain no requirements or opportunities for action by state agencies.

Section 414 - Low Interest Loan Program

EPAct required that by October 24, 1993, DOE was to have established a low interest loan program, with preference to small businesses, to convert or purchase alternative-fueled vehicles. Repayment schedules would be based on the difference between the cost of gasoline and the cost of fuel on which the motor vehicle would operate. Congress authorized $250 million per year for 1993-95. But funding has not been made available to DOE for this program and so the program is deferred indefinitely.

OPTIONS:	• do nothing; • in conjunction with opportunities pursuant to Sections 409 and 410, encourage participation in loan programs when developed (see also § 507, below)
RESPONSIBLE AGENCIES:	Division of Energy, Department of Economic Development

Title V - Availability and use of Replacement Fuels, Alternative Fuels and Alternative Fueled Private Vehicles

Title V primarily establishes minimum requirements for alternative fuel vehicles for non-federal fleets. The requirements vary for alternative fuel providers, state fleets, and other private fleets.

Section 501 requires alternative fuel providers (including natural gas and electric utilities) to have a certain percentage of their new light duty motor vehicles to be alternative fueled vehicles. For **providers of alternative fuels other than electricity** (primarily natural gas companies -- pipelines, producers, distribution companies, etc.), the percentages and model years would be:

- 30% for model year 1996 purchases;
- 50% for model year 1997 purchases;
- 70% for model year 1998 purchases; and
- 90% for model years 1999 and thereafter.

However, if the vehicles are not readily available in the area in which they are to be operated, the company would be exempt. DOE can revise the percentage requirement downward for models 1997 and beyond (but not to less than 20%) and can extend the time for up to 2 model years. Electric utilities and wholesale electricity generators will have to comply with these percentage requirements beginning January 1, 1998.

Section 501 contains no requirements or opportunities for action by state agencies. However, the Public Service Commission should be aware of these requirements in determining the cost recovery and ratemaking treatment for these alternative-fuel-related expenses by natural gas and electric utilities.

Section 502 requires DOE to establish a program to promote the use of alternative fuels as replacement fuels attempting to meet the goals of replacing 10% of the projected consumption of motor fuel in the U.S. by 2000 and 30% by 2010, with at least half of the replacement fuels being from domestic sources. Sections 503-506 require DOE to obtain certain fuel demand estimates and fuel supply information; allow DOE to review and modify the goals set in § 502; direct DOE to get voluntary supply commitments from alternative fuel suppliers; and require DOE to conduct a technical and policy analysis of the alternative fuel provisions of the Act. These sections contain no requirements or opportunities for action by state agencies.

Section 507 - Fleet Requirement Program

Section 507 requires entities acquiring or owning light duty motor vehicles that are not part of federal or state government or were not subject to Section 501 to achieve a certain percentage of alternative fueled vehicles in the vehicles acquired after 1998. **Anyone purchasing a fleet of new cars or other light duty vehicles** after 1998 must meet the alternative fueled vehicles requirements unless these requirements are revised by DOE. The requirements are as follows:

- 20% for model years 1999, 2000, and 2001 purchases;
- 30% for model year 2002 purchases;
- 40% for model year 2003 purchases;
- 50% for model year 2004 purchases;
- 60% for model year 2005; and
- 70% for model years 2006 and thereafter.

However, DOE can make a determination (by January 1, 2000) that a fleet requirement program is not necessary. If DOE does determine (by January 1, 2000) that a fleet requirement program is necessary, it can establish the following alternative fuel vehicle private fleet requirements:

- 20% for model year 2002 purchases;
- 40% for model year 2003 purchases;
- 60% for model year 2004 purchases; and
- 70% for model years 2005 and thereafter.

DOE can revise downward or extend compliance dates for any of these requirements.

Section 507(o) requires **state fleets** (but <u>not</u> municipal fleets) to purchase the following percentages of new vehicles to be alternative fuel vehicles:

- 10% for model year 1996 purchases;
- 15% for model year 1997 purchases;
- 25% for model year 1998 purchases;
- 50% for model year 1999 purchases; and
- 75% for model years 2000 and thereafter.

DOE is required to promulgate rules to implement the state fleet program by April 24, 1994. The rules must allow states to file a plan for state-owned alternative fuel vehicles that, if approved by DOE, can be implemented by states in lieu of the percentage requirements in § 507(o). The plan must be filed within a year of the promulgation of State fleet program rules by DOE.

OPTIONS:	•	requires purchase of alternative fuel vehicles to comply with percentage requirements;
	•	pursuant to DOE regulations, file alternative fuel vehicle plan for implementation in lieu of percentage requirements.
RESPONSIBLE AGENCIES:		Office of Administration, other vehicle-purchasing agencies; Division of Energy for alternative fuel vehicles plan

In addition, state agencies considering the opportunities provided by Title IV, above, may wish to be prepared to coordinate informational efforts on the low-interest loan program (§ 414), if and when it is developed, in light of the private fleet requirements in § 507.

Title VI - Electric Motor Vehicles

Title VI primarily encourages the development of electric motor vehicles and related technologies. Subtitle A of Title VI requires DOE to establish an electric motor vehicle commercial demonstration program in consultation with program site operators, manufacturers, the electric utility industry, and others to evaluate field operation, fleet operation, and necessary supporting infrastructure.

By April 24, 1994, DOE must issue a solicitation for proposals to demonstrate this equipment in one or more metropolitan areas. A minimum of 50 percent of the project funds must be derived from non-federal sources. Congress authorized a total of $50 million for the 10-year period beginning in fiscal year 1994. However a lack of funds has caused this program to be deferred indefinitely.

Subtitle B of Title VI requires DOE to establish a program to provide financial assistance to non-federal entities for cost-shared research, development and demonstration of stations to service electric vehicles or service related equipment, installation of charging facilities, rates and cost recovery for electric utilities who invest in infrastructure, capital-related expenditures, health and safety procedures and guidelines related to batteries and emissions, and other related items as deemed necessary by DOE. The program would distribute up to $4 million per project to no more than 10 projects, and is authorized by Congress to receive a total of $40 million in funds for the 5-year period beginning with fiscal year 1994. This program will begin at a start-up level in FY 1994 and expand in subsequent years as funding permits.

The sections in Title IV contain no requirements or opportunities for action by State agencies, with the exception of § 625, below.

Section 625 - Electric Utility Participation Study

Section 625 requires DOE to consult with appropriate federal agencies, representatives of state utility regulatory commissions, electric utilities, and others as appropriate in undertaking a study to determine the means through which electric utilities may invest in, own, sell, lease, service or recharge batteries used to power electric motor vehicles.

OPTIONS:	• do nothing; • participate actively in study
RESPONSIBLE AGENCIES:	Public Service Commission

Title VII - Electricity

Title VII represents the most significant restructuring of electricity regulations since the passage of PURPA in 1978. Reform of the Public Utilities Holding Company Act of 1935 (PUHCA) has been discussed in Washington and urged by both regulators and the electric industry for years. Title VII provides PUHCA reform to allow for a more competitive electricity generation market, as well as a framework for increased electricity transmission access.

Subtitle A - Exempt Wholesale Generators

Section 711 - Public Utility Holding Company Act Reform

Section 711 amends PUHCA to allow entities known as "exempt wholesale generators" (EWGs) to independently generate and sell power at wholesale without being subject to PUHCA's restrictions on corporate structure. A firm seeking EWG status must apply to FERC for a determination that it meets certain statutory criteria, and FERC must make this determination within 60 days of application.

An EWG may lease as well as own and operate "eligible facilities," but the wholesale transaction would be treated as any other wholesale sale subject to the same rules governing those eligible facilities owned and/or operated by utility affiliates (or other entities as applicable). Eligible facilities are defined as plants used for generation of electric energy exclusively for sale at wholesale, or facilities generating electricity and leased to one or more public utilities (including interconnecting transmission facilities required to effect the sale).

Facilities may be spun off a utility's rate base and be owned by EWGs subject to approval by state utility regulatory commissions. To approve a spin-off, a state commission must make a specific determination that the change will benefit consumers, is in the public interest, and does not violate state law. In the case of a registered holding company, this determination must be made by each state commission with jurisdiction over the retail rates of the utility's affiliates.

State commission approval is also a prerequisite for operation of hybrid facilities (i.e., facilities owned in part by an EWG and included in part in the rate base of a nonaffiliated electric utility). No EWG may share ownership or operation of a portion of any facility with an affiliate or associate of the EWG.

An EWG may not contract to sell power to an affiliated electric utility unless each state commission with jurisdiction over the utility's retail rates determines in advance that the state has sufficient authority, resources, and access to books and records to exercise its duties, and that the transaction will benefit consumers, not

violate state law, not provide the EWG a competitive advantage, and be in the public interest. Similarly, after enactment, an electric utility company may not enter into a contract to purchase electric energy at wholesale form an EWG affiliate or associate unless permitted by the state commission.

A registered holding company may (without pre-approval) acquire and hold securities or an interest in the business of one or more EWGs. However, the issuance of securities by a registered holding company for purposes of financing the acquisition of an EWG, the guarantee of securities, the entering into services, sales or construction contracts and the creation or maintenance of any other relationship, shall remain subject to the jurisdiction of the Securities and Exchange Commission (SEC). SEC is directed to promulgate regulations to ensure that such acquisition has no adverse impact on any utility subsidiary or its customers or on the ability of the State commissions to protect such interests.

OPTIONS:	•	The extensive reform of PUHCA does not require any immediate action by states. However, the Public Service Commission has gained significant additional responsibilities as a result of this section. EWGs will be requesting action from the PSC on the issues described above.
RESPONSIBLE AGENCIES:		Public Service Commission

Section 712 - State Consideration of the Effects of Power Purchases on Utility Cost of Capital; Consideration of the Effects of Leveraged Capital Structures on the Reliability of Wholesale Power Sellers; and Consideration of Adequate Fuel Supplies

Section 712 amends PURPA § 111(d) by adding an additional paragraph (10) requiring state commissions to consider and determine whether to adopt, in whole or in part, a standard requiring a general evaluation of four issues listed below related to long-term purchases of wholesale power:

(1) the potential for increases or decreases in the costs of capital of electric utilities, and any resulting increases or decreases in the retail rates paid by electric consumers, that may result from purchases of long-term wholesale power supplies in lieu of the construction of new generation facilities by utilities;

(2) whether the use by EWGs of capital structures which employ proportionately greater amounts of debt than the capital structures of electric utilities threatens reliability or provides an unfair advantage for EWGs over utilities;

(3) whether to implement procedures for the advance approval or disapproval of the purchase of a particular long-term wholesale power supply; and
(4) whether to require as a condition for approval of the purchase of power that there be reasonable assurances of fuel supply adequacy.

EPAct section 712 requires state commissions to complete their consideration and determination of whether to adopt this standard by **October 24, 1993**. Because § 712 is a new PURPA § 111 standard, review of whether to adopt section 712 should take into account whether adoption fulfills the purposes of PURPA, namely, does adoption encourage energy conservation, the efficient use of utility resources and equitable rates to consumers.

OPTIONS:	• Requires hearings to consider whether to adopt these standards; after hearings, can decide not to adopt
RESPONSIBLE AGENCIES:	Public Service Commission
On July 6, 1993, the Public Service Commission held a hearing in this matter (Docket No. EO-93-218) where a settlement agreement was presented to the Commission. In the agreement, various utilities, Commission staff, consumer advocates, and other parties agreed that there was no need to establish generic standards for purchased power, and that these issues should be considered on a case-by-case basis within the Commission's IRP framework. As of 9/22/93, the Commission had not acted on this settlement.	

Section 713 allows registered holding companies under PUHCA to acquire an interest in any qualifying cogeneration facilities and small power production facilities as defined by PURPA and shall qualify for any exemption of such facilities provided under the law. Section 714 permits state commissions to obtain and examine books and records of EWGs.

Section 715 allows EWGs to own facilities outside the U.S. and preserves the right of such owners to sell power at wholesale and retail at those facilities. Registered holding companies would be allowed to own foreign affiliates but would have to assure the SEC that the U.S. customers of the utility and the holding company system would be protected. State utility regulatory commissions would make recommendations to the SEC regarding the holding company's relationship to the foreign utility and the SEC would have to "reasonably and fully consider such state recommendations." Exempt holding companies would have to obtain permission from each state commission with jurisdiction over retail utility rates. The state commission would have to certify that it had adequate authority and resources to protect consumers from harm, that there would be no harm resulting from these

investments, and that the diversification would not impair the ability of a PUC to effectively regulate the operation of such a company. A utility holding company would also be banned from pledging or guaranteeing any utility assets to indemnify the foreign subsidiary.

Sections 713-715 contain no requirements or opportunities for action by state agencies. However, the Public Service Commission has gained significant additional responsibilities as a result of § 715. EWGs will be requesting action from the PSC on the issues described above.

Subtitle B - Federal Power Act; Interstate Commerce in Electricity

Subtitle B of Title VII amends the Federal Power Act to permit any utility, federal power marketing agency, or other entity generating electric power for wholesale (cogenerators and small power producers) to apply to FERC for an order requiring a transmitting utility to provide wholesale transmission services, including enlargement of transmission capacity. Subtitle B also requires the FERC to establish rates, charges and terms to permit utilities to recover all costs, including and not limited to an appropriate share of legitimate verifiable and economic costs, and enlargement if necessary. Under the amended rules, FERC will determine whether a wholesale transmission arrangement is in the public interest or interferes with existing utility service reliability. Rates, charges, terms and conditions for wholesale transmission and associated services must be just and reasonable and not unduly discriminatory or preferential.

FERC's authority to order transmission services applies to any electric utility, qualifying cogeneration or small power production facility, or federal power marketing agency with wholesale transmission facilities. FERC cannot issue a transmission order unless the applicant makes a request for service to the transmitting utility at least 60 days earlier. This Subtitle also bans mandatory "retail wheeling" to direct customers. However, a clause is included to preserve existing state laws which either prohibit or permit retail wheeling.

By October 24, 1993, FERC must promulgate a rule requiring transmitting utilities to submit information annually identifying what transmission capacity is potentially available and any possible known constraints. Subtitle B contains no direct requirements or opportunities for action by state agencies. It is important to note that Subtitle B specifically preserves the right of states to mandate or prohibit retail transmission of electricity.

The last provision of Title VII, Subtitle C, only states that nothing in Title VII shall preempt environmental protection and facilities siting regulations of state and local governments.

Title VIII -- High-Level Radioactive Waste

Title VIII primarily requires the Environmental Protection Agency to promulgate high level waste standards at the proposed Yucca Mountain repository based upon and consistent with the findings and recommendations of the National Academy of Sciences to prescribe maximum annual effective doses to which individual members of the public can be exposed to from radioactive releases related to the site. The new standard will be the only standards applicable to the Yucca Mountain site.

Title VIII contains no requirements or opportunities for action by state agencies.

Title IX -- United States Enrichment Corporation

Title IX amends the Atomic Energy Act of 1954 to create a new privatized uranium enrichment enterprise, and authorizes this new enterprise to lease the existing federal uranium enrichment facilities. Title IX contains no requirements or opportunities for action by state agencies.

Title X -- Remedial Action and Uranium Revitalization
Title XI -- Uranium Enrichment Health, Safety and Environment Issues

Title X and XI stipulate that the costs of decontamination, decommissioning and other remedial actions at active uranium or thorium processing sites are to be paid by the holders of Atomic Energy Act Sections 62 and 81 licenses (including utilities owning nuclear power plants). Costs for all of the domestic utility licenses combined are limited to a maximum exposure of $150 million per year, or $2.25 billion (adjusted for inflation) over 15 years.

Titles X and XI contain no requirements or opportunities for action by state agencies. However, the Public Service Commission should note the cap on remedial costs for utilities that own nuclear generating stations.

Title XII -- Renewable Energy

Title XII significantly expands the federal government's efforts to foster renewable energy sources. Title XII increases federal funding and support for research and development on renewable energy technology, and establishes a 1.5 cent per kWh incentive payment for electricity generated from renewable sources owned by state and local governments and non-profit electric cooperatives.

Section 1201 states that the purposes of Title XII are to promote: (a) increases in the production and utilization of energy from renewable energy sources; (b) advances in renewable energy technologies; and, (c) exports of U.S. renewable energy technologies and services.

Section 1202 requires DOE to establish a Demonstration and Commercial Application Project for renewable energy and energy efficiency technologies. The program will focus on projects that would, among others, need federal involvement to speed commercialization, have significant market potential, significantly advance the technology, have environmental benefit, have export potential, be likely to succeed and contain significant private or other non-federal funding. The project technologies list is expansive. The program includes an authorization for up to $50 million for project grants for fiscal year 1994, with DOE required to solicit proposals for projects within nine months of enactment.

Section 1203 requires DOE to establish a training program for developing countries in the operation and maintenance of renewable energy and energy efficiency technologies. Section 1204 authorizes DOE to make Renewable Energy Advancement Awards in recognition of advances in the practical application of renewable energy technologies. Sections 1201-1204 contain no requirements or opportunities for action by state agencies.

Section 1205: Study of Tax and Rate Treatment of Renewable Energy Projects

This section requires DOE to work with state utility regulatory commissions to determine and report to Congress by October 24, 1994 if conventional taxation and ratemaking procedures result in economic barriers to, or incentives for renewable energy facilities compared to conventional power plants.

OPTIONS:	• do nothing; • participate actively in study
RESPONSIBLE AGENCIES:	Public Service Commission

Section 1206 requires DOE to conduct a study of the marketing of energy byproducts from rice milling. Sections 1207-1211 establish a federal interagency working group to encourage exports of renewable energy and energy efficiency products and services. Sections 1206-1211 contain no requirements or opportunities for action by state agencies.

Section 1212 - Renewable Energy Production Incentive

Section 1212 requires DOE to provide (subject to the appropriation of funds) incentive payments of 1.5 cents per kilowatt hour of electricity generated by the facility through the use of solar, wind, biomass or geothermal energy. The payments apply to facilities constructed and started up during the 10-year fiscal period from 1993-2002 which were and owned and operated by state governments, municipalities, other local governmental entities or non-profit electric cooperatives. These payments would be made by the DOE for a 20-year time period. The term biomass energy explicitly excludes municipal solid waste incineration.

OPTIONS:	• do nothing; • encourage municipalities or other agencies involved in the generation, transmission and distribution of electricity to take advantage of credit
RESPONSIBLE AGENCIES:	Division of Energy; Public Service Commission

Title XIII - Coal

Title XIII primarily provides support for clean coal technologies by authorizing funding of research, development and demonstration programs. Provisions also encourage the commercialization and exports of coal technologies.

Subtitle A - Research, Development, Demonstration, and Commercial Application

Subtitle A requires DOE to conduct programs for research, development, demonstration, and commercial application of coal technologies in a way which meets certain goals and objectives such as: reliability of electricity supply; environmental compliance; achievement of the same or lower emission of NO_x, SO_2, air toxics, greenhouse gases or solid and liquid wastes, than currently available commercial technology; cost-competitive conversion of coal to transportation fuels; and, the availability for commercial use of such technologies by the year 2000. The Subtitle also requires DOE to establish research, development and demonstration programs for coal-fired diesel engines, clean coal in combination with waste-to-energy, non-fuel use of coal, advanced coal refining, enhanced coal-bed methane recovery, metallurgical coal development, coal by-products utilization, underground coal gasification, low-rank coal, coal liquefaction (to substitute for oil) and magnetohydrodynamics. Congress authorized $278 million for fiscal 1993, and similar sums as necessary for fiscal 1994-1997 for these programs.

Subtitle A contains no requirements or opportunities for action by state agencies.

Subtitle B - Clean Coal Technology Program

Subtitle B establishes criteria and guidance to DOE, and authorizes DOE to consider the potential benefits, and, if warranted, carry out additional solicitations similar in scope and federal cost-share percentages as those previously mandated for the Clean Coal Technology Program. Subtitle B contains no requirements or opportunities for action by state agencies.

Subtitle C - Other Coal Provisions

Sections 1331-1334 of Subtitle C create an interagency working group for promotion of clean coal technology exports, technology transfer, and study of utilization of clean coal technology byproducts and coal combustion byproducts. For innovative clean coal technologies, $100 million was authorized for each fiscal year 1993-1998. These sections contain no requirements or opportunities for action by state agencies.

Section 1335 - Calculation of Avoided Cost

Section 1335 states that state commissions do not need to treat costs incurred during construction or operation of a clean coal technology project that is part of the DOE Clean Coal Program as incremental costs (i.e., avoided costs) of alternative energy.

Although this section does not contain any requirements or opportunities for action by state agencies, the Public Service Commission should be aware of this section when reviewing estimates of avoided costs of Missouri electric utilities.

Sections 1336-1338 require DOE to conduct a study on coal fuel mixture technologies, to establish an national clearinghouse for coal technology information, and to prepare a plan for expanding U.S. coal exports. These sections contain no requirements or opportunities for action by state agencies.

Section 1339, Ownership of Coal-bed Methane, requires each affected state to promulgate a regulation or pass a law promoting the permitting, production and drilling of coal-bed methane wells within 3 1/2 years of enactment. Missouri is not on of the affected states.

Finally, Section 1340 requires DOE to review and establish a database of transportation rates for domestic oil, coal, and gas. This section contains no requirements or opportunities for action by state agencies.

Title XIV -- Strategic Petroleum Reserve

Title XIV amends the Energy Policy and Conservation Act to broaden the President's powers to authorize a draw-down and distribution of oil in the reserve. This Title also requires the President to enlarge the existing reserve to 1 billion barrels as rapidly as possible (75% of which must be stored in U.S.-owned facilities). Title XIV authorizes funding for leasing of property and purchases of domestic production from stripper well properties for reserve storage. Title XIV contains no requirements or opportunities for action by state agencies.

Title XV -- Octane Display and Disclosure

Title XV extends the requirements for the display and disclosure of octane ratings to all liquid fuels for use in any motor vehicle. The Title preempts any state from adopting octane ratings-related laws or regulations that are less stringent than those contained in the Title and the Petroleum Marketing Practices Act. Title XV also expands authority for EPA enforcement, certification and posting of automotive fuel ratings. Finally, the Title requires several federal agencies to conduct studies on ratings display and disclosure requirements. Title XV contains no requirements or opportunities for action by state agencies.

Title XVI -- Global Climate Change

Title XVI requires DOE to study and report to Congress on the effects of greenhouse gas emissions worldwide. It requires DOE to prepare a least-cost energy strategy plan. The Title requires DOE to develop guidelines for the voluntary reporting of greenhouse gases and develop a national inventory of greenhouse gas emissions. The Title requires DOE to establish an environmental technology transfer program to encourage the export of pollutant-reduction technologies.

The goals established by this section include an increase in efficiency by 2010 of thirty percent over 1988, an increase in the percentage of energy from renewable sources by 2005 of seventy-five percent from 1988, and a reduction in the amount of oil consumed out of the total energy usage from forty percent in 1990 to thirty-five percent in 2005. Title XVI contains no requirements or opportunities for action by state agencies.

Title XVII -- Additional Federal Power Act Provisions

Title XVII primarily revises FERC's regulatory definition of the term "fishway" as applied to federal power licensing applications covered by the Federal Power Act. Title XVII contains no requirements or opportunities for action by state agencies.

Title XVIII -- Oil Pipeline Regulatory Reform

Title XVIII requires FERC to issue a final rule by October 24, 1993 establishing a simplified and general ratemaking methodology for oil pipelines. At the same time, FERC must develop a final rule, for issuance not later than April 24, 1994, to streamline FERC procedures in order to reduce costs and delays in oil pipeline ratemaking cases. The Title encourages alternative dispute resolution mechanisms (e.g., arbitration) to resolve rate disputes. In general, oil pipeline rates existing at least one year prior to enactment will be deemed just and reasonable if they were not subject to investigation, protest or complaint during that year. Title XVIII contains no requirements or opportunities for action by state agencies.

Title XIX -- Revenue Provisions

Title XIX amends the Internal Revenue Code of 1986 to provide a variety of tax deductions and incentives. Notable tax changes include: deductions and tax credits for clean-fuel vehicles and related investments; a 1.5 cents per kWh tax credit for electricity generated from renewable energy sources; an indefinite reinstatement of a 10% tax credit for business investments in renewable energy; and an exemption from taxable income for rebates paid by utilities to residential customers for the purchase or installation of energy conservation measures.

Subtitle A - Energy Conservation and Production Incentives

Section 1911 of Subtitle A sets a maximum amount of qualified parking expense that is excludable from an employee's gross income. Other transportation fringe benefits are also restricted.

Section 1912 excludes from gross income (for tax purposes) utility subsidies for the purchase or installation of energy conservation measures. The Public Service Commission, although not required to act, should note this encouragement of utility conservation efforts.

Section 1913 provides limited deductions for the incremental cost of qualified clean-fuel vehicle property as follows:

- Light duty motor vehicle weighing less than 10,000 pounds - $2,000
- Medium duty trucks/vans weighing 10,000 to 26,000 pounds - $5,000
- Heavy duty trucks/vans over 26,000 pounds - $50,000
- Buses over 20 passenger - $50,000
- Refueling centers for alternative fueled vehicles - up to $100,000
- Electric vehicles a 10% investment tax credit, up to $4,000, for the cost of qualifying electric vehicle investments by reducing the basis for which a credit is allowable.

Section 1914 provides a 1.5 cents/kWh tax credit for electricity generated from qualified wind and biomass facilities constructed after December 31, 1993 for wind and December 31, 1992 for closed loop biomass energy. The production incentive tax credit would be reduced by the amount of other federal tax assistance, tax exempt bonds or subsidized energy financing. Otherwise, the credit would be increased based on inflation rates.

Section 1915 repeals certain minimum tax preferences for depletion and intangible drilling costs for independent oil and gas production companies, except for integrated oil companies. Section 1916 extends indefinitely the 10% business investment tax credit for qualified solar and geothermal energy property, with an

effective date of June 30, 1992. Section 1917 repeals federal investment restrictions that apply to nuclear decommissioning funds, beginning with tax year 1993. In addition, it reduces the rate of tax burden on the income of decommissioning funds from 34% to 22% for tax years 1994-95, and to 20% for tax years after 1995.

Under Section 1918, a facility that produces gas from biomass or produces solid synthetic fuels from coal will qualify for a production credit equal to $3 per barrel or per Btu of oil equivalent if it is placed in service prior to January 1, 1997 pursuant to a written binding contract in effect before January 1, 1996. Section 1919 reduces tax rates on gasohol fuels. Section 1921 provides tax-exempt financing for environmental enhancements at hydroelectric generating facilities. Finally, Section 1922 modifies the tax credit given for payments to the Trans-Alaska Pipeline Liability Fund.

The provisions in Subtitle A contain no requirements or opportunities for action by state agencies. However, the Public Service Commission may wish to encourage utilities to take advantage of **Section 1914's 1.5 cent/kWh tax credit** for renewable energy projects.

Subtitle B - Revenue Increases

Subtitle B increases tax rates on ozone-depleting chemicals and changes several non-energy-related provisions of the tax code. The Subtitle also establishes a framework to allow for continued health benefits for retired miners.

The provisions in Subtitle B contain no requirements or opportunities for action by state agencies.

Subtitle C - Health Care for Coal Miners

Subtitle C establishes a new fund to provide health and death benefits for retired coal miners and their dependents. This fund would be mainly financed by insurance premiums on assigned operators.

The provisions in Subtitle C contain no requirements or opportunities for action by state agencies.

Title XX -- General Provisions; Reduction of Oil Vulnerability

Title XX establishes various programs to be conducted by DOE relating to oil and gas supply and demand enhancement. DOE must conduct separate five-year programs on increasing the recoverability of domestic oil resources, on oil shale extraction and conversion technologies, on increasing the recoverability of natural gas resources, on co-firing natural gas with coal in utility and large industrial boilers and on natural gas end use technologies. This Title also requires DOE to conduct studies on oil and gas demand reduction programs aimed at improving motor vehicle fuel economy, and especially advancing applications of alternative fuel technologies. Finally, Title XX requires DOE to conduct studies on renewable hydrogen energy systems, diesel emissions reduction technologies, and the potential costs and benefits of telecommuting. Title XX contains no requirements or opportunities for action by state agencies.

Title XXI - Energy and Environment

Title XXI requires DOE to establish separate, five-year programs on energy efficient natural gas and electric heating and cooling technologies for residential and commercial buildings, on advanced pulp and paper technologies, on increasing building energy efficiency, on increasing the efficiency of electric drives and motors, on increasing the energy efficiency and cost effectiveness of pollution prevention and source reduction technologies, on the generation of electricity from renewable energy sources, on high-efficiency heat engines, on fusion energy, on fuel cells, on high-temperature superconductivity and on the commercialization of advanced light water reactor technologies. In addition, DOE is required to perform studies on improving efficiency in energy-intensive industries, on minimizing the volume and toxic lifetime of civilian nuclear waste, on the effect of electric and magnetic fields on human health and on encouraging the deployment of advanced nuclear reactor designs. Title XXI contains no requirements or opportunities for action by state agencies.

Title XXII - Energy and Economic Growth

Title XXII requires DOE to establish separate, five-year programs on advanced materials technologies and on advanced manufacturing technologies. This Title also provides further support for DOE's efforts in supporting basic research and technical analysis, and math and science education programs. Title XXII contains no requirements or opportunities for action by state agencies.

Title XXIII -- Policy and Administrative Provisions

Title XXIII requires DOE to establish an Energy Research, Development, Demonstration, and Commercial Applications Advisory Board to advise DOE on technical matters. This Title also establishes several administrative procedures for DOE. Title XXIII contains no requirements or opportunities for action by state agencies.

Title XXIV -- Non-Federal Power Act Hydropower Provisions

Title XXIV revises federal legislation and regulations with regard to rights-of-way on certain federal lands, dams in National Parks, and third-party contracting of environmental impact statements and assessments by FERC. This Title also requires studies of opportunities for increased hydroelectric generation at existing federal facilities, including water conservation for energy production and for hydroelectric projects in Hawaii. This Title also supports certain power projects in the Pacific Northwest and Alaska. Title XXIV contains no requirements or opportunities for action by state agencies.

Title XXV -- Coal, Oil and Gas

Title XXV contains provisions addressing hot dry rock geothermal energy, coal remining, surface mining, federal lignite coal royalties, federal mineral leases, various oil and gas production leases and claims conditions and small coal operators. Title XXV contains no requirements or opportunities for action by state agencies.

Title XXVI -- Indian Energy Resources

Title XXVI contains provisions promoting Indian energy resource development, including energy efficiency and renewable energy resources, and assisting Indian energy regulation, including the establishment of an Indian Energy Resource Commission. Title XXVI contains no requirements or opportunities for action by state agencies.

Title XXVII -- Insular Areas Energy Security

Title XXVII establishes financial assistance programs for the development of energy efficiency and renewable energy options for "insular areas" -- American

Samoa, Mariana Islands, Puerto Rico, Micronesia, Guam, Marshall Islands, Palau, and Virgin Islands. Title XXVII contains no requirements or opportunities for action by state agencies.

Title XXVIII - Nuclear Plant Licensing

Title XXVIII amends Section 185 of the Atomic Energy Act of 1954 to require the Nuclear Regulatory Commission (NRC) to issue (after holding a public hearing) to applicants a combined construction and operating license if the applicant submits sufficient information that there is reasonable assurance they will construct and operate the facility in conformity with the license. If a plant has been issued a combined license, the NRC must publish a notice of intended operation of the facility at least 180 days before the scheduled date for the initial loading of fuel.

This notice gives 60 days for interested parties to request a hearing on whether the facility as constructed meets the criteria established in the license. The request must show, *prima facie*, that one of the acceptance criteria would not be met, and that the specific consequences of this nonconformance would not provide reasonable assurance of protecting the public. The NRC may order a hearing, and/or may determine there is or is not a threat to public health and safety within 180 days of publication of the notice of intended operation. Title XXVII contains no requirements or opportunities for action by state agencies.

Title XXIX - Additional Nuclear Energy Provisions

Section 2901 - State Authority to Regulate Radiation Below Level of NRC Regulatory Concern

Section 2901 gives states the authority to regulate, on the basis of the potential radiological hazards, the disposal or off-site incineration of low-level radioactive waste if the NRC exempts such waste from regulation.

OPTIONS:	•	do nothing;
	•	if NRC exempts low-level radioactive waste from its regulation, then exercise authority and regulate its disposal or off-site incineration
RESPONSIBLE AGENCIES:	Department of Natural Resources	

Section 2902 adds additional protections for nuclear whistleblowers. Section 2903 exempts certain small educational and research reactors from annual NRC fees. Section 2904 requires the President and the NRC to conduct a study on the safety of shipments of plutonium by sea.

These sections contain no requirements or opportunities for action by state agencies.

Title XXX - Miscellaneous

Various miscellaneous provisions in Title XXX include: abolish the Office of Federal Inspector of Construction for the Alaska Natural Gas Transportation System and revoke certain provisions of the System's regulations; encourage use of geothermal heat pumps; require a study of the use of energy futures as a way to hedge against fuel price increases; require an analysis of energy subsidies; require a study of the energy potential of tar sands; and address other general energy-related issues.

Title XXX contains no requirements or opportunities for action by state agencies.

CHAPTER III
TECHNICAL ANALYSIS

Introduction

To determine what steps Missouri should take to improve the energy efficiency of its buildings required a thorough analysis of the building practices within the state and a determination of what level of energy efficiency made economic sense for the building owners and tenants and the state as a whole. This Chapter is divided into four sections. The first provides an overview of the methodology of the technical analysis process. The next two sections provide the findings as they relate to residential and commercial buildings. The final section analyzes the economic and environmental Impact of constructing more efficient buildings in Missouri.

The principal focus of the analysis was to assess the Missouri specific impacts of improving the energy efficiency of buildings in the state. The Energy Policy Act of 1992 (EPAct) has two codes that are prescribed: (1) for residential energy efficiency, the Council of American Building Officials' Model Energy Code of 1992 (MEC 92); and, (2) for commercial energy efficiency, the American Society of Heating, Refrigeration and Air Conditioning Engineers' Standard 90.1 (ASHRAE 90.1). To analyze the impact of constructing new buildings to higher standards, several steps were required, including:

- determination of representative Missouri buildings and prevailing construction practices and efficiency levels;
- a review of the Missouri specific requirements of the code/standard;
- economic modeling to determine cost-effectiveness of energy efficiency measures, accounting for Missouri material and labor costs and natural gas and electricity rates;
- developing a forecast of new building starts in Missouri; and,
- projecting state-level utility, environmental and macroeconomic impacts.

The technical analysis of specific building models was a complex task that involved the interaction of a number of variables. This included a projection of what types of buildings would be constructed and the level of energy efficiency expected in those buildings, absent any minimum code or standard. This was combined with a review of current and emerging technology to determine what is and might be available to make buildings more efficient. This information was then analyzed to determine the most effective mix of applications and equipment to raise the level of building energy efficiency in the most cost effective manner.

The overall approach to the assessment of building energy standards is shown in Figure III-1 on the following page.

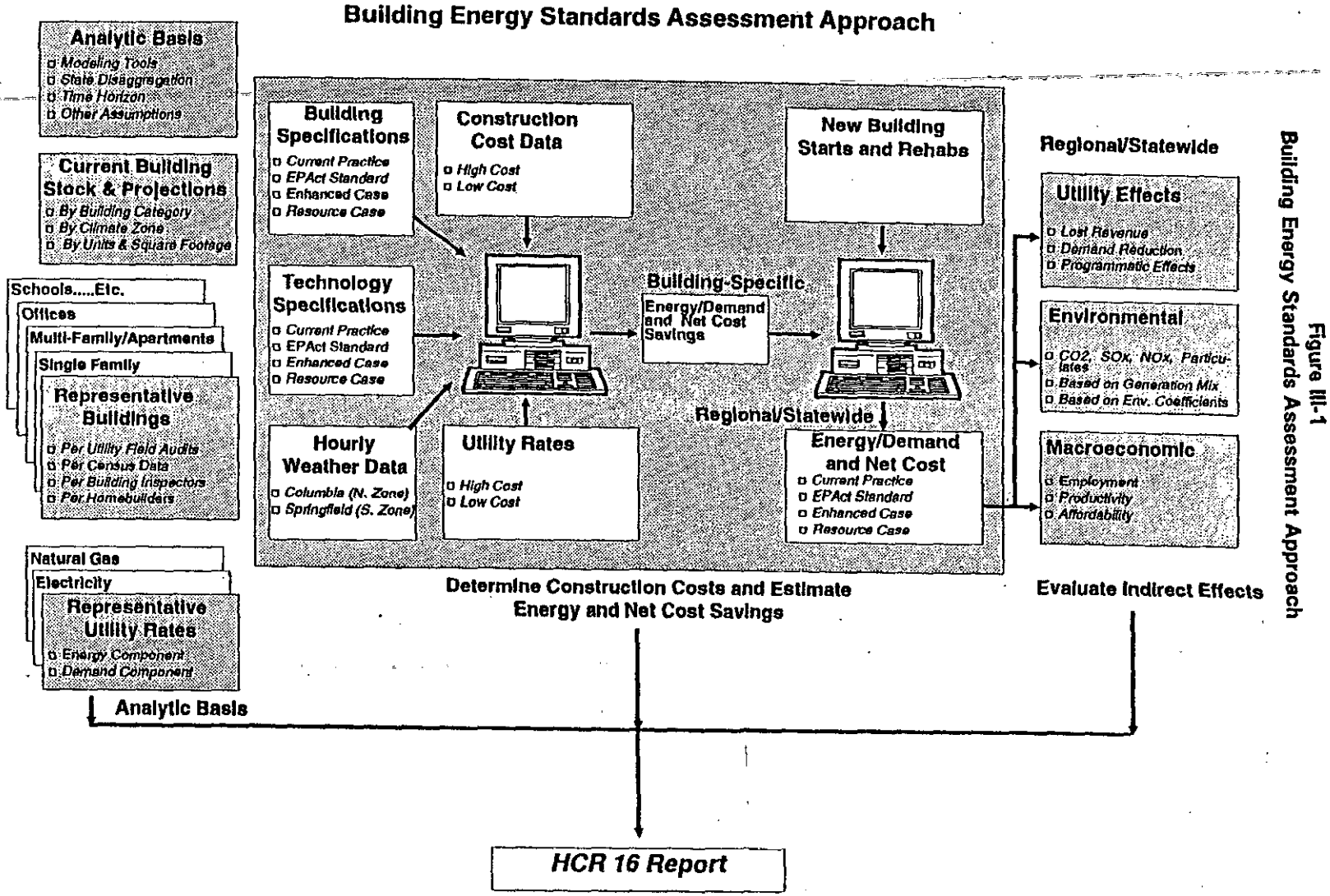


Figure III-1
Building Energy Standards Assessment Approach

Methodology

Profile of Missouri Buildings

In order to maximize the relevance of the assessment of standards to Missouri buildings, market data and characteristics of Missouri commercial and residential buildings was needed. A review of available data and inquiries with the Missouri State Data Center, the U. S. Bureau of the Census, and the DOE's Energy Information Administration indicated that detailed, Missouri-specific building inventory data is not available in the public sector.

The F. W. Dodge division of McGraw-Hill, as a result of its extensive day-to-day tracking of the construction industry, has developed two significant buildings databases, the *Building Stock Data Base* and *Construction Analysis System*, which were used in this assessment. The Dodge data bases provided the following data specific to Missouri:

- an estimate of total building area (in square foot) by fifteen major building type categories (thirteen commercial/institutional and two residential).
- detailed individual building project records for 200+ building categories, including building size, number of buildings, age, and type.
- forecasts (through 2002) of future building activity by building area.

The Dodge data, available at the county level, was aggregated into two sub-state analytic zones, north and south. The delineation of Missouri into north and south zones was determined largely by a review of Missouri climate conditions and utility service areas. (See Figure III-2 on page 70).

Table III-1, on the following page, provides a summary of the Dodge data sets for the entire state. The information that was contained in this data was then analyzed to determine the building types that represented the largest number of projected new construction for the period of 1995 - 2000. These building types were then used to develop the models that were analyzed within the scope of this Report.

Missouri Building Inventory

Summary Table

Building Area (square feet x 1,000)

	1995	1996	1997	1998	1999	2000	Total
Residential							
Pre-1995	2,433,914	2,426,498	2,419,107	2,411,734	2,404,378	2,397,033	na
New Construction	34,156	32,802	32,682	32,875	32,937	33,026	198,478
Total Residential Buildings Inventory	2,468,070	2,493,456	2,518,746	2,544,249	2,569,829	2,595,511	
Commercial							
Pre-1995	1,250,932	1,241,114	1,231,242	1,221,238	1,211,074	1,200,712	na
New Construction							
Buildings covered by ASHRAE Std 90.1-'89							
Buildings Modeled							
Small Office Buildings	1,698	1,969	2,168	2,310	2,517	2,763	13,424
Large Office Buildings	784	909	1,001	1,068	1,162	1,275	6,196
Retail Buildings	2,392	2,264	2,191	2,174	2,164	2,164	13,349
Nursing Homes	1,224	1,344	1,419	1,393	1,358	1,326	8,064
Elementary Schools	2,886	2,892	2,963	3,225	3,454	3,504	18,925
University Building (Library)	512	513	526	572	613	622	3,357
SubTotal	9,495	9,891	10,268	10,740	11,268	11,653	63,316
Buildings Not Modeled	6,591	6,484	6,504	6,496	6,517	6,593	39,185
SubTotal	16,087	16,375	16,772	17,236	17,785	18,246	102,500
Percent of ASHRAE covered buildings modeled	59%	60%	61%	62%	63%	64%	
Building NOT covered by ASHRAE Std 90.1-'89	4,926	4,802	4,762	4,775	4,827	4,885	28,977
TOTAL, New Construction	21,013	21,177	21,534	22,011	22,612	23,131	131,477
Percent of TOTAL MODELED	45%	47%	48%	49%	50%	50%	
TOTAL, Commercial Building Inventory	1,271,944	1,283,305	1,294,965	1,306,972	1,319,420	1,332,169	
TOTAL, Residential & Commercial							
(covered by MEC 92 or ASHRAE Std 90.1-'89)	50,243	49,177	49,454	50,111	50,722	51,272	300,978
Percent of code covered buildings modeled	87%	87%	87%	87%	87%	87%	
TOTAL, NEW Residential & ALL Commercial Buildings	55,169	53,979	54,216	54,885	55,549	56,158	329,955
Percent of all buildings modeled	79%	79%	79%	79%	80%	80%	
TOTAL, ALL Building Floor Area	3,740,014	3,776,761	3,813,712	3,851,221	3,889,249	3,927,700	
Percent Residential	66%	66%	66%	66%	66%	66%	
Percent Commercial	34%	34%	34%	34%	34%	34%	

Note:
Residential buildings includes all residential buildings.
Small Office Buildings includes all offices, banks, and financial buildings less than 3 story, Large Office Buildings include all the same building types of 4 story or more. The Retail Building category includes all retail buildings except shopping centers. The School category includes elementary, junior high, high school, and vocational schools. The Nursing Home category includes nursing homes, clinics, and convalescent facilities. The University Building (Library) includes all university buildings except dormitories.

Based on the projected square footage of new buildings through the year 2000 in Missouri shown in Table III-1, six commercial buildings and three single family buildings, collectively representing 79% of the total projected building activity, were selected for performance modeling. These include:

Commercial

- Small Office
- Large Office
- Retail Building
- School
- Nursing home
- University Building

Residential

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

Table III-2 provides a summary of the Dodge data for the commercial and residential sectors and of the nine buildings that were selected for modeling in the analysis.

Table III-2
Missouri Building Inventory Additions 1995-2000 (New Construction)

Building Types Modeled	Building Area (sq. ft. x 1,000)	Percent of Total
Small Office Building	13,424	4%
Large Office Building	6,196	2%
Retail Building	13,349	4%
Nursing Home	8,064	2%
Elementary School	18,925	6%
University Buildings	3,357	1%
Single Family Housing - 1 Story Detached	128,969	39%
Single Family Housing - 2 Story Detached	42,989	13%
Multi Family Housing - Units	26,520	8%
Other (Not Modeled)	68,161	21%
TOTAL	329,955	100%

Building Codes and Standards

The assessment of building standards began with a review of the ASHRAE 90.1 and MEC 92 published standard/code documents. Alternate "consensus" standards and their associated documents were also reviewed, including ASHRAE Standard 90.2 and the Department of Energy (DOE) voluntary standard for residential buildings and the DOE voluntary standard for commercial buildings. From the review, the methods of compliance and the requirements for energy efficiency were summarized.

Energy codes and standards intended for national adoption represent necessarily a wide range of conditions. As such they may not accurately reflect local climate, energy costs or design and construction preferences. Adoption of building energy codes and standards is best justified by a careful analysis of representative buildings based on local conditions.

To determine the impact of building energy standards in Missouri, the energy and demand savings, construction costs and ownership costs were evaluated for a range of Missouri-specific residential and commercial building prototypes, utility costs and weather conditions .

To place the EPAct prescribed building standards in perspective, our assessment is based on four conceptual levels of energy efficiency, defined as:

Current Practice - This scenario is an estimation of what the actual practice is in Missouri today.

EPAct Standard - This scenario uses the prescriptive requirements of the CABO Model Energy Code and the ASHRAE Standard 90.1-1989 and represents the minimum recommendations of the Energy Policy Act. It is modeled based on improvements over Current Practice.

Enhanced Case - This scenario incorporates a cost-effective package of energy efficiency measures that exceeds the performance of the EPAct Standard scenario, yet does not increase the total cost of ownership of the building.

Resource Case - This scenario includes additional measures added to the Enhanced Case. It also accounts for utility avoided capacity and environmental externality offsets. In this scenario, the building owner is assumed to receive, in addition to the utility bill savings, additional payments reflecting utility avoided-cost benefits and some compensation for the environmental benefits of reduced energy use.

Energy/Demand Performance Modeling

Computer modeling on an hour-by-hour basis using historical, Missouri-specific weather data is a reasonable method of determining relative building energy and demand requirements. The analysis of commercial buildings was conducted by using DOE 2.1d, a modeling tool provided by the U.S. Department of Energy. For residential buildings, the analysis was conducted using ESPRE 2.1, a modeling tool developed by the Electric Power Research Institute. Both models used weather data from two Missouri climatic zones, Columbia (North Zone) and Springfield (South Zone), shown in Figure III-2, on the following page.

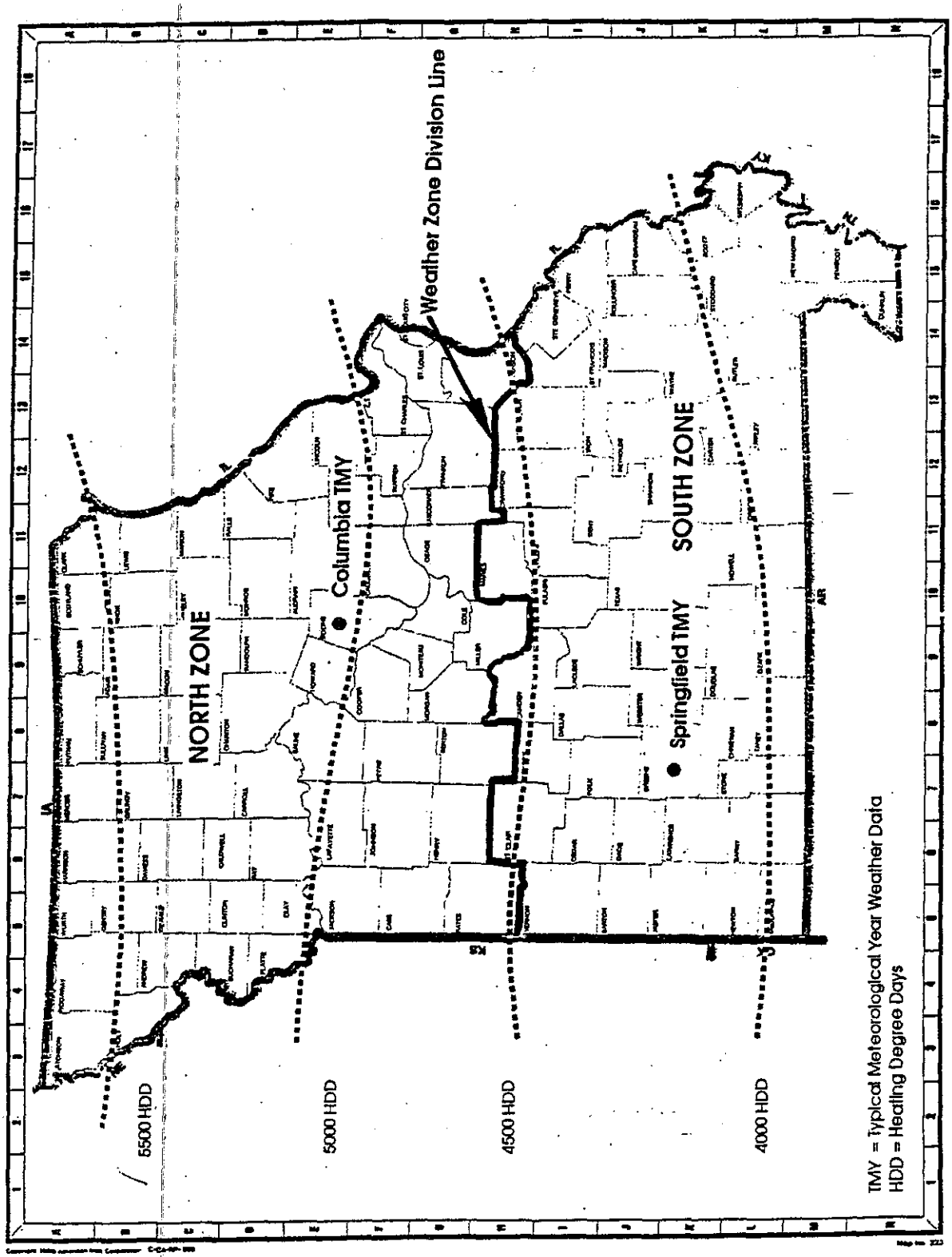
From the hourly simulations several data values were extracted that were then used in subsequent analysis, including:

- natural gas consumption (monthly and annual),
- natural gas peak load (winter, for peak hour)
- electricity consumption (monthly and annual),
- electric peak demand: residential (summer, for peak hour),
- electric peak demand: commercial (monthly, for peak hour), and
- natural gas and electric water heating loads and electrical lighting/appliance loads (monthly and annual).

The building performance models yielded energy consumption in common energy units (e.g. therms of gas, kilowatt-hours of electricity). These values, along with electrical demand for commercial buildings, provided the basis for determining operating costs. Natural gas and electricity energy units were also converted to "building boundary energy" and "resource energy."

Building boundary energy represents the British Thermal Unit (BTU)-equivalent on-site energy consumption associated with operation of a particular building. Resource energy represents the BTU-equivalent on-site and off-site energy consumption associated with operation of a particular building, accounting for conversion efficiencies and transmission losses. The results of the performance modelling of residential and commercial buildings are compiled in the appendices to this Report. Detailed information is available in the technical papers that were used to develop the analytic basis for the computer modeling.

Figure III-2
Analysis Zones and Weather Data Locations in Missouri



Economic Modeling

The merits of building energy efficiency standards may be evaluated based on several factors, including cost-effectiveness, their ability to be implemented, and broad public policy objectives. Cost effectiveness in particular may be evaluated by a wide variety of techniques ranging from first cost, net present value, cost-benefit ratio or rigorous life-cycle cost analysis.

In this assessment of building efficiency standards, a ***net cash flow/affordability test*** was used. This approach involves calculating the total annual cost of ownership with and without energy efficiency improvements. If the additional costs of energy efficiency investments are more than offset by resulting operating (energy and demand) savings and the building owner's net cash flow, on an annual basis, is equal to or lower than the net cash flow for the same building without energy efficiency improvements, then the investment is considered cost-effective.

The assessment of net cash flow/affordability is a comprehensive analysis that involves several steps:

- estimation of the average cost of construction for residential and commercial buildings in Missouri;
- estimation of the incremental costs for additional energy efficiency measures for the four energy efficiency levels described earlier:
- applying representative utility rates to the modelled energy and demand requirements of the four efficiency levels for representative Missouri buildings; and,
- calculation of annual mortgage costs to which annual energy costs are added.

Construction Costs - For the analysis, an average cost per square foot of floor area for each building type was determined. For residential buildings, costs of $55 per square foot and $45 per square foot were used for single family and multi-family construction, respectively. For commercial buildings, average constructions cost vary according to building type, but values used in the assessment ranged from $45 to $75 per square foot.

Incremental Costs - Achieving increased energy efficiency is almost always assumed to increase initial cost, although there may be circumstances, particularly in commercial buildings, where the interaction among multiple measures results in a significant reduction in equipment size leading to a decline in first cost. Average costs of energy efficiency measures for both residential and commercial buildings in Missouri were derived from information provided by a local professional construction cost estimating firm, *Means Residential Cost Data*, *Means Mechanical Cost Data* and national laboratory data.

Average costs were modified to yield a "high" (average plus 10%) and "low" (average less 10%) cost, representative of the variance in Missouri construction costs reported by R.S. Means. Cost estimates distinguish between materials and labor to provide input for secondary economic impact analysis. Cost estimates also include direct and indirect costs, including overhead and profit, applicable taxes, and, for commercial buildings, architectural and engineering design fees. The assessment assumed the following incremental cost scenarios:

Current Practice - Represents a building from which energy efficiency savings will be measured, and has no incremental energy efficiency costs.

EPAct Standard - These buildings have incremental costs determined by the prescriptive requirements of ASHRAE 90.1 and MEC 92.

Enhanced Case - Represents a building that incorporates a package of energy efficiency measures that exceeds the performance of the EPAct Standard level yet does not increase the total cost of ownership.

Resource Case - Depending on cost of energy, investments in energy efficiency beyond the Enhanced Case may not have economic merit to Missouri homebuyers. However, the state and its utilities are rapidly focusing on the interactions of energy end-use and utility operations. The Resource Case represents additional efficiency measures added to the Enhanced Case until net cash flow/affordability results that incorporate utility avoided capacity and environmental externality offsets approach the same cost of ownership as the Current Practice case. In some commercial building cases, the Resource Case has a better affordability than Current Practice as a result of substantial energy savings and large first cost savings from smaller HVAC equipment.

Utility Rates - Utility natural gas and electric rates currently applicable in Missouri were determined from a review of rate information provided by the Missouri Public Service Commission and individual utilities. Energy and demand charges (where applicable), with embedded customer charges and sales/gross receipt taxes, were applied to the results of the performance simulations to determine monthly and annual operating costs.

Mortgage and Energy Summation (Affordability) - The economic assessment of energy efficiency measures is based on a net pre-tax cash flow/affordability test. Any additional capital costs resulting from increasing a new building's energy efficiency, residential or commercial, will typically be paid for, in whole or in part, by a mortgage. The relative economic merits of each of the four efficiency levels is assessed by comparing their associated total cost of ownership, or annual PITIE (principal, interest, taxes, insurance and energy).

To establish traditional PITI values, a mortgage calculation was conducted using economic variables such as construction costs, land-to-building ratios, mortgage rates and terms, down payment, and taxes and insurance for both residential and commercial scenarios. To the annual PITI values were added annual energy costs (to yield PITIE). (Annual energy costs were determined based on applying a range of natural gas and electric rates (high and low) to the monthly and annual energy results from the hourly building/mechanical simulations.

A PITIE value is reported for the Resource Case, as well as a value that includes a credit for avoided electrical capacity (PITIEC) and environmental emissions (PITIECE). An avoided electrical capacity credit of $400/kW was applied to the cost of energy efficiency measures above and beyond the Enhanced Case and externality credits of $0.014/kWh and $0.27/mcf were applied to the energy savings from Current Practice.

While, ideally, the total cost of ownership of the Enhanced Case energy efficiency level should be the same as Current Practice (with significant energy and environmental savings), 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.

Impact Analysis

The *aggregate* impact of adopting building energy standards is a significant consideration for Missouri in determining the proper scope and intensity of any standards implementation effort. Our analysis of building energy standards was not limited to individual buildings, but reflects the potential impact of standards on energy, demand, costs, utility and indirect effects.

Forecasting future impacts requires reasonably detailed information on the distribution and characteristics of the state's current building inventory, as well as forecasts regarding new building starts. The Dodge buildings database was used to forecast the state-level energy, demand and cost savings based on the results from the building-specific performance modeling of the three residential and six commercial buildings. The forecasts were aggregated at the climate zone level. From this aggregation, the resulting effects on Missouri utilities, environmental emissions, and economics were estimated.

Economic Benefits - As previously described, the building code improvements were modeled from the perspective of the building owner. For the purpose of analyzing the overall impact of the building code improvements, the analysis, at this point, takes a broader perspective: that of society as a whole. To do this, the analysis shifts away from customer energy bills, and instead evaluates how improved

building codes will affect the costs and benefits associated with the overall production and use of electricity and natural gas. Also included are other impacts, such as those on the environment and on the economy in general.

Electricity Generation

The direct economic benefits of electricity savings from the building code improvements will be in the form of reduced costs of electricity generation, referred to as avoided energy costs, and reduced costs of constructing electric generation capacity, referred to as avoided capacity costs. To develop avoided costs, 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.

Our assumption is that without the improved building codes, Missouri electric utilities, as a whole, are likely to need additional combustion turbines by 1998 and a new combined cycle facility by 2000, both fueled by natural gas. 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.

It is also assumed 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 marginal energy generation during these years is forecast to be mostly from coal units. Avoided energy costs from 2000 and beyond are based on the annual fuel costs of the avoided natural gas combined cycle facility.

Natural Gas

The primary economic benefits of natural gas savings from the building code enhancements include reduced cost of natural gas production and reduced cost of natural gas transmission. The sum of these two costs is the city -gate, or cost to the local distribution company, avoided cost, which is used in this Report to evaluate benefits of natural gas savings.

This analysis estimated avoided gas costs for two basic types of load reduction: a peak day reduction and a non-peak day reduction. 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.

These estimates of the Missouri avoided gas costs were prepared based on the data of one of the largest Missouri natural gas utilities - Laclede Gas Company, which serves the Northeastern part of the state, including St. Louis City and County. Our analysis indicates that this information is representative for all of Missouri.

Environmental Benefits - The analysis also accounted for some of the environmental impacts which will result from the improved building code standards. It focused on air emissions which are primarily responsible for global warming, acid rain and ground-level ozone. While there are a variety of additional environmental impacts associated with energy consumption, they are not included in our analysis here. Monetary values of these pollutants have been applied, in order to compare the environmental impacts of these pollutants with the direct economic costs and benefits of the building code improvements.

The environmental impacts of the building code improvements have been estimated using a similar approach as the direct economic impacts. In other words, from 1995 through 1999 the code improvements are assumed to displace air emissions from existing coal plants, and after 1999 the air emissions from the new combined cycle facility are assumed to be displaced.

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, our analysis has estimated avoided environmental costs of end-use natural gas consumption based on the same monetary values of the pollutants that are primarily responsible for global warming, acid rain, and ground-level ozone.

Comparing Costs and Benefits Over the Study Period

As described above, the analysis models the impact of building code improvements implemented during the six years from 1995 through 2000. In order to capture the long-term benefits of the building code 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.

The costs of the building code improvements, however, are incurred during the 1995 through 2000 period only. These include all of the labor and materials costs that are incurred by building owners to purchase and install the additional measures required by the improved codes.

Macroeconomic Effects - The forecast of energy and operating savings as well as the aggregate cost of material and labor invested in energy efficiency measures

was also analyzed for their economic impact on Missouri. Using comprehensive data bases maintained at the University of Missouri, Columbia, the economic impact analysis was calculated in present dollars for new income, employment, retail sales, service sales, new sales tax generated, state sales tax, local sales tax and local property tax. The results paint an economic picture of the impact of energy efficiency improvements on Missouri's economy.

Residential Buildings

Introduction

Section 101 of EPAct states that each State shall certify to the Department of Energy that it has reviewed its building code regarding energy efficiency and make a determination whether it is appropriate for its building code to meet or exceed the provisions of the Council of American Building Official's (CABO) Model Energy Code, 1992 (MEC 92). At present, Missouri does not have a state-wide residential building code. Certain jurisdictions in Missouri have adopted and do enforce varying consensus building codes applicable to residential buildings. As the issue of whether Missouri should, in fact, pursue a state-wide residential building code is discussed elsewhere, this section discusses and analyzes MEC 92 and alternate energy efficiency standard scenarios.

Closely related to EPAct's provision for a voluntary residential efficiency code are:

- EPAct's provisions that key Federal mortgage financing to MEC 92 or equivalent; and
- mandatory national appliance standards.

Section 101 of EPAct, by amending the Cranston-Gonzalez National Affordable Housing Act, required the U.S. Department of Housing and Urban Development (HUD) and the Department of Agriculture (DoA) to establish energy efficiency standards by October, 1993 for housing financed by the Federal Home Administration (FHA), the Veterans Administration (VA), and the and the Farmers Home Administration (FmHA).[1] EPAct required that such standards meet or exceed MEC 92. If HUD and DoA did not establish a standard, MEC 92 automatically became the mandatory standard for such housing.

As of October, 1993, MEC 92, either through HUD/DoA initiative or inaction, became mandatory for HUD/DoA-backed housing. Therefore, "a loan for the purchase or construction of new residential property.....may not be financed through the assistance of (such loan programs) unless the residential property is constructed in compliance with such standards." In addition, HUD is promulgating new standards for manufactured housing through authority contained in the Manufactured Home Construction and Safety Standards Act.

[1] Statistics were not readily available on the number or percentage of new housing in Missouri financed with HUD/DoA-backed mortgages. The *American Housing Survey for the United States in 1989* reports that 22% of all new housing units built and purchased in the U.S. between 1985 and 1989 were financed with HUD/DoA-backed mortgages (15% VA; 6% FHA and 1% FmHA).

The National Appliance Energy Conservation Act of 1987, as amended, designates minimum efficiency levels for 13 product categories, including central air conditioners and heat pumps, furnaces, and water heaters. NAECA's built-in rulemaking process requires DOE to update and strengthen these standards on a regular basis to keep pace with technological improvements. After a Federal standard is in effect for an appliance, a building code can not be designed to pressure builders to install appliances exceeding Federal minimum standards.

CABO Model Energy Code

While building codes are adopted and enforced locally, few states or local jurisdictions develop their own codes. Instead, four major organizations develop and publish model building codes for State and local use: the Building Officials and Code Administrators International (BOCA - the National Building Code), the International Conference of Building Officials (ICBO - the Uniform Building Code), the Southern Building Code Congress International (SBCCI - the Standard Building Code) and the Council of American Building Officials (CABO - the Model Energy Code), which is a federation of the first three organizations. The National Congress of States on Building Codes and Standards (NCSBCS) is an independent group that is supportive of states adopting more effective building codes. BOCA, ICBO, SBCCI, and NCSBCS rotate responsibilities for management of the annual MEC review process. The first Model Energy Code was developed by CABO in 1978, largely based on ASHRAE Standard 90-75. MEC began to move from reliance on ASHRAE standards (i.e. Standard 90A-1980) in the late 1980's by evolving its own efficiency performance provisions in MEC 89.

The Model Energy Code is formally updated every three years, with MEC 95 due to supersede MEC 92. However, MEC is a dynamic process, where improvements and updates are discussed and debated twice annually. Among the many issues being discussed in the 1993 review cycle are refinements to the envelope U-values, the relationship of heating loads and cooling loads, better agreement on economic assumptions and improved code language. From these annual reviews, supplements to the current version of MEC (MEC 92) are developed.

Energy efficiency provisions in MEC 92 have been developed by conducting a series of cost-effectiveness analyses of various residential energy efficiency measures. In the model code document, nomographs relate thermal efficiency requirements to heating degree days. Thermal efficiency values are reported in U-value, which can be readily converted to the more familiar R-value. MEC U-value requirements are "effective" values, meaning they require all components of an assembly (e.g. ceiling insulation, ceiling joists, ceiling drywall) to be considered, not just the insulation. For walls, MEC combines the opaque wall, windows, and doors into a wall assembly and sets a maximum U_o value. MEC also sets minimum

efficiencies for heating, cooling and water heating equipment, although its values and rating requirements are not consistent with NAECA.

Where MEC 92 is adopted, compliance can be met through one of two basic avenues: a component-based (prescriptive) approach or a systems-based (performance) approach. The prescriptive approach requires a builder to meet a list of maximum U-values (or minimum R-values) for major construction assemblies and minimum levels for equipment efficiency. Where all requirements are met, compliance is achieved. Compliance may be achieved through the performance path by the use of computer modeling where the energy consumption of an alternate design is demonstrated to be equal to or less than the performance of the same building if it were to meet the prescriptive requirements.

Alternate Residential Standards

ASHRAE Standard 90.2 - The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has been instrumental over the past 20 years in developing residential standards. ASHRAE worked with DOE to develop a consensus standard that was first issued in 1975 (ASHRAE 90-75). This standard included provisions for residential envelope and mechanical efficiencies. The provisions of ASHRAE 90-75 were used in the first MEC in 1978. ASHRAE conducted its first update in 1979, resulting in ASHRAE 90A-1980. ASHRAE 90A-1980 provisions remained in the MEC through 1986, and are still used in several state energy codes.

Continuing its evolution of residential standards, ASHRAE is in process of developing Standard 90.2: Energy Efficient Design of New Low-Rise Residential Buildings. The Second Public Review Draft (dated May 1990) has been the point of reference for discussions and debate to develop a consensus standard. ASHRAE 90.2 is now in its fifth review draft, and a final standard is pending. In ASHRAE 90.2, specific prescriptive criteria are presented for the exterior envelope, HVAC systems, and service water heating. Compliance is achieved when all prescriptive criteria have been met. Compliance may also be achieved through a comparison of annual energy costs for the proposed building and the same building if it were to meet the prescriptive provisions.

Two major distinctions between MEC 92 and ASHRAE 90.2 are:

- ASHRAE 90.2 does not combine opaque walls, windows, and doors into a singular assembly (and single efficiency requirement); instead ASHRAE 90.2 assigns insulated walls, windows, and doors distinct efficiency provisions (90.2 limits window area to 15% of total floor area, which can be exceeded if compliance is demonstrated through the annual energy cost method); and

- ASHRAE 90.2 provides two energy efficiency levels for the building envelope, one that assumes ductwork is entirely inside conditioned space and another that assumes ductwork is entirely outside of the conditioned space (in current practice, ductwork is often routed through both conditioned and unconditioned spaces).[2]

DOE Voluntary Standard - The U.S. Department of Energy has established two separate residential standards: mandatory standards for Federal residential buildings, a majority of which is military housing, and voluntary performance standards for new non-Federal residential buildings. DOE published proposed rules for the non-Federal residential buildings standard in August 1992. The proposed non-federal standards do not establish nationwide energy efficiency requirements per se, but, rather, encourage the generation of a building standard unique to the climate, cost factors, and construction practices of a particular location. The core of DOE's voluntary non-Federal standard is the Automated Residential Energy Standard (ARES) computer program and data base. To establish a standard using ARES, the following information is entered:

- the location where the standard will apply (to determine climate variables);
- on of three basic housing types (single family detached, multi-family attached or manufactured);
- one or more prevalent foundation types where the standards will apply; and,
- the available energy sources (electricity, natural gas or propane) where the standards will apply.

The ARES program and data base can be customized by inserting information on local fuel costs, construction costs, prevailing building practices, and economic factors such as mortgage rates and income tax brackets. ARES automatically optimizes all energy efficiency measures that pass a cost-effectiveness test to specify the residential design with minimum life cycle costs. The annual space conditioning cost for this design becomes the standard for determining compliance.

The DOE non-Federal standard allows three methods of compliance: prescriptive, points-based and performance-based. The simplest and most straightforward is the prescriptive. A "prescriptive package" is generated by the ARES program, which lists minimum insulation levels, heating and cooling equipment efficiencies, and recommended window type. The points-based compliance approach

[2] In general, ASHRAE 90.2 required efficiency levels are in the same range as MEC 92 when ductwork is installed inside conditioned space. When ductwork is installed outside conditioned space, ASHRAE 90.2 efficiency values exceed MEC 92 values in several categories, particularly for basement and crawlspace insulation and window performance.

compares the points of an alternate design (perhaps one with higher mechanical efficiencies and less insulation) to the points assigned to the "prescriptive package." If the points of the alternate design do not exceed the points of the optimum (prescriptive package) design, compliance is achieved. DOE has developed the companion Automated Compliance for Residential Energy Standards (ACRES) program to perform point calculations. Performance-based compliance may be demonstrated through the use of computer modeling where the cost performance of an alternate design is equal to or better than a "reference dwelling unit" defined by DOE. The DOE non-Federal voluntary standard is considered "interim." A final version of the standard is anticipated in the next year, at which time the ARES and ACRES software is scheduled to be updated.

Depending on financing and utility cost data modeled, the DOE non-Federal voluntary standard generated by ARES typically suggests higher insulation levels for the exterior envelope than MEC 92.

Missouri Voluntary Programs - There are several voluntary residential energy efficiency programs in the state sponsored by utility companies, such as Kansas City Power & Light Company's *Energy Efficient Home*™ program, Empire District Electric Company's new *Healthy Home* program and others based on the *Super Good Cents*™ program.

The Kansas City Homebuilders Association's *SAVE*™ (Saving America's Valued Energy) program, a voluntary program originally developed by the Association for the benefit of its builder membership and area homebuyers, has been a highly successful program for a dozen years. To participate in the *SAVE*™ program, a builder must install base energy efficiency measures (e.g. wall sheathing or house wrap, R-30 ceiling insulation, measures designed to reduce air infiltration and aluminum windows with thermal breaks). Beyond these base measures, a builder can continue to add energy efficiency measure to a home to garner "points," which determines the rating level of the home (either Bronze, Silver, or Gold).

These ratings then provide the builder with a marketing tool for selling the home, and potential homebuyers are informed of the relative efficiency of the home. The advantages of the *SAVE*™ program's point-based approach is it

- allows a builder the flexibility to achieve an energy efficient home without a strict prescriptive requirement (aside from the base measures);
- explicitly addresses the measures required to reduce infiltration in housing to appropriate levels;
- rewards the builder for installing heating, cooling and water heating equipment that exceed the Federal minimums;
- recognizes efficiency improvements related to unconventional design (passive solar, earth contact, etc.); and,

- avoids the need to conduct computer simulations to determine compliance of a target level (unlike MEC 92 and ASHRAE 90.2, which both require computer calculations if the prescriptive requirements are not fully met).

Related Code/Standard Activities in Other States

A number of states have adopted state-wide residential energy standards. Many standards have been in effect for a decade or more. With the provision in EPAct requiring states to certify that they have evaluated or reevaluated energy standards relative to MEC 92, many states are likely to be soon updating residential energy codes that have become dated. Although a detailed review of state and municipality code adoption activities was outside the scope of this assessment, it is of interest to note that nearby states such as Arkansas, Nebraska, Iowa, Oklahoma and Wisconsin all have state-wide energy codes in effect. Several of these codes are based on older versions of MEC or dated standards (e.g. ASHRAE Standard 90A-1980), while others, such as Wisconsin's state-wide residential code, were updated in 1992.

Residential Technology Overview

Energy efficiency technologies for residential buildings are evolving rapidly. Federal- and industry-sponsored research and development efforts are leading to a steady flow of new energy-saving building-related technologies, including advanced insulations, *super* and *smart* windows, variable speed HVAC equipment, renewable energy applications, and others. Also emerging are many building products that increase energy efficiency while minimizing impacts on native timber and other natural resources.

In an effort to accelerate the adoption of new energy efficient space conditioning, water, heating and household appliances, the Federal government, through the National Appliance Energy Conservation Act (NAECA), has developed minimum efficiency levels that are periodically updated based on economically-justified technological innovations. In contrast, the Federal government does not have in place a "minimum standard" for the efficiency of residential building envelope components or assemblies. With its recommendation for adoption of MEC 92, the Federal government is seeking to promote the inclusion of minimum levels of efficiency in residential building envelopes by state and local authorities.

The discussion that follows and Tables III-3, III-4 and III-5, starting on page 89, provide a summary, by envelope component/assembly or equipment type, of energy efficiency associated with the Federal minimum (if applicable), current practice, MEC

92, alternate standard options, and the range of efficiencies available in the market that are above and beyond MEC 92 or the Federal minimum.

Foundation Insulation - Common foundations types in Missouri are basements and crawl spaces for single family housing and slab-on-grade for multi family.

Basements

Foundation insulation on basements (full or partial) is not common practice in new Missouri residential construction. This is due, in part, to two reasons:

- the expense of installing basement insulation as well as the difficulty in maintaining the integrity of the insulation during construction backfill and the longevity of the insulation that extends above finished grade.
- the recognition that uninsulated basement walls, particularly portions of the wall deep in the earth (i.e. 4 to 8 feet), provide a moderate cooling benefit to the home during the cooling season.

MEC 92 does not distinguish between unheated or heated basements. It requires that the exterior walls of all basements below uninsulated floors be insulated the full depth of the basement wall to approximately R-7.5 in southern Missouri locations and R-10 in northern Missouri locations. Requirements, as suggested by ASHRAE 90.2 and the DOE voluntary standard, generally echo these insulation levels. From a construction standpoint, these levels can be achieved in two basic ways: with 1.5 inches (R-7.5) or 2 inches (R-10) of rigid foam insulation applied to the exterior of the foundation wall or by insulating the cavities of a frame wall located on the interior of the foundation wall.

It is important to note, at the time of construction, most basements in Missouri are unfinished and unheated (although duct loss, heating equipment and a water heater may provide residual heat to the basement). As basements are often finished at a later date, it is common for basement walls to be subsequently insulated on the interior of the basement wall. The distinction between unheated and heated basements is significant. The *Builder's Foundation Handbook*, sponsored by the U.S. Department of Energy, indicates that no insulation for unheated basements in Missouri is warranted at "low to average" fuel costs, and that R-5 exterior insulation to a depth of 4 feet is recommended if "high" fuel prices prevail. According to the *Handbook*, only for unheated basements in far northern U.S. locations with "high" fuel costs is the MEC 92 requirement for R-10 insulation to a depth of 8 feet recommended. For heated basements in Missouri, the *Handbook* does recommend R-10 exterior foundation insulation for "average" fuel costs. The recommendations found in the *Handbook* are consistent with recommendations from a previous energy

efficiency study conducted for the Kansas City Home Builders Association and the Kansas City Power & Light Company for Missouri housing.[3]

Crawl Spaces

Crawl spaces are an alternate foundation approach to basements for homes in southern Missouri. Crawl spaces may be vented or unvented. If vented, the floor above a crawl space should be insulated. Unvented crawl spaces, a common practice in Missouri, are basically shallow, unheated basements. While some builders do insulate unvented crawl spaces, the majority of unvented crawl spaces are not insulated. MEC 92 requires R-10 crawl space wall insulation to a depth of 2 feet for southern Missouri locations and R-15 insulation to a depth of 2 feet for crawl spaces in northern Missouri locations. As is the case for basements, ASHRAE 90.2 echoes the MEC 92 requirement. To achieve these insulation levels, 2 inches (R-10) or 3 inches (R-15) of rigid foam insulation may be applied to either the exterior or the interior of the crawl space wall. Relative to insulation recommendations found in the *Handbook*, MEC 92 and ASHRAE 90.2 recommendation are considerably more aggressive. The *Handbook* recommends R-5 to R-10 exterior insulation to a depth of 2 feet for unvented crawl spaces in Missouri locations, depending on fuel costs. If the crawl space wall is insulated on the interior, the *Handbook* recommends only R-5 to a depth of 2 feet for all Missouri locations.

Slabs

Slab-on-grade construction is not common practice for single family housing in Missouri, although it may be occasionally used by builders in extreme southern and southwestern Missouri. Slab-on-grade is, however, the predominant foundation type for most of Missouri's multi-family construction. In new multi-family buildings in Missouri, slabs are not typically insulated. For all Missouri locations, MEC 92 would require the perimeter of slabs be insulated with 1 inch of rigid foam insulation (R-5) to a depth of 24 inches from the top of the slab or 24" under the slab from the perimeter. ASHRAE 90.2 and the Federal voluntary standard also recommend R-5 with similar installation details. In contrast to basements and crawl spaces, where MEC 92, ASHRAE 90.2, and DOE voluntary requirements were more aggressive than recommendations found in the *Builder's Foundation Handbook*, the values for recommended slab insulation in the *Handbook* suggest values higher than MEC 92, ASHRAE 90.2, and DOE values may be merited (up to R-10 to a depth of 4 feet depending on fuel costs).

Wall Insulation - Wood framing is the predominant wall construction method in Missouri housing, both single family and multi-family. Insulation is typically

[3] "Life Cycle Energy Cost Analyses to Determine Preferred Building Options: A Residential Building Optimization Study for Kansas City Area Home Builders". For the Kansas City Power & Light Company and the Kansas City Home Builders Association. Hannifan & King. May, 1986.

provided by simply placing insulating batts in the framing cavities. As a majority of housing is built with 2x4 framing, 3-1/2 inch insulating batts (high density R-13 batts for single family and regular density R-11 batts for multi-family) are the prevailing common practices. MEC 92, as noted earlier, does not specifically require wall insulation levels per se, as it sets a requirement for the entire wall assembly, including windows and doors. Assuming typical values for wall, window and door area in single family and multi-family houses, the MEC 92-equivalent requirements for wall insulation are approximately R-15 and R-19 for single family housing in southern and northern Missouri locations, respectively, and R-11 for multi-family housing in all Missouri locations. By sharp contrast, ASHRAE 90.2 and the DOE voluntary standard recommend wall insulations levels of R-19 or higher for all Missouri housing, both single family and multi-family. Achieving insulation levels in the R-19 range are achievable through the use of a foam sheathing material applied to the exterior of an insulated 2x4 wood frame or by using 2x6 construction. To achieve insulation levels to the R-24 to R-26 range, sheathed 2x6 construction is typically required.

Ceiling Insulation - Flat ceilings with attics is the predominant roof/ceiling configuration in Missouri housing. Common practice is to insulate ceilings with about 9-10 inches of blown-in, loose fill or batt insulation. For southern Missouri locations, common practice is approximately equivalent to the MEC 92 requirement, while MEC 92 would require an improvement to the R-38 level for northern Missouri. Surprisingly, ASHRAE 90.2 and the DOE voluntary standard do not recommend insulation levels higher than R-30. In certain cases, the DOE voluntary standard recommends only R-19 for southern Missouri locations. Additional ceiling insulation above R-19 to R-30 is relatively easily achieved, although there is diminishing economic return above the R-45 level.

Air Tightness - Many studies over the past fifteen years have demonstrated the importance of measures that restrict, to an appropriate level, uncontrolled air movement through housing. With the exception of minimum ratings for air leakage via windows and doors, the tightness of housing is not a provision of MEC 92 nor of the alternate residential standards. MEC 92 sets minimum levels of tightness for all window types at 0.34 cubic feet per minute per lineal foot (cfm/ft.) of operable sash crack. ASHRAE 90.2 sets its minimum levels of tightness at 0.34 cfm/ft. for wood windows and 0.37 cfm/ft. for aluminum and PVC windows. High efficiency windows on the market today are rated as low as the 0.05 to 0.15 cfm/ft. range. MEC 92 and ASHRAE 90.2 would both require residential doors not to exceed a rating of 0.5 cfm per square foot (cfm/ft^2) of door area. High efficiency doors on the market are rated as low as 0.15 to 0.30 cfm/ft^2.

Windows - Windows are one area of the residential envelope where recent technical innovations have led to significant energy performance improvement. Windows are inherently a major source of conductive heat loss or gain in housing.

The current practice in Missouri for both single family and multi family is the use of dual glazed windows with aluminum frame (w/o thermal break) that have an insulating value of about R-1.5 for the entire "unit" (glass and frame). In Missouri, single glazed aluminum windows with accompanying storm window is also common. Wood windows are not considered common in low to medium priced housing; in more expensive housing, wood windows are more common. MEC 92 does not specifically set a requirement for window conductive efficiencies, as they are embedded in the requirement for the overall wall system. ASHRAE 90.2 requires unit insulating values (for glass and frame) of R-1.2 to 2.8. DOE voluntary standards, depending upon economic assumptions, indicate that R-3 to R-4 "center-of-glass" values may be merited. Such thermal performance gains in "center-of-glass" R-values are due to use of thin, "low-e" films (applied directly to glass or suspended in the glazing system) that inhibit radiative heat transfer through the window and the use of low conductance gases (such as argon) in lieu of air. Innovative plastic, wood, and metal frames are also emerging that, when combined with high performance glazings, enhance the unit (glass and frame) R-value of windows.

To date, there is a not a consensus, national system for rating the efficiency of windows. The National Fenestration Rating Council (NFRC) has developed a U-value labeling and certification system for windows, NFRC 100-91. It is undergoing review by DOE to determine if it is consistent with the objectives as set forth in Section 121 of EPAct. NFRC 100-91 has been adopted by several states into their building efficiency codes. If DOE does not approve NFRC 100-91 as a reasonable national standard, DOE and the Federal Trade Commission will administer a program within two years.

Heating and Cooling - Although MEC 92 and other alternate residential standards set minimum efficiency levels for residential heating and cooling equipment, they by default adopt the minimum efficiency levels set forth by NAECA.

Gas Furnaces

Per NAECA, all residential gas furnaces (< 225,000 Btu per hour capacity) manufactured after January, 1992, shall have an *annual efficiency* of 78%, or 78 AFUE (Annual Fuel Utilization Efficiency). Although many gas furnaces in the range of 65 to 78 AFUE have been installed in Missouri in recent years, the new NAECA minimum now is synonymous with current practice. As written, MEC 92 does not use the now conventional AFUE rating, but instead requires that residential gas furnaces have a *steady state efficiency* of 74%, which has now been significantly superseded by the NAECA requirement. ASHRAE 90.2 and the DOE voluntary standard recommendations generally match NAECA's 78 AFUE level. Gas furnaces with AFUE ratings of 78 to 95+ are available from several manufacturers which use a combination of electronic ignition, automatic vent dampers, and variable speed operation. AFUE values for hundreds of gas-fired furnaces may be found in the *GAMA*

Consumer Directory of Certified Energy Efficiency Ratings for Residential Heating and Water Heating Equipment.

Air Conditioning

NAECA provisions require that residential, split-system air conditioners (<5-1/2 tons) manufactured after January, 1992, shall achieve an *annual efficiency* of 10.0 SEER (Seasonal Energy Efficiency Ratio). Prior to NAECA minimums, 7 to 9 SEER air conditioners were common in new Missouri housing. The new NAECA requirements now elevates the current practice for air conditioner selection by most homebuilders and homebuyers. As written, MEC 92 does not use the now conventional SEER rating, but instead requires that residential air conditioners have a *steady state efficiency* of 2.28 COP (coefficient of performance) at 95°F outdoor air temperature. ASHRAE 90.2 and the DOE voluntary standard also echo the NAECA requirement of 10.0 SEER. Electric air conditioners with SEER ratings of 10 to 16+ are available from many manufacturers which use improved heat exchangers and variable speed operation. SEER values for hundreds of residential air conditioners may be found in the *ARI Directory of Certified Unitary Air Conditioners and Unitary Air Source Heat Pumps.*

Electric Heat Pumps

NAECA provisions require that residential, split-system electric heat pumps (< 5-1/2 tons cooling) manufactured after January, 1992, shall have an *annual heating efficiency* of 6.8 HSPF (Heating Seasonal Performance Factor) and the same *annual cooling efficiency* (SEER) requirement as described above for air conditioners. Prior to NAECA minimums, 5.5 to 6.5 HSPF electric heat pumps were not uncommon in new Missouri housing. The new NAECA requirements now elevates the floor of electric heat pump efficiency. As written, MEC 92 does not use the conventional HSPF/SEER rating, but instead requires that residential heat pumps have a *steady state efficiency* in the heating mode of 2.7 COP and 1.8 COP at 47°F and 17°F outdoor temperatures, respectively. MEC 92 cooling efficiency requirements for electric heat pumps are the same as those described for air conditioners. ASHRAE 90.2 and the DOE voluntary standard. Electric heat pumps with HSPF ratings of 6.8 to 10+ are currently available. Electric heat pump SEER ratings are consistent with the efficiencies available for air conditioners. HSPF and SEER values for hundreds of residential electric heat pumps may be found in the *ARI Directory of Certified Unitary Air Conditioners and Unitary Air Source Heat Pumps.*

Storage Water Heating - New residences in Missouri almost exclusively use storage water heaters as the means to provide hot water, with most operating on natural gas and electricity. NAECA standards cover gas-fired storage water heaters of 75,000 Btuh capacity or less, and electric units of 12 kW or less. Energy performance of these units is described by their energy factor (or EF). An EF is an *annual efficiency* value defined in the DOE test procedure described in Title 10, CFR,

Chapter II, Part 430, Subpart B, Appendix E. NAECA requires that gas-fired and electric units achieve a minimum EF of 0.52 and 0.86, respectively. Section 504 of MEC 92 addresses water heating efficiency, but in a manner that is not consistent with the now more common EF rating. MEC 92 requires that gas-fired units have a *"recovery efficiency"* not less than 75% and a maximum standby loss based on tank volume. For electric units, MEC 92 also bases its efficiency requirement on tank standby loss, not to exceed 4.0 watt/ft2 of tank surface or 43 watts, whichever is greater. The NAECA required minimum EF ratings and the MEC 92 required values approximately yield similar energy performance, but the MEC 92 rating format is cumbersome and the data to determine compliance not readily available. By contrast, EF values for hundreds of gas-fired and electric storage water heaters may be found in the *GAMA Consumer Directory of Certified Energy Efficiency Ratings for Residential Heating and Water Heating Equipment*.

By comparison to the NAECA minimum values, the best available storage water heaters on the market today (as found in the *GAMA Directory*) have EF ratings of 0.72 for gas units and 0.97 for electric units. Actual energy performance of an installed water heating system is affected by the location in which the tank is placed, the schedule and amount of hot water used, the length of pipe through which hot water must travel to the point of end use and thermal losses associated with service water piping on top of the tank.

Appliances - Household appliances are not directly addressed as part of MEC 92, nor any of the alternate residential standards. However, efforts designed to improve the efficiency of building envelopes and space conditioning and water heating equipment will likely result in appliances such as refrigerators, clothes washers and dryers, and dish washers accounting for a larger portion of total household energy use in the future. To ensure that appliance efficiencies keep pace with cost effective and available technological features, NAECA provisions will periodically raise the minimum efficiency of household appliances that may be manufactured and sold.

Technology and Standards in Perspective

Residential: Single Family — **Building Envelope**

Table III-3
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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 @ 6% (22)	Federal @ 8% (22)	Federal @ 10% (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-10 (17)	R-10 (17)	R-5 (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-5 (18)	R-10 (14)
Walls										
Exterior	NA	R-Value	NA	R-13	R-15-19 (#)	R-19 (25)	R-26	R-23	R-13	R-19-24
Ceiling										
Flat w/ Attic	NA	R-Value	NA	R-30	R-30-38	R-30 (23)	R-30	R-30	R-30	R-38-55 (2)
Cathedral	NA	R-Value	NA	R-19 (15)	R-30-38	R-33 (24)	R-30	R-30	R-30	R-35-42 (3)
Floors										
Over Unconditioned Space	NA	R-Value	NA	R-19	R-19 (16)	R-13-19 (26)	NA	NA	NA	R-19-38
To Exterior	NA	R-Value	NA	R-19	R-30-38 (6)	R-30	R-30	R-30	R-30	R-19-38
Windows										
Conduction	NFRC (32)	R-Value	NA	R-1.65 (7)	NA (33)	R-1.2-2.8 (30)	R-4 (19)	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-11-14
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 (insulated walls, windows, and doors) of R-6.9-7.7. Values represent the insulated wall portion only based on 12% glazing (Dbl Alum. w/o TB).

1. Center of glass values of R-4-8 from 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 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. 2x8 rafters with R-19 fiberglass.
16. MEC 92 requires a total floor assembly R-20; R19 insulation w/ carpet and floor deck will achieve this level.
17. Insulation to depth of 48 inches.
18. Insulation to depth of 24 inches.
19. Triple glass w/ low-e. R-value is center of glass.
20. Double glass w/ low-e. R-value is center of glass.
21. ASHRAE 90.2P values based on prescriptive path. Ductwork is considered to be inside conditioned space.
22. Per DOE's ARES 1.2 standards generator for single family; % represents mortgage rate (assumptions: 30 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-values 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 R-1.2-2.8 for entire window assembly (glass and frame), depending on location of ductwork.
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.
33. MEC 92 does not specifically require window efficiency (included in requirement for wall assemblies); Double glazings needed to meet wall R-values in this table.

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

Table III-4
Page One

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.

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)

Table III-5
Page One

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 (20.6 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 $0.076 per kWh; winter heat rate of $0.0375. ARES 1.2 recommended heat pump heating efficiencies exceed the current federal equipment standard.

Table III-5
Page Two

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.

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.

Table III-6

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.

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[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 ft² (North)	$55/ft²	NA
One Story with Crawl Space: 1700 ft² (South)	$53/ft²	NA
Two Story with Basement: 2460 ft² (North/South)	$55/ft²	NA
Apartment with Slab: 960 ft² (North/South)	NA	$45/ft²
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 ft² one story and 2460 ft² 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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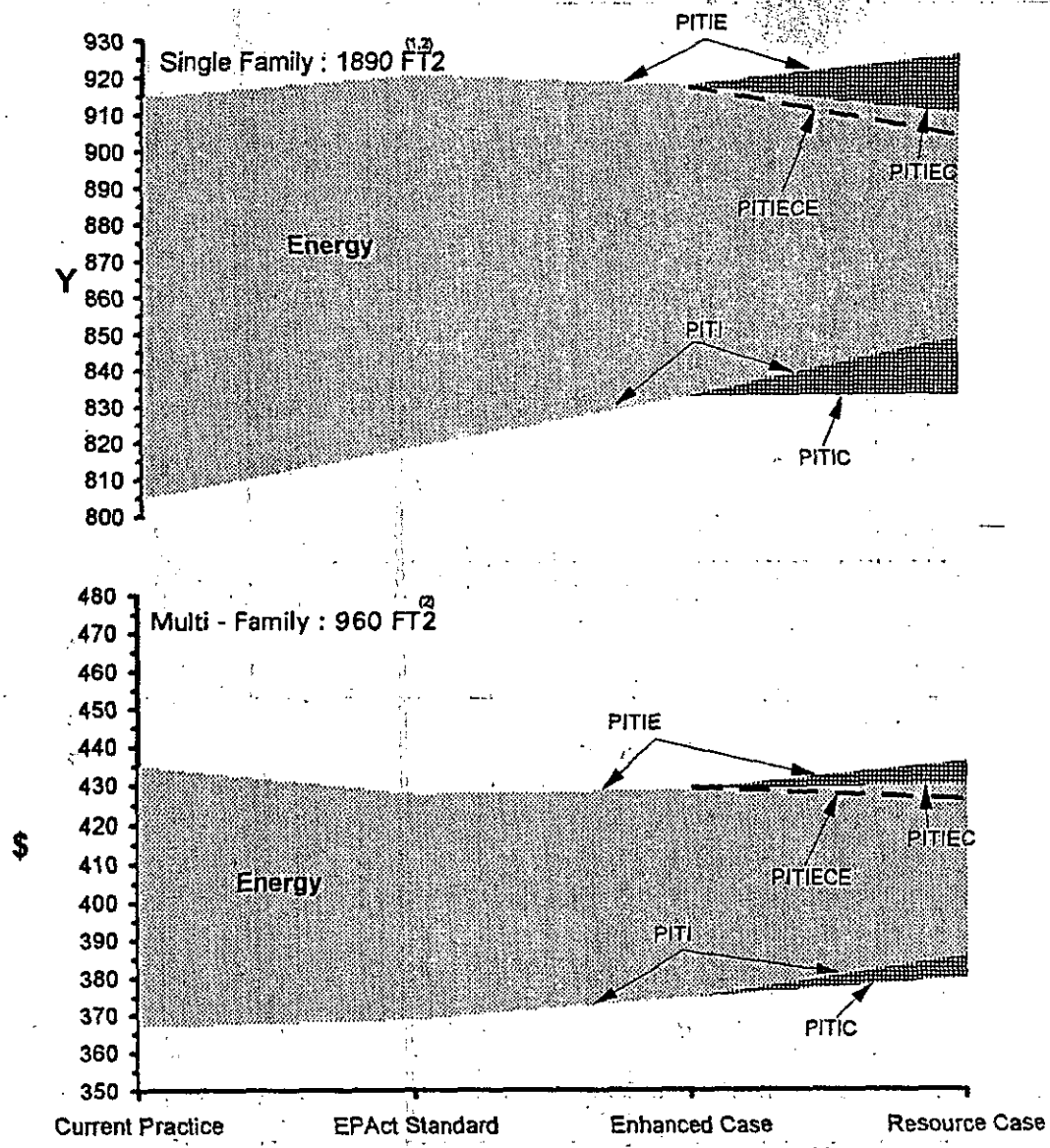
[13] One and two story single family housing have been combined. When analyzed separately, two story single family housing consistently demonstrated about 10% lower energy costs per square foot of floor space than one story single family housing due to a lower ratio of exposed wall, ceiling and foundation 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 ft². It is assumed that 75% of new single family units in that period will be 1700 ft² and 25% of new single family units will be 2460 ft² [(0.25 x 2460) + (.75 x 1700) = 1890 ft²].

[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 ft², with an energy cost of $0.62 per ft² (total cost of ownership of $5.89 per ft²). 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 ft² and $0.63 per ft², $5.24 per ft² and 0.63 per ft², and $5.22 per ft² and $0.64 per ft². 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)

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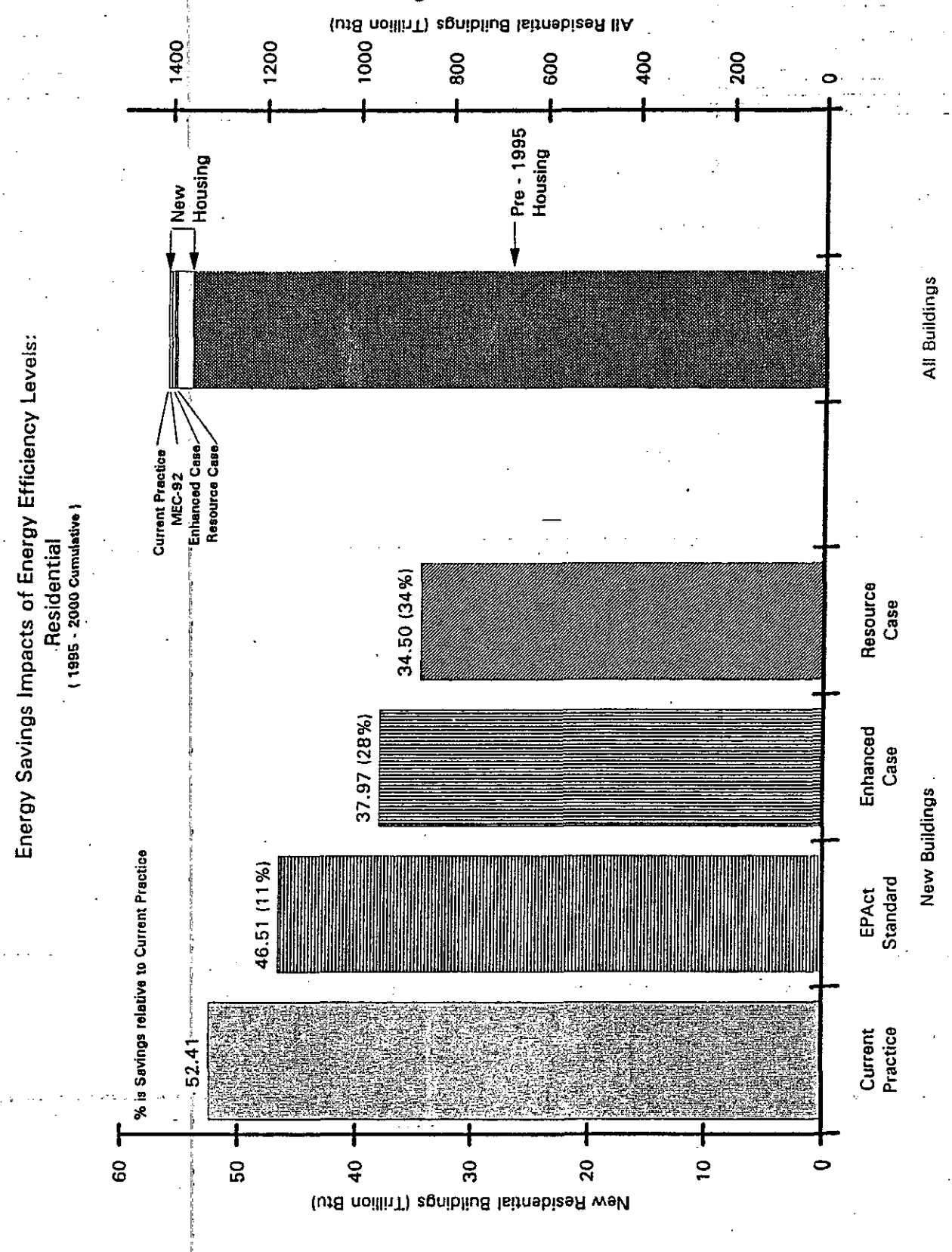
[17] Electric heating is competitive with gas heating where winter electric heat rates – which may be as much as 50% of summer rates – are offered. Most electric utilities in the state offer discounted winter electric rates for homes with electric space and water heating.

[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.

Figure III-4


Energy Savings Impacts of Energy Efficiency Levels:
Residential
(1995 - 2000 Cumulative)
% is Savings relative to Current Practice
52.41
46.51 (11%)
37.97 (28%)
34.50 (34%)
Current Practice
EPAct Standard
Enhanced Case
Resource Case
New Buildings
All Buildings
New Residential Buildings (Trillion Btu)
All Residential Buildings (Trillion Btu)
Current Practice
MEC-92
Enhanced Case
Resource Case
New Housing
Pre - 1995 Housing

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 all 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.

[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%

Table III-9
Page One

Commercial Buildings Performance Summary

Table III-9
Page Two

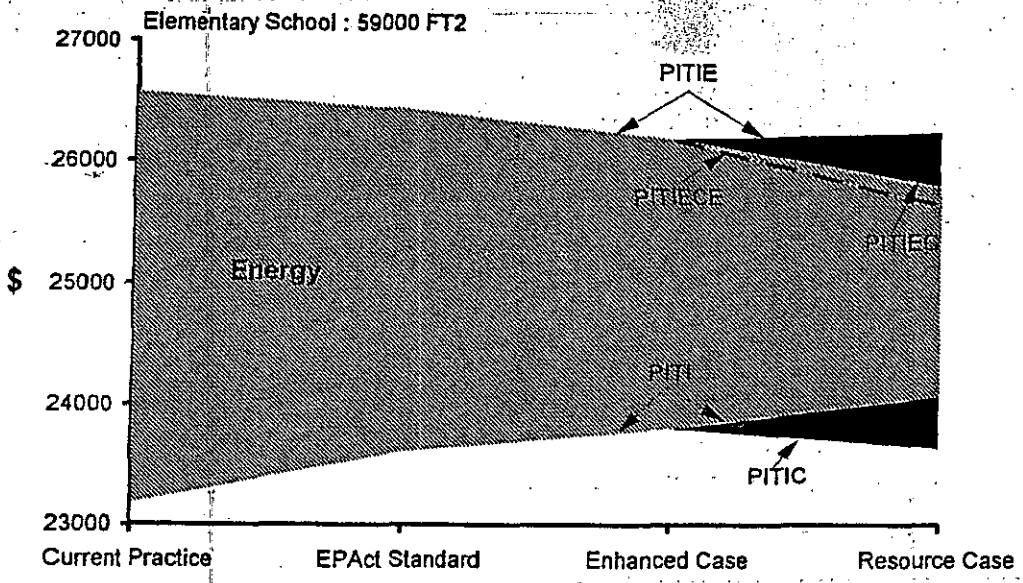
Building Type						Examples are all for North Zone	
Variable	Current Practive	EPAct Case	% change from C.P.	Enhanced Case	% change from C.P.	Resource Case	% change from C.P.
Small Office Building							
Gas Heat							
Peak gas demand, Btu/SF	52	42	19.23%	31	40.38%	21	59.62%
Annual gas, Btu/SF	32000	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	4.38%	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		$7.43	-1.50%
PITIECE$/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		$7.48	1.58%
PITIECE$/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		$7.99	1.72%
PITIECE$/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		$8.09	4.37%
PITIECE$/SF	na	na		na		$7.94	6.15%

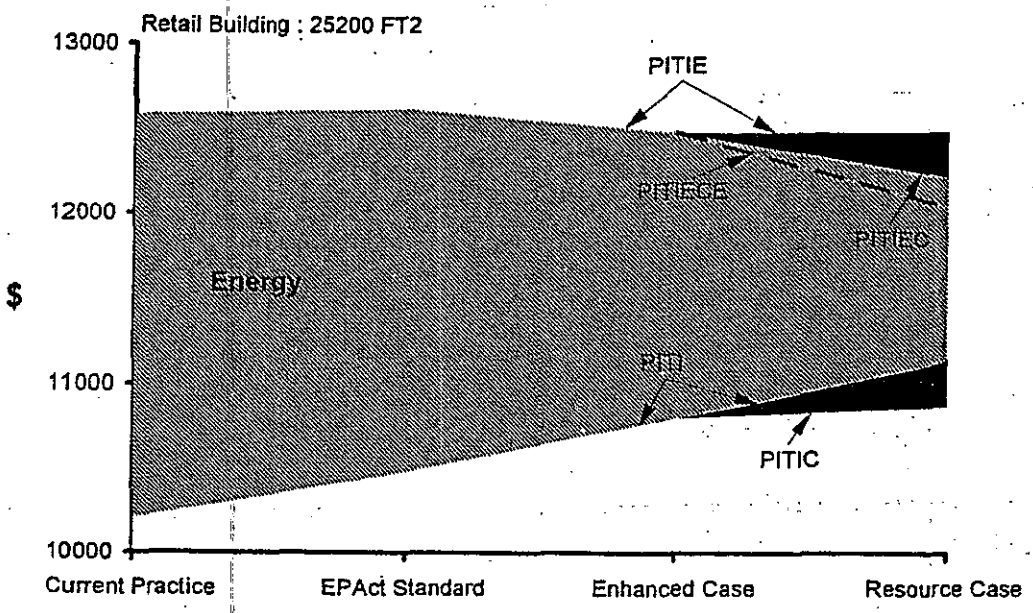
Commercial Buildings Performance Summary (cont'd)

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

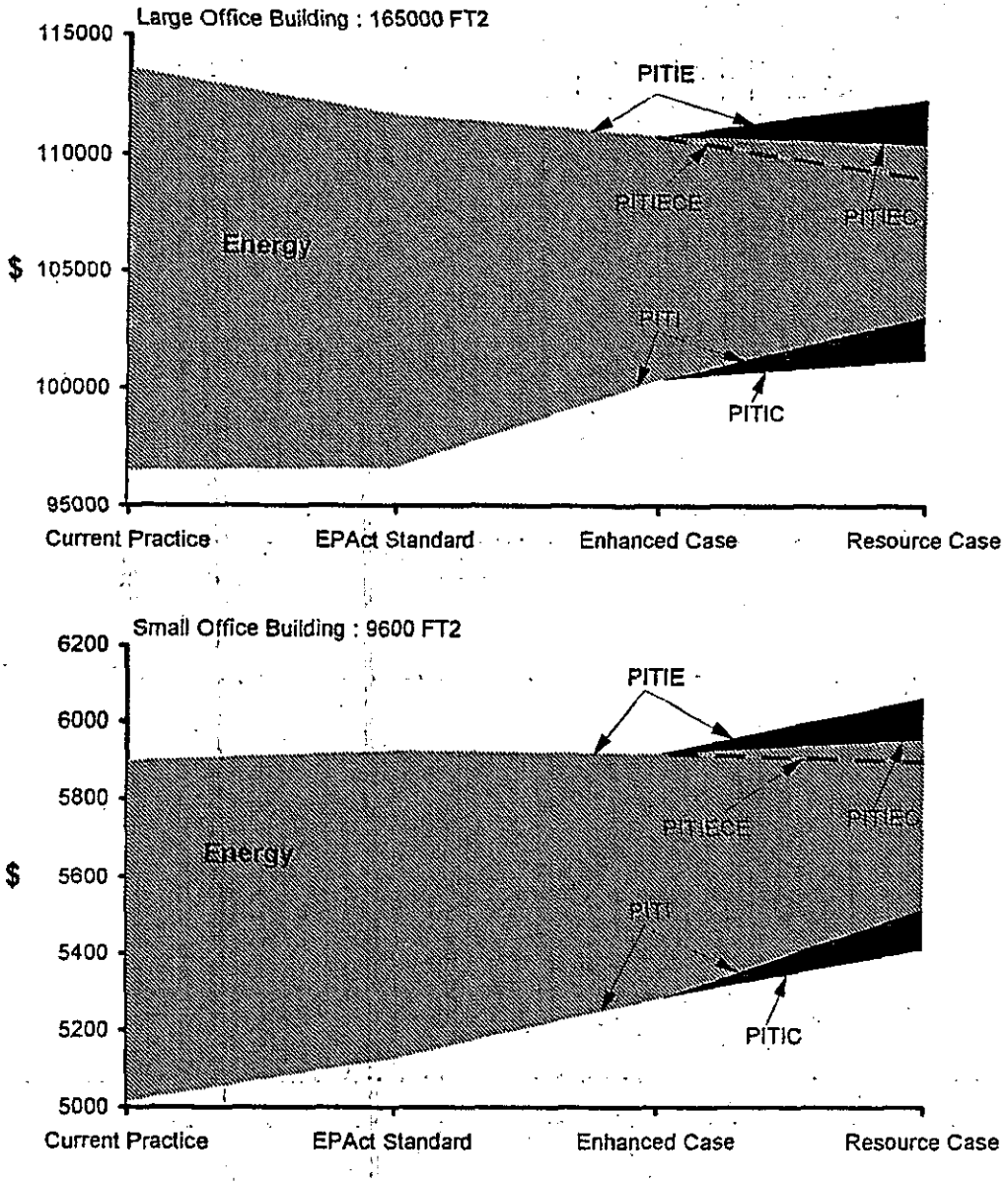


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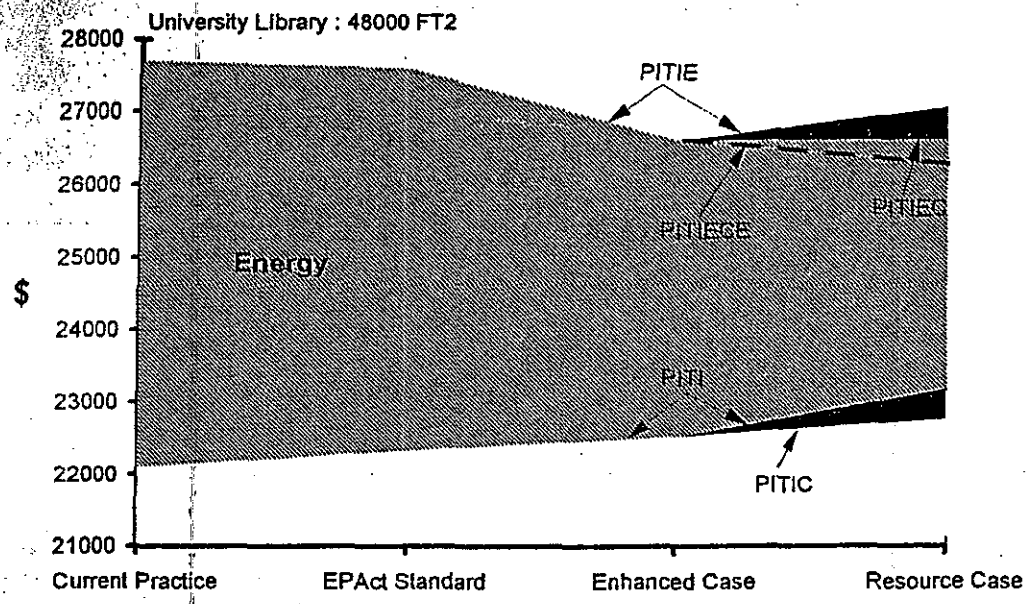
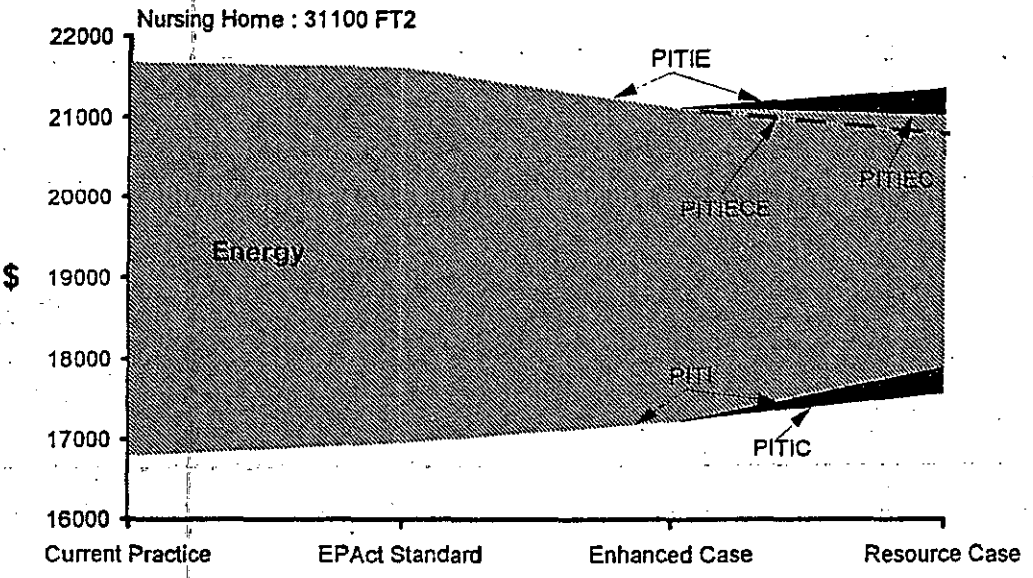
Figure III-5
Page Three

Average Monthly Ownership Costs





PITI = Principal, Interest, Taxes, Insurance
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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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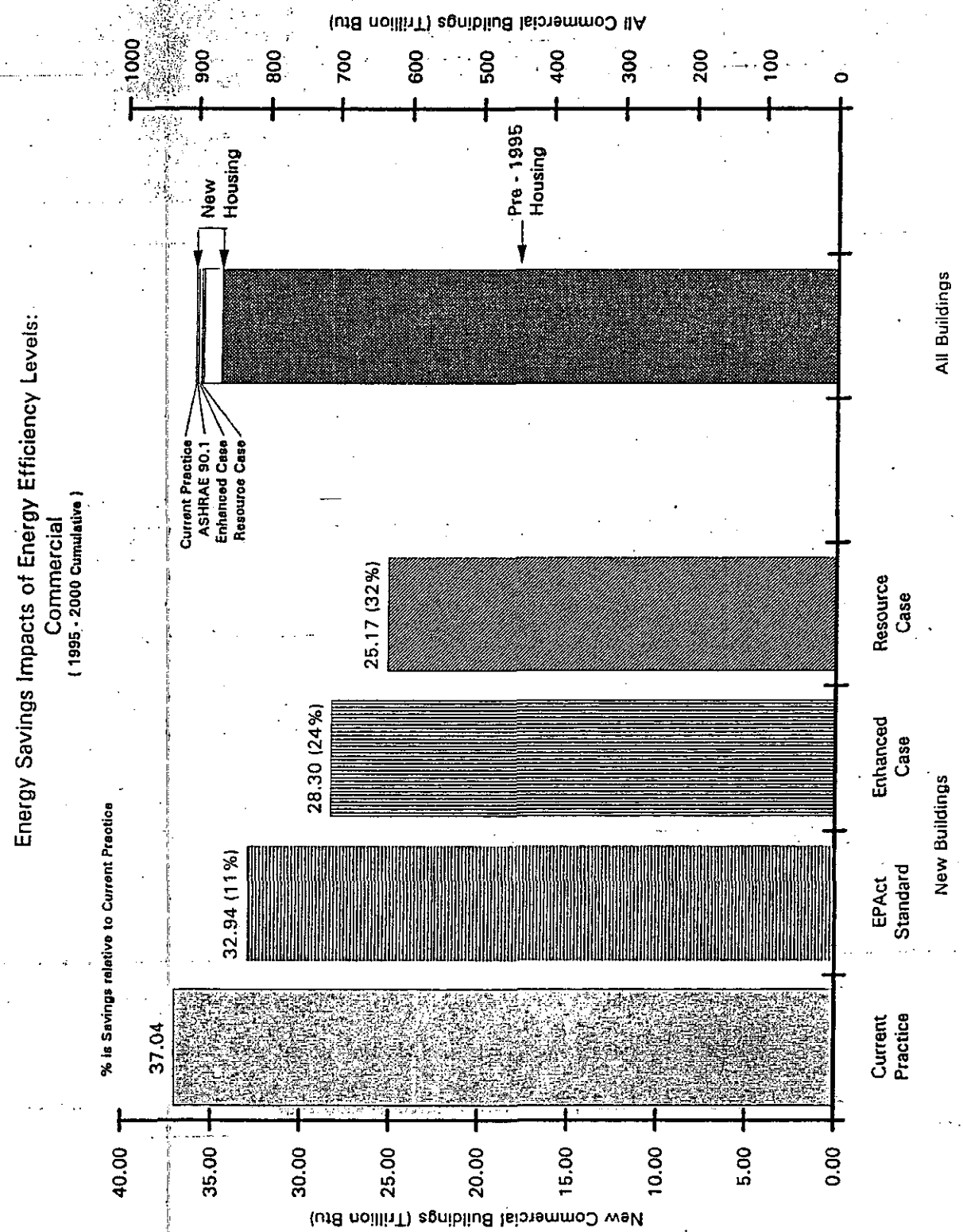
[24] EPAct requires that states certify that they have reviewed energy standards for appropriateness by October, 1994. Assuming this date for a standard to be in place, it would begin to affect building efficiency in 1995. Although the benefits of energy standards continue far beyond the 1995-2000 period, 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 all 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.

Figure III-6


Energy Savings Impacts of Energy Efficiency Levels:
Commercial
(1995 - 2000 Cumulative)
% is Savings relative to Current Practice
37.04
32.94 (11%)
28.30 (24%)
25.17 (32%)
Current Practice
EPAct Standard
Enhanced Case
Resource Case
New Buildings
All Buildings
New Commercial Buildings (Trillion Btu)
All Commercial Buildings (Trillion Btu)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1000
900
800
700
600
500
400
300
200
100
0
New Housing
Pre - 1995 Housing
Current Practice
ASHRAE 90.1
Enhanced Case
Resource Case

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