State-Level Office Building Energy Efficiency Rankings

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July 15, 2008

About the Author

Jerry Jackson is an energy economist, author and Texas A&M University professor with over thirty years experience addressing energy industry issues. He recently authored Energy *Budgets at Risk (EBaR) ®: A Risk Management Approach to Energy Purchase and Efficiency Choice* (John Wiley and Sons, April 2008) which shows organizations how to apply financial risk management principles to identify profitable energy efficiency investments. He is also president of the consulting firm, Jackson Associates. His consulting clients include more than 20 Fortune 500 companies, state energy agencies, the Department of Energy, and national research laboratories. He holds a Ph.D. in economics from the University of Florida. Additional information is available at http://www.energybudgetsatrisk.com/jj.htm .

Introduction

Energy efficiency improvements are widely acknowledged as the best strategy to combat increasing energy prices and reduce greenhouse gases. In spite of widely publicized efforts like the EPA/DOE Energy Star program and the US Green Building Council's LEED programs, evidence from the field indicates that most commercial building owners can still significantly reduce energy use with cost-effective energy efficiency investments. Cost savings are so great relative to amortized investment costs that nearly all buildings can actually increase cash flows by making energy efficiency investments. In addition to reducing energy costs, carbon emissions and increasing cash flows, these investments also increase the capital value of the building.

Commercial building owners have bypassed profitable investments in the past in large part because traditional investment analysis does not address risk associated with future energy prices, weather, equipment performance, operating hours and other factors. This impediment can be overcome by applying a financial risk management approach that I developed and describe in my recently published book *Energy Budgets at Risk (EBaR)®: A Risk Management Approach to Energy Purchase and Efficiency Choice* (John Wiley and Sons, April 2008).

To provide readers with estimates of potential energy cost savings for their buildings, I included a series of tables in the *Energy Budgets at Risk* appendix that readers can use with their monthly bill information. The data in these tables was developed from analysis of commercial sector building energy use data across the US from the MAISY® Utility Customer Energy Use Database (http://www.maisy.com).

While the *Energy Budgets at Risk* appendix tables help individual building owners assess energy efficiency opportunities and potential cost savings in their own buildings, no assessment of current efficiency achievements and opportunities has been conducted for individual states. Such rankings can provide value to federal and state agencies in evaluating potential energy and cost savings available with additional efficiency programs.

This paper describes the results of the first ranking of office buildings electric efficiency for the 48 continental states.

Methodology

This state efficiency ranking focuses on office buildings electricity use efficiency. Office buildings make up approximately 23 percent of commercial buildings and account for about 26 percent of commercial sector electricity use.

Efficiency ratings for each state are estimates of the fraction of buildings that achieve electricity use per square foot in most efficient quartile of office buildings in the continental US. This criterion is consistent with EPA's Energy Star rating though Energy Star ratings consider natural gas and other energy sources used within the building.

The methodology applied in this study is similar to that detailed in the Appendix of *Energy Budgets at Risk*; however, instead of using electric billing data, end-use energy use data are taken directly from customer records in the MAISY Utility Customer Energy Use State Databases.

MAISY databases are comprised of a representative sample of commercial buildings throughout the US. Each building record includes building energy use as well as energy use by end use including space heating, air conditioning, ventilation, interior lighting, water heating, cooking, refrigeration, office equipment, exterior lighting and miscellaneous equipment. The databases have been widely used by utilities, retail electricity providers, equipment manufacturers, research laboratories and other energy-related organizations. More information on the databases and database clients is available at http://www.maisy.com.

The office efficiency ranking analysis was completed in two steps: (1) calculating the distribution of electricity efficiency in office buildings across the continental US and (2) determining the fraction of buildings within each state that fall within the most efficient quartile of buildings.

Baseload electricity efficiency, which excludes heating, air conditioning and ventilation (HVAC) was selected as the most accurate indicator of building energy efficiency. Baseload uses include interior lighting, office equipment, miscellaneous plug loads, exterior lighting, water heating, cooking and refrigeration. Baseload uses account for about 75 percent of office building electricity use. Interior lighting, which is about 50 percent of baseload electricity use, offers one of the greatest opportunities for energy efficiency investments. Inefficiently lit office buildings can easily use twice as much electricity/square foot as more efficient buildings. Office equipment and miscellaneous plug loads account for approximately 40 percent of baseload electricity use and similarly provide significant energy efficiency opportunities. The baseload efficiency measure was also selected because, unlike space heating and air conditioning, lighting and other baseload energy requirements do not vary by geographic location (except for insignificant variations caused by fewer daylight hours in northern states). A national distribution of baseload efficiency measures was used to identify the upper quartile efficiency boundary used in the ranking.

Results

State efficiency rankings, scores and cost/efficiency savings are shown below

Efficiency Rank	State	Score (% Exceeding Energy Star Standard)	% Cost Savings*	Efficiency Rank	State	Score (% Exceeding Energy Star Standard)	% Cost Savings*
1	ME	41.70	29.9	25	MN	21.66	7.4
2	MA	40.07	27.8	26	OR	21.59	7.3
3	NH	37.77	24.9	27	FL	21.53	7.4
4	VT	37.72	24.1	28	IL	21.44	7.3
5	NV	35.57	22.2	29	MT	21.36	7.3
6	NY	33.27	18.9	30	TX	21.28	6.9
7	CA	33.22	19.2	31	OH	21.20	7.0
8	CT	33.17	19.0	32	AR	21.14	6.9
9	RI	33.13	19.4	33	WA	21.04	6.9
10	NJ	32.64	19.1	34	KS	20.99	7.2
11	CO	31.47	17.7	35	MD	20.97	6.7
12	UT	31.37	17.6	36	WV	20.92	6.8
13	ID	29.07	14.4	37	GA	18.62	4.2
14	PA	28.99	14.9	38	MO	17.64	3.3
15	DE	28.98	15.0	39	TN	17.64	3.3
16	WI	28.92	15.0	40	SC	17.62	3.2
17	NM	28.83	14.9	41	NC	17.53	3.2
18	SD	26.53	11.8	42	LA	17.48	3.1
19	AZ	26.48	12.1	43	MS	17.43	3.0
20	NE	24.18	9.9	44	KY	16.40	2.0
21	IN	21.88	6.9	45	OK	15.58	1.1
22	WY	21.79	7.5	46	ND	15.51	1.0
23	MI	21.71	7.3	47	AL	14.58	0.0
24	IA	21.70	7.3	48	VA	14.51	0.0

*Cost savings are savings in electricity costs associated with efficiency differences between each state and the two least energy-efficient states (Virginia and Alabama with an average of 14.55 office buildings meeting the Energy Star Standard). For example, the Maine cost savings of 29.9 percent indicates that Maine office building electricity costs are 29.9 percent less than they would be if the Maine score were 14.55 percent.

Observations

Each state's rank is determined by its score: the percent of buildings that exceed the Energy Star upper quartile energy efficiency standard. The table shows New England states leading the country in office building energy efficiency. Maine, Massachusetts, New Hampshire, and Vermont scored the top four spots in this first state ranking of office building energy efficiency. Nevada scored a 5th place while New York and California followed in sixth and seventh places. Connecticut, Rhode Island and New Jersey rounded out the top 10.

The cost savings column shows savings in electricity costs associated with efficiency differences between each state and the two least energy-efficient states (Virginia and Alabama with an average of 14.55 office buildings meeting the Energy Star Standard). For example, the Maine cost savings of 29.9 percent indicates that Maine office building electricity costs are 29.9 percent less than they would be if the Maine score were 14.55 percent.

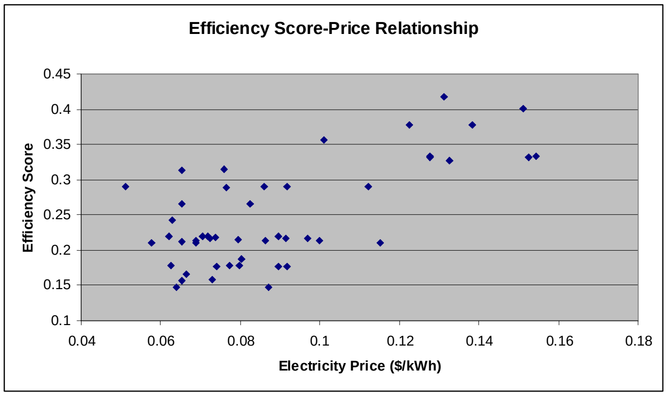
It is important to note that Alabama and Virginia still receive a score of nearly 15 percent. That is, 15 percent of office buildings in these two states meet the Energy Star standard. Energy savings are presented relative to those achieved in Alabama and Virginia to highlight electricity cost savings potentials for less efficient states,

It is interesting to note that while Maine has achieved an electricity use and cost advantage over the least efficient states, 58.3 percent of office buildings still do not meet the Energy Star standards. Clearly significant potential exists to increase the number of efficient office buildings and to reduce electricity use and costs even further.

While the rankings and savings provide an interesting picture of energy efficiency disparity across the states and illustrates the significant potential for reducing electricity costs, these results two important questions: Why are some states more efficient than others and what can be done to improve building efficiency in the future? These issues are addressed below.

Impact of Electricity Prices on Electric Efficiency

Electricity prices are expected to impact office building efficiency as higher prices make efficiency investments more attractive. As expected, the top 10 states appear to owe much of their efficiency advantage to higher prices. The average electricity price in these top ten states is 13.4 cents/kwh, more than 5 cents/kWh higher than the average price in the other 38 states. The efficiency score-electricity price relationship is evident in the following graph.



Impact of Office Growth on Electricity Efficiency
Newer office buildings are built to more energy efficient standards than older buildings; consequently states with greater office building growth are expected to exhibit greater energy efficiency, other things equal. Nevada appears to have landed in the top 10 in part on the basis of its strong commercial sector growth (62 percent increase in commercial sector employment since 1994) rather than because of its electricity price of 10.1 cents/kWh. Similarly Idaho's growth of 37 percent in this same time period is likely a large factor in its number 13 spot given its average electricity price of only 5.1 cents/kWh. Maryland commercial employment, on the other hand, grew at only 14 percent resulting in an office building stock that is less efficient than the average because of a larger percentage of older buildings even though Maryland electricity price is 11.5 cents/kWh.

Impact of State and Utility Programs on Electricity Efficiency
State building standards and state and utility electric efficiency programs undoubtedly have some influence on the current state of office building energy efficiency. Unfortunately no detailed information on office-related programs is available to quantitatively evaluate these influences impacts.

Conclusion on Factors Affecting State Efficiency Scores
Energy prices are clearly a primary determinant of state efficiency achievements, explaining over 50 percent of the variation in efficiency scores in a statistical analysis. The growth of the office sector is also a statistically significant variable in explaining variation in state efficiency scores.

Implications for Improving State Efficiency Scores
Study results provide implications for the design of state and utility efficiency initiatives. Office building owners clearly respond to economic incentives in the form of higher electricity costs by increasing energy efficiency. State and utility programs that educate office-building owners on efficiency investment opportunities to reduce electricity costs along with financial incentives including investment analysis, purchase incentives and financing can potentially provide a similar impetus to increase efficiency in all states.

Summary

This first effort to compare energy efficiency achievements on a state-by-state basis indicates that economic incentives created by high electricity prices are a dominant factor in explaining rankings of individual states. Growth in the office sector were also found to have an impact on efficiency rankings.

The results of this study show that even the most efficient states still have significant potential for electric efficiency improvements. For example, in Maine, the most efficient state, 58.3 percent of office buildings fall short of the Energy Star efficiency criterion.

Study results suggest that economic incentives can be a powerful incentive to promote increased energy efficiency. State and utility programs consisting of a combination of education, investment and financing incentives provide promising opportunities to promote energy efficiency.