How States Can Harness Energy Efficiency to Fortify the Economy and Reduce Pollution with Building Energy Codes

Sara Hayes and Garrett M. Herndon, American Council for an Energy-Efficient Economy

ABSTRACT

Section 111(d) of the Clean Air Act requires the Environmental Protection Agency (EPA) to regulate greenhouse gases from existing power plants. One of the lowest-cost options for reducing pollution from the power sector is making energy efficiency improvements in buildings. EPA has proposed a rule that includes end-use energy efficiency as a compliance mechanism, and states will very likely have the flexibility to credit energy efficiency in their implementation plans. While there is a great potential for pollution reductions from efficiency, many important questions remain unanswered. One of the most important questions is: What is the potential for energy efficiency in buildings to reduce greenhouse gases? This paper draws from new and ongoing research to answer this question. Specifically, it includes the results of a state-by-state analysis of the energy, economic, and air-quality benefits that could be achieved through adoption of improved building efficiency programs and updated building codes.

Introduction

On June 25, 2013, President Barack Obama called on the U.S. Environmental Protection Agency (EPA) to regulate greenhouse gases from existing power plants. One of the most promising opportunities for low-cost pollution abatement is end-use energy efficiency. On June 2, 2014, EPA issued a proposed rulemaking that specifically includes end-use energy efficiency as a possible compliance mechanism. In EPA's rulemaking, building codes are called out as a potential compliance path, but it suggests that the development of "appropriate quantification, monitoring, and verification protocols" might be needed (EPA 2014, 491).

In an attempt to help states determine the value of pursuing this path to compliance, this paper will quantify the energy, economic, and pollution impacts that could be attributable to the adoption of updated building energy codes. This analysis is intended to be moderate and relies on fairly conservative assumptions and common current practices.

Our results demonstrate that through the adoption of model building energy codes, states can accrue considerable economic, environmental, and societal benefits. Nationally, these policies would cumulatively save over 1.1 million gigawatt-hours of electricity by 2030. This would translate to a roughly 4% reduction in electricity consumption in 2030 relative to 2012 levels. These reductions in electricity consumption could reduce greenhouse gas emissions by over 106 million tons in 2030.

Building Energy Codes

Methodology

Building codes establish minimum requirements for the design and construction of new and renovated residential and commercial buildings. States have the authority to adopt building codes, which are generally based on model codes developed by national consensus standards organizations. The International Code Council® develops the International Energy Conservation Code® (IECC), the national residential model code, and updates it every three years. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) updates model commercial codes (ASHRAE Standard 90.1) every three years. The most recent national model codes date from 2012 and 2010 for residential and commercial buildings, respectively.[1] While many states have been leaders, not all states have adopted model building codes, and almost all states are several years behind in adopting the most recent codes. Figures 1 and 2 show the current status of building code adoption by state.

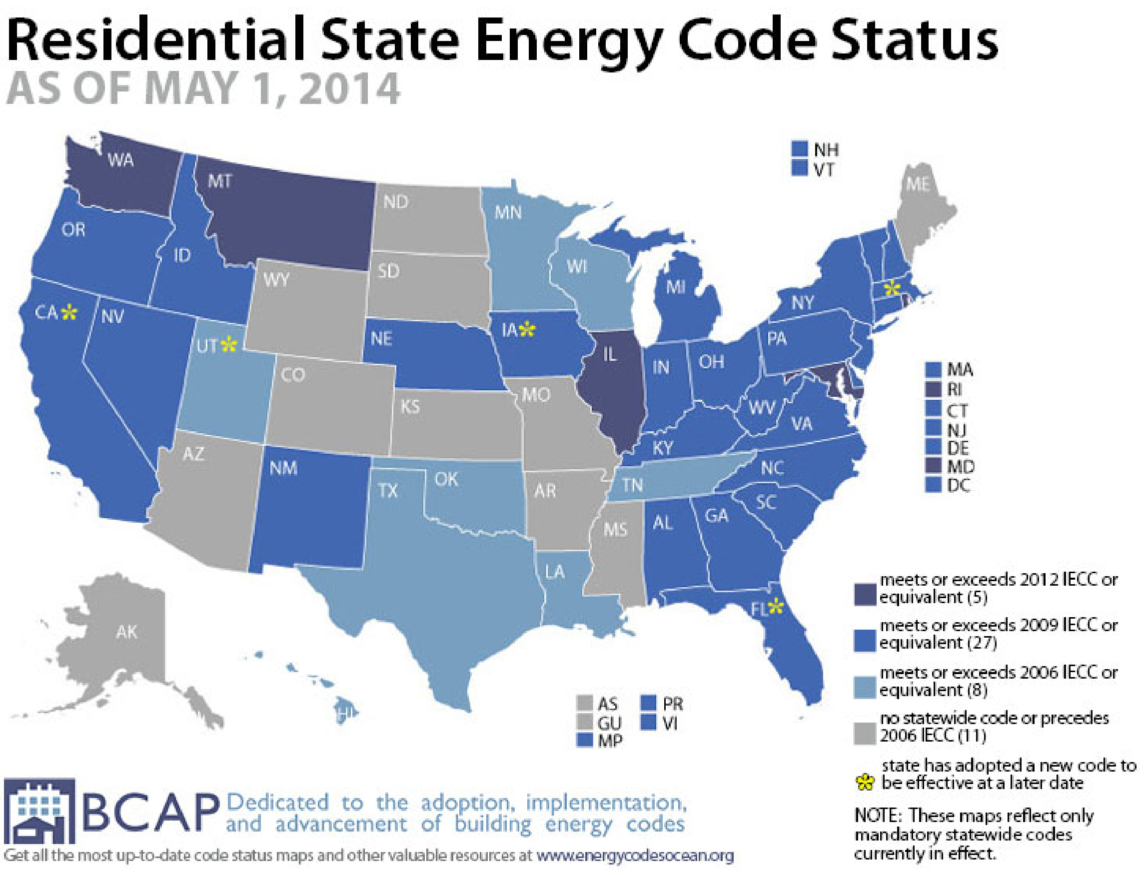

Figure 1. Residential state energy code status. *Source*: BCAP 2014.

[1] The 2013 standard has recently been developed for commercial buildings; however, we used the 2010 standard here because the data needed to complete this analysis are not yet available for the new standard.

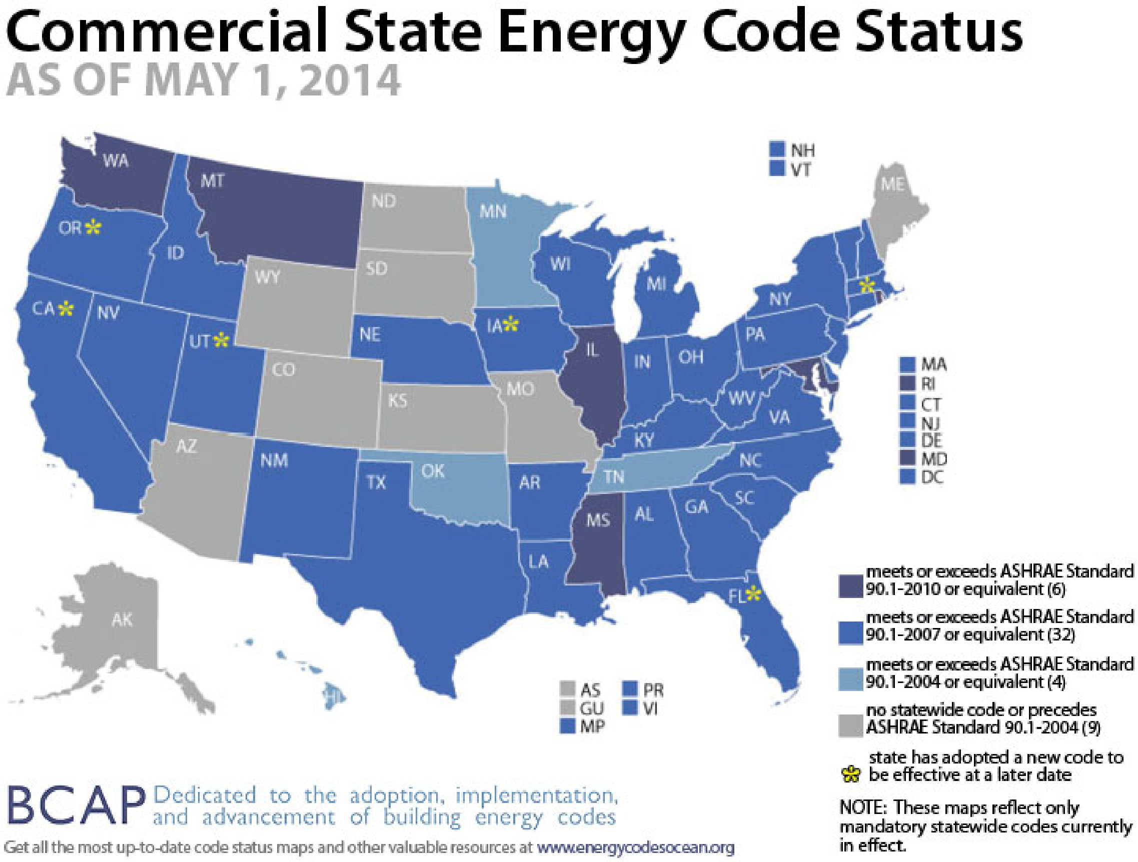

Figure 2. Commercial state energy code status. *Source*: BCAP 2014.

For purposes of this analysis, we assume that by 2016 all states have adopted the 2012 IECC model code, which is in effect from 2016 to 2021. In 2022 all states adopt the 2021 IECC model code, which is in effect for the remainder of our analysis. For commercial buildings we assume that by 2016 all states have adopted the ASHRAE Standard 90.1-2010, which is in effect from 2016 to 2019. In 2020 all states adopt the 2016 standard, which is in effect for the remainder of our analysis. Both 2021 IECC and ASHRAE Standard 90.1-2016 are assumed to reach 50% energy savings relative to 2006 IECC and 90.1-2004, respectively.

While building codes save both natural gas and electricity, only electricity savings are considered in this scenario. Due to data limitations, we estimate the energy savings and costs that would accrue only for new buildings, not for renovated buildings.

Because building energy code administration and enforcement are the responsibilities of individual states, the potential energy savings from implementing new building codes may vary. Energy savings will be based in large part on how vigorously code officials enforce the code and common practices in each state. Our calculations do attempt to take into account these differences in enforcement to ensure the most accurate estimate of energy savings occurs. We do this by looking at current compliance in a state. Relying on data collected for the ACEEE State

Scorecard, we assign each state to one of three tiers, which determines their starting point. All states are assumed to reach 95% compliance by 2020.[2]

Impacts of Building Policy Scenario

National Impacts

Table 1, below, summarizes some of the national economy and energy impacts of implementing this scenario.

Table 1. Summary of national building energy code electric savings and costs in 2030

Annual electricity savings (million MWh)	**155**
Cumulative electricity savings (million MWh)	**1,100**
Annualized cost ($2011 billion)	**$11.39**
Annual avoided electricity purchases ($2011 billion)	**$22.00**

Cumulatively, the total electricity savings from the adoption of new building codes is roughly 1,100 million megawatt-hours (MWh) by 2030. In that single year, (annualized) savings would be over 155 million MWh. This scenario saves around 1% of electricity consumption in 2020 and over 4% in 2030, both relative to 2012 levels of electricity consumption.

In addition to electricity savings, meeting demand with end-use efficiency reduces carbon dioxide emissions and eliminates emissions of mercury, particulates, smog, and a long list of additional hazardous air pollutants. The pollution avoided by implementation of this policy scenario would mean healthier Americans, fewer children with asthma, and significantly fewer greenhouse gas emissions. Tables 2 and 3 below list just some of the pollution avoided and health benefits that would come with the adoption of updated model building energy codes.

Table 2. Summary of national pollution benefits in 2020 (tons)

Region	SO_2	NO_x	CO_2
California	53	471	666,700
Great Lakes/Mid-Atlantic	9,975	3,708	4,185,500
Lower Midwest	1,277	1,038	1,000,700
Northeast	1,672	1,281	1,933,800
Northwest	868	1,654	1,437,700
Rocky Mountains	588	787	797,500
Southeast	9,898	4,924	6,511,200

[2] For additional detail on compliance tiers, see Appendix to Hayes et al. 2014. For ACEEE State Scorecard, see http://www.aceee.org/research-report/e13k.

Southwest	448	1,384	1,909,300
Texas	3,271	1,486	2,720,600
Upper Midwest	3,798	2,130	2,380,500
National	31,848	18,863	23,543,500

Table 3. Summary of national pollution benefits in 2030 (tons)

Region	SO_2	NO_x	CO_2
California	264	2,354	3,311,500
Great Lakes/Mid-Atlantic	42,217	15,571	17,659,400
Lower Midwest	5,348	4,177	4,069,000
Northeast	6,464	5,091	7,979,500
Northwest	4,139	7,532	6,646,300
Rocky Mountains	2,489	3,255	3,315,800
Southeast	47,806	23,614	31,384,000
Southwest	2,022	7,442	9,422,700
Texas	15,288	6,684	12,340,800
Upper Midwest	15,492	8,569	9,648,900
National	141,528	84,290	105,777,900

Comparing the costs associated with end-use energy efficiency with other energy options can be tricky. This is because end-use energy efficiency simultaneously offers multiple benefits: It meets electricity demand; it reduces pollution; it reduces congestion on the grid; it reduces stress on transmission lines; it improves living conditions; and it eliminates premature deaths and illnesses of sensitive populations, including children and babies. The amazing thing is, if you compare the costs of end-use efficiency with just one of these benefits, you are already saving money by opting for efficiency.

It's true that implementing the policy scenario will require investments. Our analysis estimates those investments would be around $154 billion over a 15-year period. The annualized cost of those savings (in 2030) would be about $11 billion (2011$). Those investments save more by avoiding the need to generate electricity than they cost. In fact, the electricity cost benefits in our scenario outweigh the costs, ranging from 1.8–3.0 times the cost of implementing the policies.

Focus on States

States play a significant role under section 111(d). Once EPA has determined an emissions limit, it is the states that must develop a plan for achieving the standard. Under our building energy code scenario, all states would benefit from using building codes to meet their compliance obligations. Every state could reduce unemployment and improve the health of its citizens. The following tables show the effects adopting updated building model energy codes would have on individual states in 2020 and 2030.

Table 4. Building code energy and cost savings in 2020

State	Annual energy savings in 2020 (MWh)	Cumulative energy savings by 2020 (MWh)	Annualized cost in 2020 (billion 2011$)	Annual avoided electricity purchases in 2020 (billion 2011$)
Alabama	501,000	1,343,000	$0.03	$0.06
Alaska	80,000	226,000	$0.01	$0.02
Arizona	2,791,000	7,231,000	$0.16	$0.33
Arkansas	317,000	878,000	$0.02	$0.04
California	1,360,000	3,406,000	$0.17	$0.26
Colorado	905,000	2,432,000	$0.08	$0.16
Connecticut	242,000	640,000	$0.02	$0.04
Delaware	164,000	450,000	$0.01	$0.02
District of Columbia	209,000	535,000	$0.01	$0.03
Florida	1,610,000	4,230,000	$0.12	$0.17
Georgia	1,096,000	2,987,000	$0.07	$0.15
Hawaii	91,000	252,000	$0.01	$0.03
Idaho	141,000	386,000	$0.01	$0.03
Illinois	990,000	2,596,000	$0.08	$0.14
Indiana	495,000	1,317,000	$0.04	$0.07
Iowa	590,000	1,581,000	$0.04	$0.07
Kansas	486,000	1,319,000	$0.04	$0.07
Kentucky	445,000	1,207,000	$0.02	$0.05
Louisiana	979,000	2,546,000	$0.06	$0.11
Maine	200,000	526,000	$0.02	$0.03
Maryland	573,000	1,599,000	$0.03	$0.08
Massachusetts	814,000	2,155,000	$0.07	$0.14
Michigan	520,000	1,400,000	$0.05	$0.09
Minnesota	608,000	1,683,000	$0.06	$0.09
Mississippi	433,000	1,170,000	$0.03	$0.05
Missouri	644,000	1,755,000	$0.04	$0.09
Montana	92,000	242,000	$0.01	$0.01
Nebraska	133,000	360,000	$0.01	$0.02

State	Annual energy savings in 2020 (MWh)	Cumulative energy savings by 2020 (MWh)	Annualized cost in 2020 (billion 2011$)	Annual avoided electricity purchases in 2020 (billion 2011$)
Nevada	309,000	812,000	$0.03	$0.05
New Hampshire	139,000	374,000	$0.01	$0.02
New Jersey	454,000	1,199,000	$0.04	$0.09
New Mexico	416,000	1,021,000	$0.02	$0.05
New York	1,990,000	5,268,000	$0.19	$0.38
North Carolina	1,257,000	3,437,000	$0.07	$0.15
North Dakota	156,000	426,000	$0.01	$0.02
Ohio	885,000	2,364,000	$0.07	$0.14
Oklahoma	555,000	1,520,000	$0.03	$0.06
Oregon	612,000	1,566,000	$0.04	$0.07
Pennsylvania	925,000	2,472,000	$0.07	$0.12
Rhode Island	55,000	147,000	$0.00	$0.01
South Carolina	645,000	1,765,000	$0.04	$0.08
South Dakota	80,000	218,000	$0.01	$0.01
Tennessee	1,439,000	3,901,000	$0.07	$0.15
Texas	4,232,000	11,634,000	$0.23	$0.46
Utah	489,000	1,288,000	$0.04	$0.07
Vermont	33,000	90,000	$0.00	$0.01
Virginia	878,000	2,431,000	$0.05	$0.11
Washington	544,000	1,453,000	$0.04	$0.07
West Virginia	336,000	906,000	$0.02	$0.04
Wisconsin	558,000	1,520,000	$0.06	$0.09
Wyoming	163,000	442,000	$0.01	$0.02
National	34,659,000	92,706,000	$2.46	$4.70

Table 5. Building code energy and cost savings in 2030

State	Annual energy savings in 2030 (MWh)	Cumulative energy savings by 2030 (MWh)	Annualized cost in 2030 (billion 2011$)	Annual avoided electricity purchases in 2030 (billion 2011$)
Alabama	2,306,000	16,206,000	$0.15	$0.29
Alaska	311,000	2,286,000	$0.03	$0.07
Arizona	13,309,000	92,559,000	$0.83	$1.70
Arkansas	1,301,000	9,440,000	$0.09	$0.16
California	6,769,000	46,818,000	$0.83	$1.25
Colorado	3,705,000	26,930,000	$0.35	$0.71
Connecticut	1,010,000	7,313,000	$0.10	$0.19
Delaware	693,000	4,982,000	$0.04	$0.09
District of Columbia	952,000	6,724,000	$0.06	$0.12
Florida	10,270,000	66,118,000	$0.63	$1.15
Georgia	5,008,000	35,161,000	$0.31	$0.67
Hawaii	445,000	3,077,000	$0.06	$0.16
Idaho	616,000	4,398,000	$0.06	$0.12
Illinois	4,304,000	30,748,000	$0.36	$0.69
Indiana	2,167,000	15,486,000	$0.19	$0.35
Iowa	2,418,000	17,606,000	$0.16	$0.30
Kansas	1,942,000	14,242,000	$0.15	$0.29
Kentucky	1,929,000	13,805,000	$0.11	$0.23
Louisiana	4,612,000	32,246,000	$0.29	$0.54
Maine	805,000	5,885,000	$0.08	$0.13
Maryland	2,276,000	16,764,000	$0.14	$0.29
Massachusetts	3,372,000	24,495,000	$0.30	$0.62
Michigan	2,054,000	15,148,000	$0.18	$0.34
Minnesota	2,307,000	17,174,000	$0.23	$0.33
Mississippi	1,875,000	13,386,000	$0.13	$0.25
Missouri	2,592,000	18,955,000	$0.19	$0.36
Montana	392,000	2,820,000	$0.03	$0.06
Nebraska	560,000	4,032,000	$0.04	$0.08
Nevada	1,516,000	10,368,000	$0.14	$0.25
New Hampshire	570,000	4,152,000	$0.06	$0.10
New Jersey	1,965,000	14,076,000	$0.19	$0.38

State	Annual energy savings in 2030 (MWh)	Cumulative energy savings by 2030 (MWh)	Annualized cost in 2030 (billion 2011$)	Annual avoided electricity purchases in 2030 (billion 2011$)
New Mexico	2,097,000	14,471,000	$0.12	$0.25
New York	8,253,000	59,927,000	$0.79	$1.60
North Carolina	5,996,000	41,496,000	$0.34	$0.68
North Dakota	615,000	4,524,000	$0.04	$0.07
Ohio	3,782,000	27,181,000	$0.32	$0.64
Oklahoma	2,263,000	16,462,000	$0.14	$0.25
Oregon	2,926,000	20,411,000	$0.18	$0.36
Pennsylvania	3,912,000	28,209,000	$0.29	$0.50
Rhode Island	227,000	1,651,000	$0.02	$0.04
South Carolina	2,937,000	20,618,000	$0.19	$0.36
South Dakota	332,000	2,396,000	$0.03	$0.05
Tennessee	6,155,000	44,238,000	$0.33	$0.64
Texas	18,934,000	133,768,000	$1.13	$2.47
Utah	2,201,000	15,570,000	$0.17	$0.36
Vermont	129,000	953,000	$0.02	$0.03
Virginia	3,641,000	26,408,000	$0.21	$0.42
Washington	2,484,000	17,475,000	$0.19	$0.35
West Virginia	1,374,000	10,008,000	$0.08	$0.16
Wisconsin	2,198,000	16,193,000	$0.26	$0.38
Wyoming	639,000	4,711,000	$0.04	$0.09
National	155,446,000	1,100,070,000	$11.39	$22.00

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