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Implementing Energy Efficiency in Building Codes Based on the American Clean Energy and Security Act of 2009

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Abstract

The purpose of this analysis is to provide better understanding of the implications of Section 201 of the American Clean Energy and Security Act of 2009, also known as the Waxman-Markey Climate Bill. This analysis examines specific provisions of the bill and investigates ways for the Department of Energy and private code-development organizations to implement these policies using existing tools and methods available to them. The topics covered here include: ways to meet new energy efficiency targets, methods for defining cost-effectiveness, procedures to assure state compliance and issues that may arise if private organizations do not meet the requirements of the bill. For each of these topics, this analysis focuses on the relevant language in the bill, determines what questions stakeholders are interested in and answers these by taking both technical and policy factors into consideration.

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Introduction

This policy analysis takes a speculative look at the future of building energy codes according to H.R. 2454, the American Clean Energy and Security Act of 2009, commonly known as the Waxman-Markey Climate Bill. Section 201 of this bill creates a new system for building energy code adoption with the goal of, by the year 2010, achieving a 30% reduction in energy use in new buildings compared to buildings constructed under the baseline code. The Waxman-Markey Bill defines the baseline code as the 2006 International Energy Conservation Code (IECC) produced by the International Code Council (ICC) for residential buildings and the ASHRAE Standard 90.1-2004, which is produced by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for commercial buildings. The bill requires that ICC and ASHRAE, two recognized developers of building energy codes, meet the 30% target in order to have their codes adopted as the new national building energy code.[1]

Currently, building energy codes adopted by states and localities vary drastically throughout the nation, with much of the central/mid-western states using codes older than 2006 (Figures 1 and 2). If it passes, the Waxman-Markey Bill would set a new "national energy efficiency building code for residential and commercial buildings"[1] for states to adopt within a year of its establishment. The following analysis investigates the technical and policy details of meeting the 30% target, determining cost-effectiveness, assuring state compliance and finally adopting the new national building code.

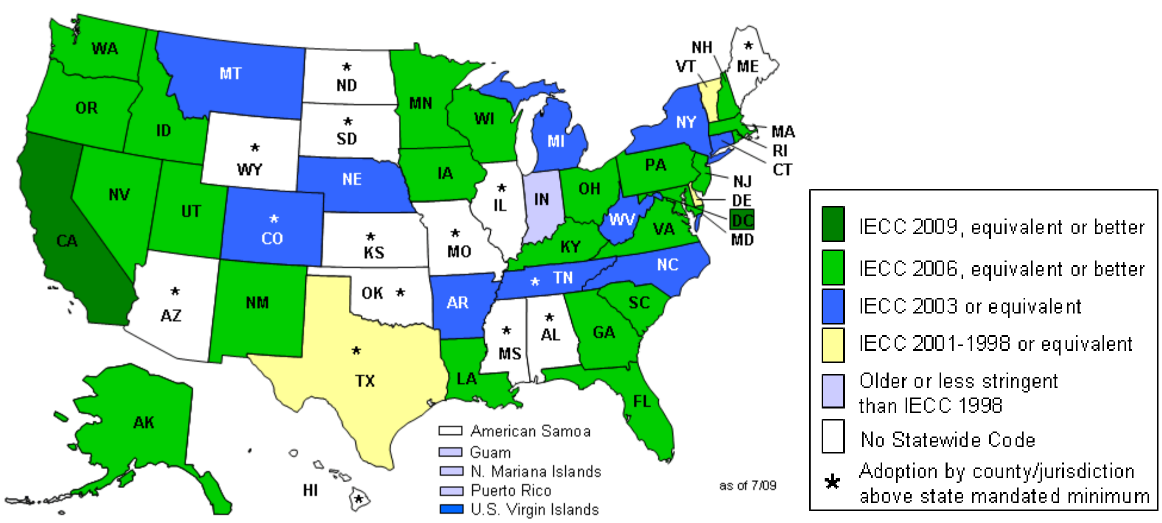


Figure 1 - Nationwide Residential Energy Codes (From DOE Website, 2009)[5]

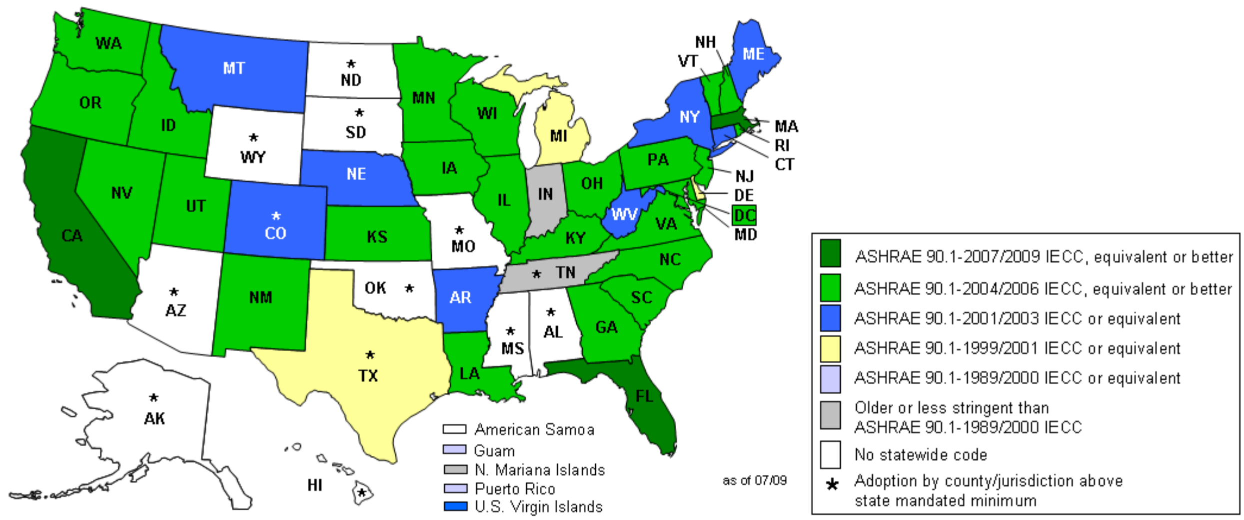


Figure 2 - Nationwide Commercial Energy Codes (From DOE Website, 2009)[5]

Energy Efficiency Targets

> "Effective on the date of enactment of the American Clean Energy and Security Act of 2009, 30 percent reduction in energy use relative to a comparable building constructed in compliance with the baseline code;"

(From ACES 2009, Sec. 201 (a)(1)(A))[1]

The preceding excerpt from Section 201 of the Waxman-Markey Bill states its initial goal: a 30% reduction in energy use of buildings built under the new building code compared to the baseline code. This seemingly straightforward objective raises several questions for stakeholders in the building code development process.

Why the 30% target and how close are current codes?

The Energy Efficiency Codes Coalition, a major proponent of this target, works to include it in the IECC residential building code, calling it an "affordable and achievable" objective using "current, everyday products and practices." [17] The Coalition has put together a list of specific changes to meet this target in their proposal EC-14, known as "The 30% Solution". This proposal intends to complement the Department of Energy's (DOE) work with ASHRAE in improving commercial building code energy efficiency by 30% [15] and address concerns for energy improvements by the Department of Energy, the National Petroleum Council, the American Institute of Architects and Mayors for Climate Protection.[6] ICF International's review of the EC-14 proposal concluded that it would affordably achieve the 30% target.[17] According to an ICF International energy savings analysis of the 2009 IECC, the current code has estimated savings of 12.2% under the "prescriptive" method, and 14.7% under the "performance-based" method compared to the 2006 version.[6] To bring IECC energy savings up to the 30% target, the Energy

Efficiency Codes Coalition has produced a list of guidelines for the 2010 Supplemental to the IECC. These guidelines push for making longevity, simplicity, ease of enforcement and comfort criteria for improvements to the IECC and promote increasing energy efficiency without adding complicated trade-offs.[8]

Why focus on buildings as opposed to other uses of energy?

According to Bill Prindle, vice president of ICF International, the recent push for energy improvements in building codes has more significance than any other action regarding energy code improvement since the 1998 Model Energy Code recognized the impact of solar heat gain on energy used in cooling.[4] This relative hiatus in major building energy code improvements has given building technologies some of the highest marginal returns compared to other technologies with CO_2 abatement potential. As depicted in Figure 3, building technologies such as water heating, lighting and insulation improvements have some of the largest negative marginal costs compared to other technologies that would reduce energy use.[10] The Waxman-Markey Bill responds to this opportunity for affordable energy savings by pressuring ICC and ASHRAE to improve their building energy codes.

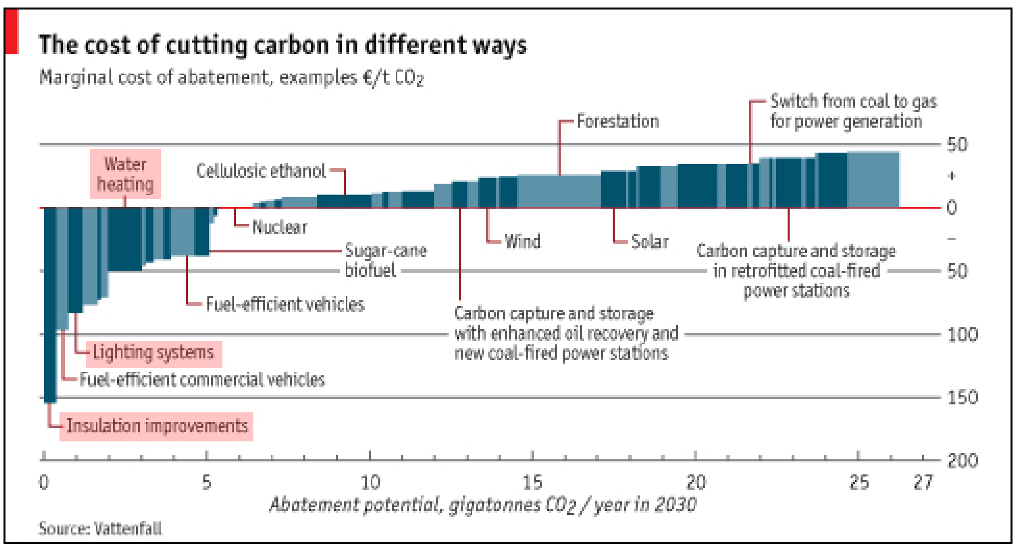


Figure 3 - Abatement Potential and Marginal Cost of Various Technologies: Water heating, lighting systems, and insulation improvements are some of the most cost-effective technologies to reduce energy use.[10]

What tools would the Department of Energy use to verify and meet energy efficiency targets?

The Waxman-Markey Bill sets a single percentage as the energy efficiency target for building codes and gives the Department of Energy the task of measuring progress towards meeting that target. The energy efficiency of a building depends on many factors including, size, occupancy, climate and the type of building. Fortunately, the Department has several tools to help consolidate these factors into a single percentage and to optimize building energy codes to reach the targets of the Waxman-Markey Bill.

PNNL's Progress Indicator

The Pacific Northwest National Laboratory (PNNL) has developed a methodology that measures energy use reductions in building codes based on these factors. A recently released progress update to the Standing Standard Project Committee on ASHRAE's 90.1 commercial building code explains the project's purpose: "to measure progress toward the 30% improvement goal in 90.1-2010 over 90.1-2004."[12] This comparison and target energy reduction exactly matches the requirements of the Waxman-Markey Bill.

PNNL's methodology involves creating 16 prototype building designs with which to model code factors (Figure 4). The Laboratory then simulates energy savings in these buildings in 17 climate zones representing conditions throughout the nation. To find the national average energy savings, PNNL weights the individual results based on McGraw-Hill Construction's data for commercial buildings; it then distributes this data into categories according to the Commercial Buildings Energy Consumption Survey (CBECS). Figure 5 shows the results of an energy savings analysis on a prototype large office building and on a hospital.

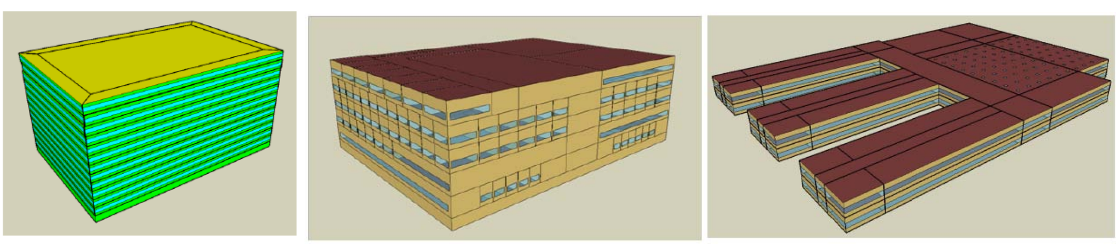
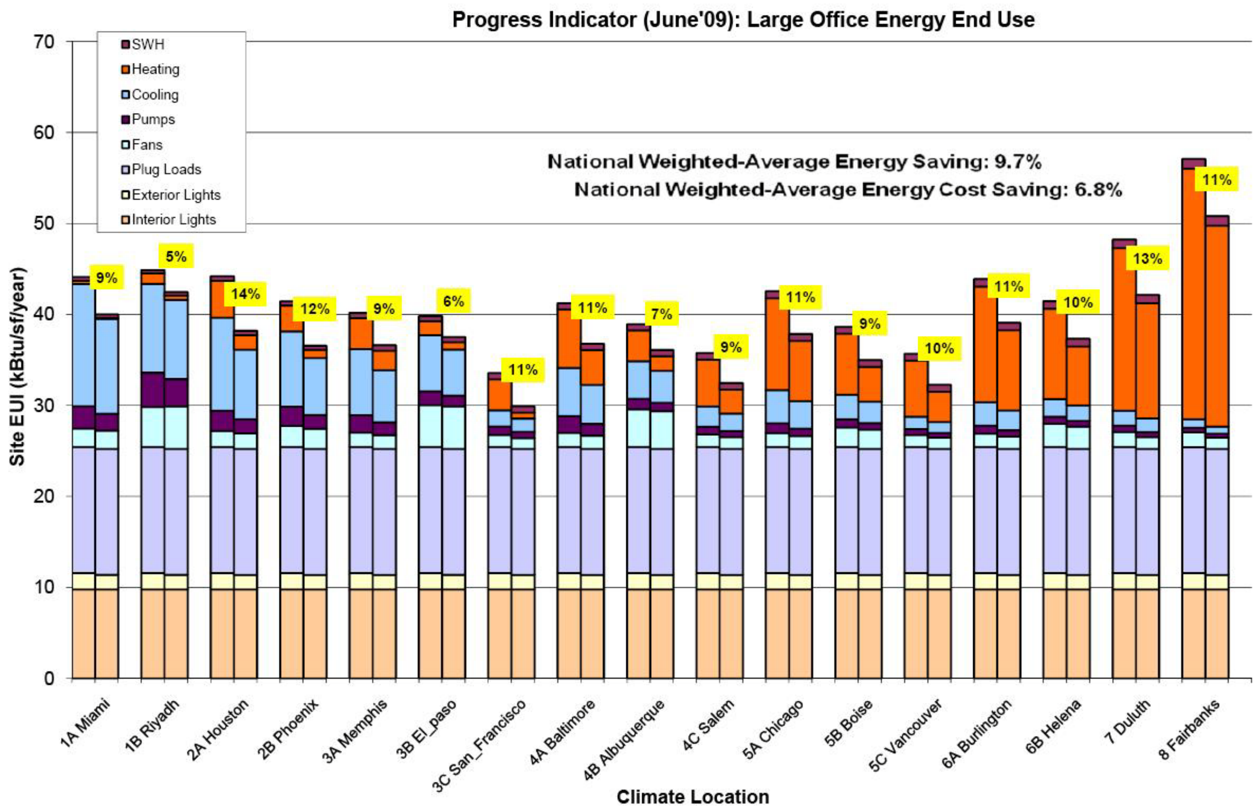


Figure 4 – Examples of Prototype Commercial Buildings:
From left to right: Large Office, Hospital, Secondary School[12]



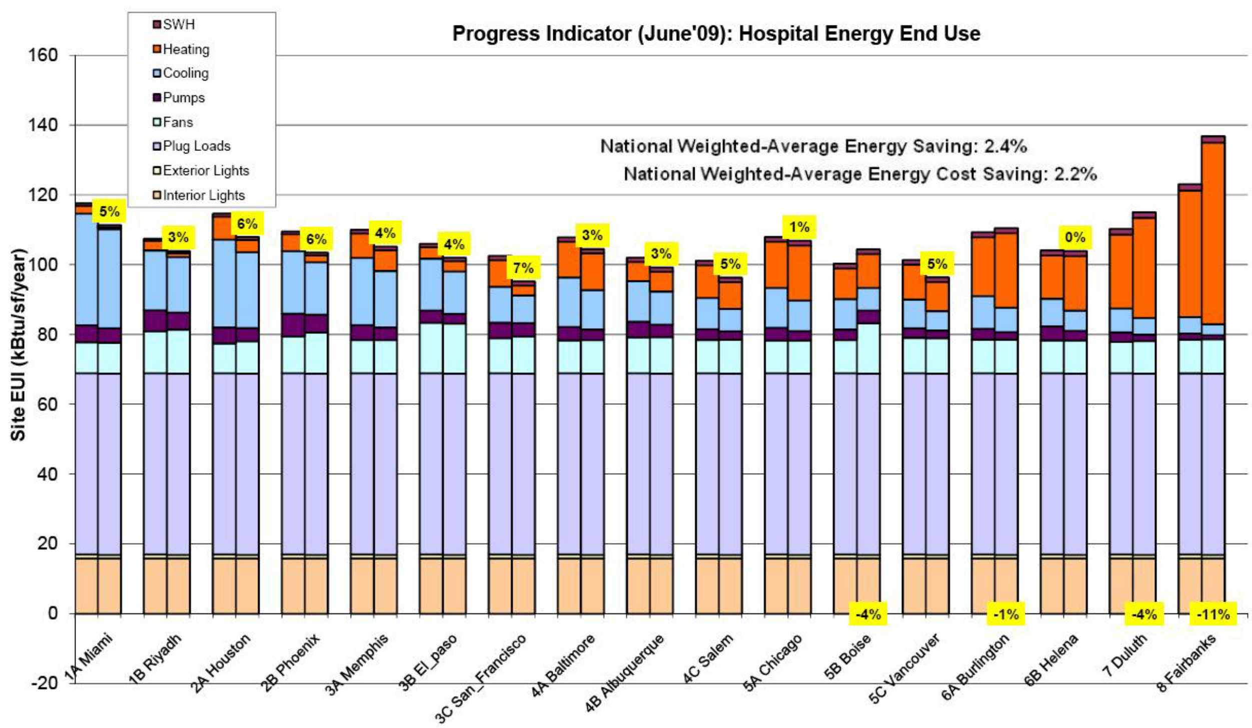


Figure 5 - Energy Savings Analysis on a Prototype Large Office Building and Hospital: These graphs estimate energy savings as a factor of climate zone and systems that use energy in a building. These are for 2 of 16 prototype buildings.[12]

The large office and hospital have national weighted energy savings of 9.7% and 2.4% respectively, based on the number of each type of building in each climate zone. By using this information on all 16 commercial building prototypes, the Department of Energy can estimate total national energy savings from a new commercial building code and use this data to help code development organizations meet the energy savings targets specified in the Waxman-Markey Bill. Though this report only addresses commercial building codes, PNNL has developed a similar methodology for residential codes that has not yet been released.[13]

BEopt

The National Renewable Energy Laboratory has developed a building energy optimization tool called BEopt that calculates the most cost-effective building designs to meet a given energy efficiency target. The Waxman-Markey Bill's 30% target begins a list of several other energy savings goals including a 50% target by 2014, 5% additional savings every three years following, and finally, an end-goal of zero-net-energy for commercial buildings.[1] Zero-net-energy represents the point when a building runs on 100% energy savings and the cash flow for a building consists entirely of mortgage costs (Figure 6).

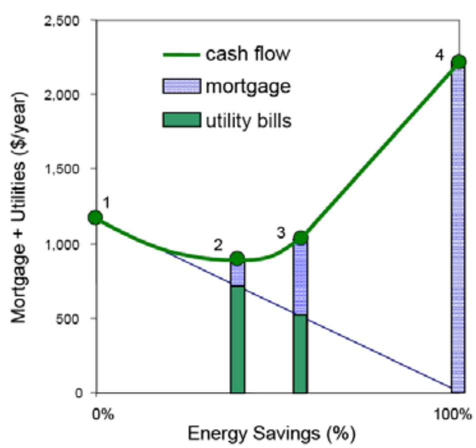


Figure 6 – A Conceptual Path to Zero-Net Energy:
100% energy savings represents the zero-net-energy point[3]

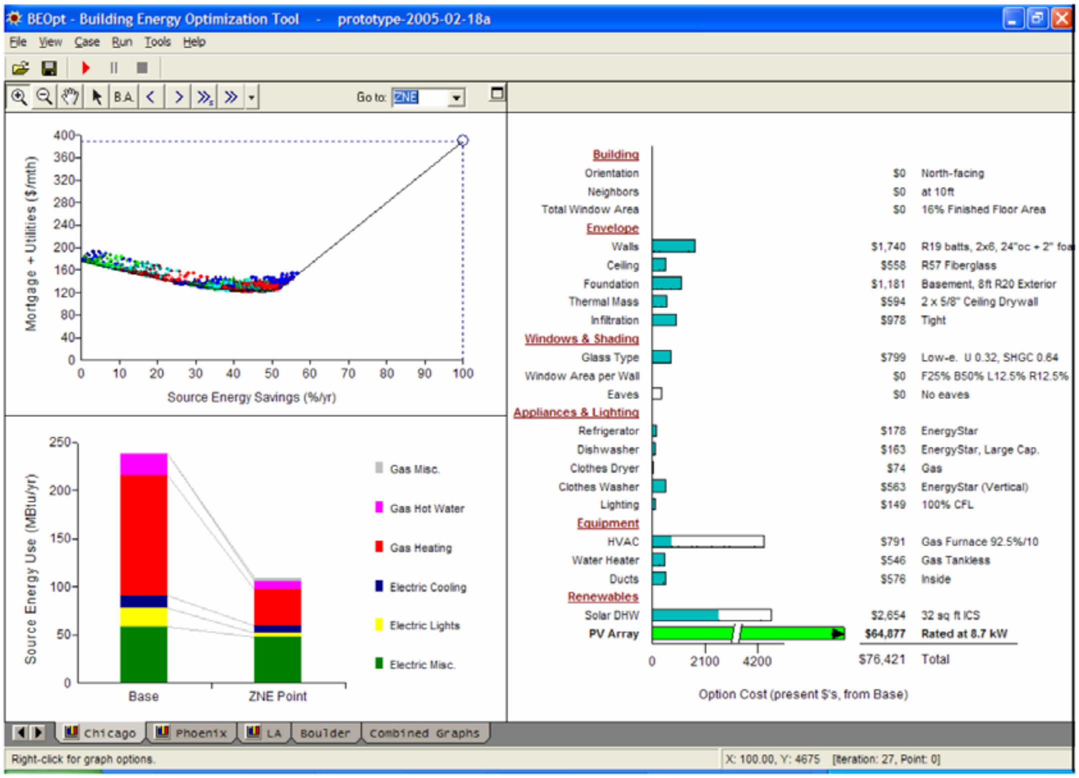


Figure 7 – An Example of BEopt's Output: This display includes an economic path to zero net energy (top left), a graph comparing the costs of various options (right), and a graph comparing the current energy breakdown with energy use at the zero net energy point (bottom left).[3]

BEopt could help code developers meet targets such as zero-net energy by using building energy simulation software like DOE2 and TRNSYS to determine the optimal energy use of a building design.[3] Figure 7 shows an example of BEopt's output for a building design at zero-net-energy. The display includes a graph showing the economic path to zero net energy (top left), a graph comparing the costs of various options (right) and a graph comparing the current energy breakdown with energy use at the zero net energy point (bottom left). Potentially, the Department of Energy could commission a portable software application that adopts BEopt for use by building inspectors. This application would allow inspectors to examine the cost-effectiveness of making specific changes to a building design.

<u>Comparative Uses for BEopt and PNNL's Progress Indicator</u>

While PNNL's methodology tracks progress towards the 30% target after private organizations have produced building energy codes, BEopt solves optimization problems that come up during the design process. To create efficient building energy codes that meet the targets of the Waxman-Markey Bill, the Department of Energy would likely use the PNNL progress indicator to evaluate codes in development by private organizations and possibly BEopt to advise these organizations on how to change their codes to meet the target. By advising private organizations, the Department would take a greater role in the code development process than it has in the past.

Defining Cost-Effectiveness

> "Cost-effectiveness calculations.- Calculations of life cycle cost-effectiveness shall be based on life cycle cost methods and procedures under section 544 of the National Energy Conservation Policy Act (42 U.S.C. 8254), but shall incorporate to the extent feasible externalities such as impacts on climate change and on peak energy demand that are not already incorporated in assumed energy costs."

(From ACES 2009, Sec. 201 (b)(2)(B)(ii))[1]

The phrase "life cycle cost-justified" appears several times in Section 201 of the Waxman-Markey Bill as a criterion that the Secretary of Energy must consider when making policy decisions. The following section discusses ways to define cost-effectiveness based on the language of the bill.

How does the bill define cost-effectiveness with regards to building codes?

The excerpt above states that cost-effectiveness calculations mentioned in the Waxman-Markey Bill will refer to Section 544 of the National Energy Conservation Policy Act (NECPA) which states: "The Secretary…shall…establish practical and effective value methods for estimating and comparing life-cycle costs for Federal buildings, using the sum of all capital and operating expenses associated with the energy system… over [the building's] expected life."[14] This means that the definition of cost-effectiveness must include two types of costs: capital expenses (purchase costs) and operating expenses. However, it does not present a methodology to use to calculate it.

In early 2009, the Florida Solar Energy Center released a report that presents an economic basis for determining the cost-effectiveness of changes to the Florida Energy Code. Like NECPA, this report recognizes that life cycle costs must factor in both capital costs (generally in the form of mortgage payments) and the operating cost of a building.[7] Figure 8 denotes these as "Mortgage Cost Increment" and "Energy Cost Increment" respectively.

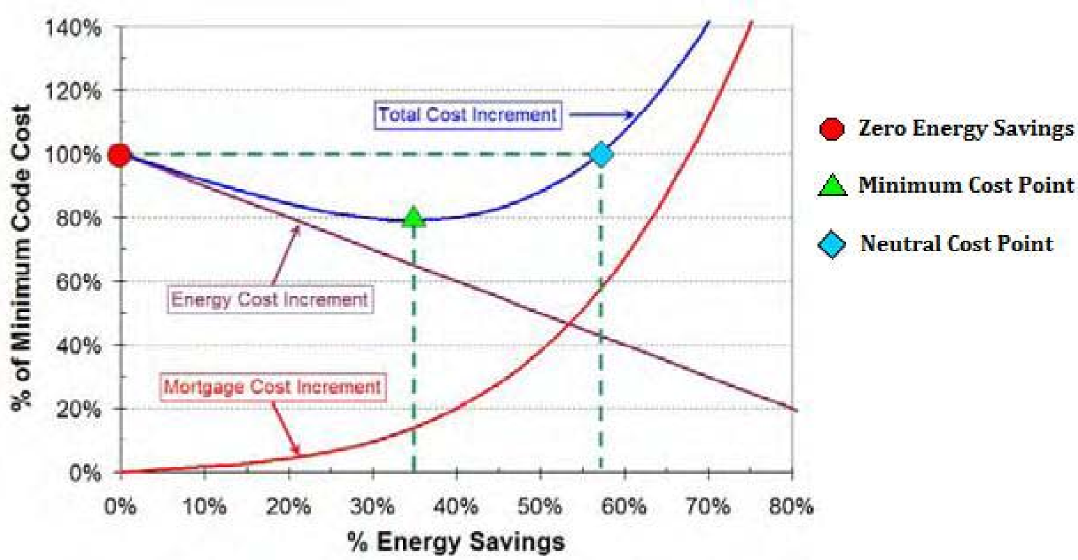


Figure 8 - Theoretical Cost Analysis Highlighting Specific Points of Cost-Effectiveness (As this is a conceptual scenario, exact values on the x and y axis are arbitrary)[7]

This plot illustrates the relationship of energy savings to the cost of meeting the minimum code requirements. With regards to cost-effectiveness, it notes two key points of interest: the minimum cost point (green triangle), and the neutral cost point (blue diamond). While the minimum cost point, which is less expensive, may seem like the best option for consumers, it is not the most cost-effective in terms of energy savings. The neutral cost point maximizes energy savings while sharing the same costs as the point of zero energy savings. Therefore, this point achieves the maximum energy savings per cost put into meeting the minimum code and constitutes the most cost-effective scenario.

The Waxman-Markey Bill gives the Secretary of Energy the power to change energy efficiency targets if he determines that a new target is "life cycle cost justified."[1] In making this determination, and in any other situations when the bill calls for judgment based on cost-effectiveness, the Secretary should strive to meet or exceed the neutral cost point.

What economic indicators should the Department of Energy use to measure cost-effectiveness?

The Florida Solar Energy Center Report also analyzes three economic indicators of cost-effectiveness: simple payback, levelized cost of conserved energy and cash flow analysis.[7] [i]

Simple payback estimates the number of years necessary to recover the cost of an energy investment by dividing the initial cost of that investment by the cost of energy savings made in the first year of use. Levelized cost of conserved energy factors in both the useful life

[i] For a detailed methodology on these indicators, see Energy Efficiency Cost Effectiveness Tests for Residential Code Update Processes [7]

of a technological investment and the capital recovery factor (which represents the levelized annual cost of the investment compounded at the discount rate). This discount rate estimates future cash flow at its present value. Essentially, the levelized cost represents the annual cost of a product over its lifetime. Cash flow analysis, the most intensive of the three methods, involves calculating the net present value, internal rate of return and present value benefit-to-cost ratio based on the initial purchase cost and anticipated future returns.

For the purpose of determining the cost-effectiveness of a change to building codes, the simple payback method has little use as it does not factor in the time value of money with respect to future energy costs or inflation rates. Though the levelized cost fails to factor in either of these directly, it does account for the discount rate and has the form of an annual cost, making it readily comparable to other annual energy costs. The final indicator, cash flow analysis, has the most use for analysts because it can estimate the present value benefit-to-cost ratio. This factor, often called the "gold standard" for cost effectiveness, consists of a ratio of the annual energy cost savings against all annual payments. When calculating the life cycle cost-effectiveness of a change to building code policies, the Department of Energy should use the levelized cost of conserved energy and a present value benefit-to-cost ratio as its primary indicators.

Compliance

"Achieving Compliance.- A State shall be considered to achieve compliance with a code described in paragraph (2)(A) if at least 90 percent of new and substantially renovated building space in that State in the preceding year upon inspection meets the requirements of the code. A certification under paragraph (2) shall include documentation of the rate of compliance based on-

(A) independent inspections of a random sample of the new and substantially renovated buildings covered by the code in the preceding year; or

(B) an alternative method that yields an accurate measure of compliance as determined by the Secretary."

(From ACES 2009, Sec. 201 (e)(3))[1]

To bring the current patchwork of different building codes currently used nationwide up to the standards of a new national building code, the Department of Energy will have to set up a plan for state compliance. Though the Waxman-Markey Bill does not establish all of the details of this compliance method, it does require states to complete a certification that they achieved compliance (see excerpt above). The options for this certification consist of two methods: independent inspection of a random sample of buildings or an alternative method approved by the Secretary.

How can the Department of Energy ensure that states comply with the new national building code?

Pacific Northwest National Laboratory (PNNL) has created a methodology for ensuring state compliance that involves testing a random sample of buildings. The State Compliance Evaluation Rev 2, currently in draft form, directs itself towards establishing criteria by which states can implement conditions outlined in the State Energy Program (SEP) Formula Grants American Recovery and Reinvestment Act (ARRA) Funding Opportunity. This section of the ARRA lists requirements for improvements to building energy codes that states and localities can make in order to be eligible for funding grants. The requirements indicate that states must have building energy codes that meet or exceed the latest IECC/ASHRAE 90.1 code with at least 90% compliance.[2] The Waxman-Markey Bill has the same basic requirement with the addition of a 30% energy efficiency improvement target. These similarities make PNNL's State Compliance Evaluation extremely adaptable for use under the Waxman-Markey Bill.

PNNL's methodology consists of onsite building audits taken from a random sample of buildings and jurisdictions within a state. The Department of Energy's Building Energy Codes Program, which develops procedures for the sampling process, has yet to release details of this methodology. However, PNNL's report indicated that sampling would be "weighted to favor audits of jurisdictions experiencing new construction and retrofits, based on permitting information."[16]

The plan provides onsite auditors with checklists specific to the building and climate zone. These checklists would include top priority items that: impact design energy efficiency, impact long-term operational energy efficiency and items that contribute to known problems for code compliance.[16] Figure 9 shows an example checklist for a residential single-family home.

PNNL's compliance program would help the Department of Energy keep track of "significant progress" made by states towards achieving compliance as outlined in the Waxman-Markey Bill. According to the bill, "significant progress" requires that state compliance plans include "hiring enforcement staff, providing training, providing manuals and checklists, and instituting enforcement programs designed to achieve full compliance within 5 years after the date of the adoption of the code."[1] PNNL's system of building audits includes all of these factors, making it the best system for establishing compliance under the Waxman-Markey Bill.

2009 IECC Compliance Inspection Checklist

Single-Family Residential

Climate Zone 5

Date:____________________ Name of Inspector:_______________________________

State:______________________________ Jurisdiction:___________________________

Project Type: O New Construction O Addition O Renovation

	Complies	Non-Compliant	Not Applicable/ Not Observed
Glazing Area	O	O	O
Glazing U-factor	O	O	O
Ceiling Insulation R-Value	O	O	O
Wall Insulation R-Value	O	O	O
50% of lamps are high efficacy	O	O	O
Foundation Insulation R-Value	O	O	O
Duct Insulation R-Value	O	O	O
Duct Sealing	O	O	O
Duct blaster test administered and passed	O	O	O
Circulating hot water pipes are insulated	O	O	O

____ ___________________________

Signature Date

Figure 9 – An Example of a Compliance Checklist from PNNL's State Compliance Evaluation[16]

Building Code Development by the Department of Energy

> "Requirement to establish code.- If the Secretary does not make a finding under subparagraph (B), the national energy efficiency building code shall be established by rule by the Secretary under paragraph (2)." [ii]

(From ACES 2009, Sec. 201 (b)(1)(C))[1]

While previous sections of this analysis speculated on how to meet energy efficiency targets set in the Waxman-Markey Bill, the following section theorizes on how the Department of Energy would handle code development if private organizations do not meet these targets. The excerpt above, taken from the Waxman-Markey Bill, represents the point in the bill when

[ii] Subparagraph (B) covers procedures for when the Secretary considers adopting codes developed by private organizations. Paragraph (2) details the procedure for when these codes do not meet the 30% target.

responsibility to develop a new national building code transfers from recognized private organizations, such as ICC and ASHRAE, to the Department of Energy. Essentially, this statement means that if the Department fails to find an existing code by a "recognized developer of energy codes and standards"[1] that meets the 30% requirement, the Secretary of Energy has the responsibility of establishing a new building code that does. The following section explores options available to the Department in such a scenario.

What options does the Department of Energy have if code-developing organizations fail to meet the 30% requirement?

According to the procedure outlined in the Waxman-Markey Bill, the Department of Energy's first course of action would involve "[proposing] improvements to such published or proposed code versions sufficient to meet or exceed the target."[1] Basically, this states that the Department should work on improving codes originally developed by private organizations so that they meet or exceed the 30% target. However, this may become a point of contention for organizations that have a copyright on these building codes. The Fifth Circuit Court of Appeals case *Veeck v. Southern Building Code Congress Int'l, Inc.* addressed a similar issue in 2002 with the consensus that; though copyright protection applies to model codes owned by a private organization, some forms of protection no longer apply once these codes become law.[11] The Supreme Court declined to hear this case's appeal, affirming the decision of the Circuit Court, but leaving several issues unresolved. For example, this ruling does not address the legality of the Department of Energy distributing a code adapted from one originally created by a private organization, but which no government has passed into law.[9] If the Department attempts to improve and adopt building codes owned by private organizations, this may bring about a resurgence of issues left undecided by the *Veeck* case.

Another, albeit unlikely, option would involve the Department developing its own building code independent of private organizations. Though this would allow it to avoid copyright issues, the Department currently does not have the resources or the expertise required to start taking part in code development.[13] To avert the copyright issue, the Department of Energy may instead contract the task of designing an energy efficient building code back to ICC and ASHRAE. This way, these two organizations would have full control over their own code development resources, but be held to the constraints set by the Department of Energy and the Waxman-Markey Bill. Alternatively, the Department could negotiate with private organizations for licenses to parts of their codes. If all else fails, the bill leaves open the option for the Secretary of Energy to lower the 30% target to "the maximum reduction in energy use that can be achieved through a code that is life cycle cost-justified and technically feasible."[1]

Conclusions

This analysis covered the technical and policy details of meeting energy targets, how to do so cost effectively, methods for assuring state compliance and the potential legal issues that might arise from the changing roles of government and private organizations. Where the language of the Waxman-Markey Bill was open to interpretation, this analysis attempted to provide realistic solutions for how stakeholders might achieve policy goals. However, there remain several issues that this analysis did not cover including the distribution of codes, funding and the unprecedented new enforcement role taken up by the Department as detailed in the bill. To fully understand the impact the Waxman-Markey Bill will have, stakeholders must view the solutions presented here within the context of all elements of building energy code development, evaluation and implementation.

Passage of the Waxman-Markey Bill would undoubtedly change the interaction of stakeholders involved in the building energy code development process. Ultimately, the bill exemplifies how policy could influence private and government organizations to cooperate more effectively to meet the challenges of climate change.

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