

Challenges and Potential Solutions in Achieving Net-Zero Commercial Buildings through Current Building Codes and Standards Processes

A Policy Research Analysis

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EXECUTIVE SUMMARY

Buildings consume 72% of our annual electricity and account for 39% of CO₂ emissions nationally, which is more than the transportation and industrial sectors. Commercial buildings constitute 18%, or nearly half, of all building CO₂ emissions. Commercial buildings have become essential in daily life; every structure from a coffee shop to gas station and grocery store to office building are each a type of commercial building. The commercial building sector will play a central role in reducing electricity consumption, reducing green house gas emissions, and raising public awareness on anthropogenic impact on the environment.

Building codes and standards were invented to protect the public from poorly designed and poorly built structures. Since 1975, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has continuously developed building energy codes to ensure a balance between achieving comfortable indoor spaces while using a reasonable amount of energy. This standard, ASHRAE 90.1, has been adopted in all 50 states and is in constant review to ensure up to date accuracy. Achieving net-zero, though, will require more stringent energy codes and standards.

Recently, the term “net-zero” has been applied to buildings in various contexts. The National Renewable Energy Laboratory (NREL) published a 2006 report defining net-zero in four different frameworks. For the purpose of this report, a net-zero building is a building that utilizes passive and active energy saving techniques through energy efficient design and environmentally safe construction materials. Next, it maximizes on-site renewable electricity and heat generation, and then utilizes off-site renewable electricity for its remaining energy needs. Natural gas, mined using proven, environmentally benign methods, may finally be used for heating and cooking purposes.

The five barriers to achieving net-zero through the codes and standards process, which for the focus of this report, were: the consensus process, code and standard type, building type, retrofitting components, and occupant use.

The policy formulated to overcome these barriers focuses on the actual process of developing codes and standards. To begin down the path of achieving net-zero, codes and standards need to evolve into outcome-based type, concentrate on retrofitting entire systems, empower the occupants, and remain predictable through stretch and reach programs. Federal, state, and local governments should focus on incentivizing building owners through several proposed means.



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Foreword

About WISE

In 1980, a handful of visionary engineering societies founded the Washington Internship for Students of Engineering (WISE) program in order to expose student engineers to governmental processes in Washington D.C. With the guidance of individual and group mentors, the young leaders spend nine weeks meeting with government officials, legislators, and other engineers, exploring the intersection of engineering and public policy. The program inspires the future engineers to a possible career in technical research and public policy decision making as an informed civil servant.

About ASHRAE

The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) was the result of the 1959 merging of two older societies, the American Society of Heating and Ventilating Engineers (ASHVE), known after 1954 as the American Society of Heating and Air-Conditioning Engineers (ASHAE) and the American Society of Refrigerating Engineers (ASRE). Tracing their historical founding to 1894, ASHRAE is currently an international organization with 51,000 members. ASHRAE's mission is to advance the arts and sciences of heating, ventilation, air conditioning, refrigeration and related human factors to serve the evolving needs of humanity and to promote a sustainable world. The society accomplishes this through research, standards writing, publishing, continuing education, and governmental relations.

About the Author

Ramsey Brown is a 2005 graduate of the Kamehameha Schools in Honolulu. He attended the California Maritime Academy from 2005-2010, serving as a resident assistant for two years while studying mechanical engineering. Ramsey also had the opportunity to expand his engineering knowledge and global perspectives by studying abroad at the University of Bradford in England. During his senior year at the California Maritime Academy, Ramsey served as President of the Associated Students and also on the Board of the California State Students Association. He graduated in 2010 earning his Bachelor of Science in Mechanical Engineering.

Following the 2010 WISE internship, Ramsey will join City Year Boston as a corps member dedicated to inspiring students of all ages to continue their education and to make a difference in their communities.

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Finally, I'd like to thank Erica Wissolik for coordinating the important, political educational meetings and the after-hour, social educational meetings. Erica stepped up as a mentor to us all and I am grateful for her help in steering the WISE interns through another awesome and successful summer.

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6 Definition of the Issue

6.1 Sustainability

One hundred years ago, the oak beams in the ceiling of the dining hall in an Oxford college were replaced by oak trees cut down from the courtyard that had been planted in 1386. The carpenters used these trees because the 14th century dining hall builder had planted them in anticipation of the time hundreds of years later when the beams would need replacing. This humble, unpretentious step foreseen by the builder allowed his structure to continue to be used centuries after its erection. Perhaps we should perpetuate this vision in our buildings today.¹

The most frequently cited definition of sustainability comes from the 1987 Brundtland report, which reads, “Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.”² This means that it is the current generation’s responsibility to continue to develop and innovate but not at a cost to the environment. Furthermore is the idea that perhaps we can and should provide for future generations by anticipating potential issues and beginning to develop the resources today that will help mitigate those future issues; as was shown by the great foresight of the Oxford dining hall builder.

Today, the world population, industry, energy consumption, and development continue to increase at unprecedented rates. In order for society to protect the state of the environment so that future generations can enjoy the same Earth we live in today, a massive reduction in pollution and waste is compulsory. There are many steps necessary to mitigate the negative effects of the western life-style that society enjoys and strives-for today. A major factor in this issue is, and will continue to be, buildings.

6.2 The Impact of Buildings

A building, an inanimate framework of manufactured, heavy-duty materials, is the primary form of shelter used to protect man from the elements and keep one comfortable. Stunningly, in the United States, buildings consume more energy annually than any other sector. It may be difficult to comprehend that a non-moving, comfortably controlled space requires more energy than both the transportation and industry sectors, but according to the Department of Energy (DOE), in 2006, buildings consumed 72% of U.S. generated electrical energy and 39% of U.S. primary energy, where primary energy refers to the natural form of energy, including fossil fuels and alternative energies. Also, over

¹ This anecdote leads to an insightful discussion on sustainable standards in Boucher’s sourcebook (Boucher, 2003)

² Report done by former World Commission on Environment and Development (WCED) and named for Chairwoman Mrs. Gro Harlem Brundtland (Federal Department for Spatial Development ARE, 2010)

half of all existing residential and commercial buildings were built on or before 1979, before energy efficiency was a high priority, and as such, much of a building’s energy is wasted due to poor insulation and inefficient mechanical design.³

The standard definition of a commercial building is one in which no more than 50% of its floor space is used for residential, manufacturing/industrial, or agricultural purposes.⁴ Figure 6-1 shows a breakdown of the actual energy use on commercial building sites, also known as the site energy consumption. By definition “commercial building” covers many building types such as office buildings, supermarkets, shopping malls, banks, bars, casinos, hotels, gas stations, coffee shops, and more.

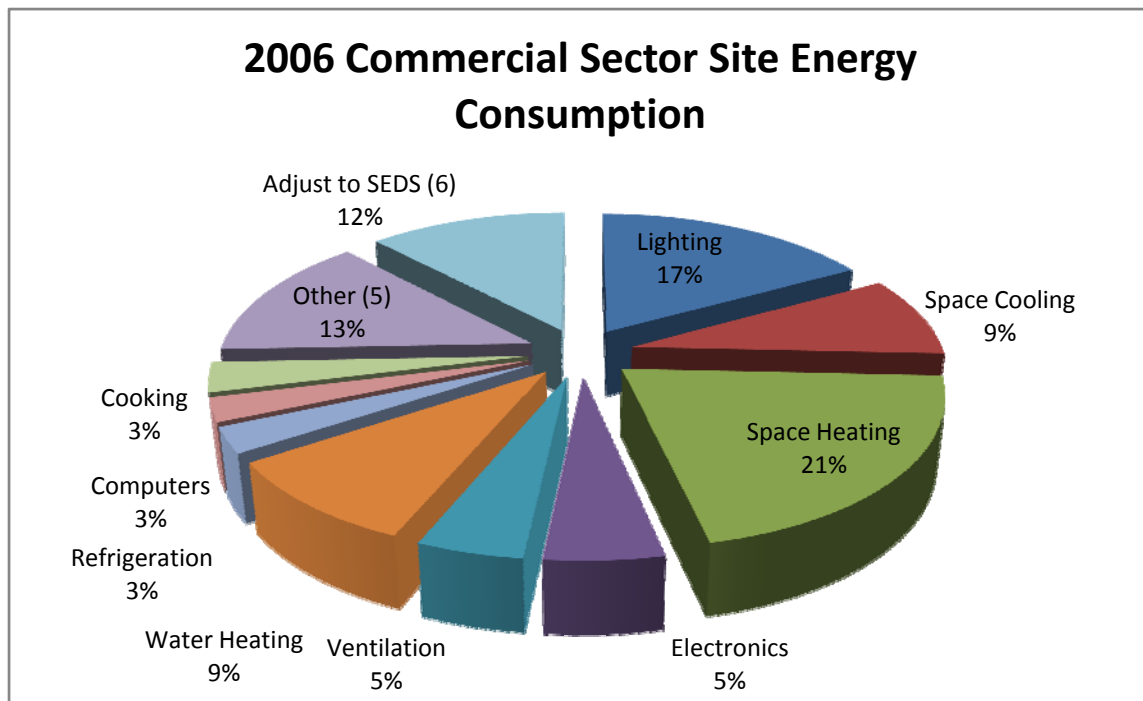


Figure 6-1: 2006 Commercial Energy End-Use ((EERE), 2009)

This data reveals that nearly 50% of all commercial building energy goes into lighting and thermal comfort. Today’s technology is capable of significantly improving the building envelope to decrease the energy required to keep a space at a comfortable temperature, and also to greatly reduce the energy consumption of traditional lighting. Technology also exists for buildings to generate much of their own energy through alternative means such as photovoltaic and solar thermal panels. In fact, global innovation has enabled companies to construct net-zero energy buildings, or buildings that generate as much electricity on-site as they consume. This building is then able to operate off of the main electric grid; simultaneously avoiding being a sink on the system and, at times, contributing its excess generated

³ According to the Building Technologies Program ((BTP), 2010), under the Department of Energy

⁴ U.S. Energy Information Association researches and releases building data through its Commercial Building Energy Consumption Survey (CBECS) office; ((EIA) U. E.-I., 2010)

energy to the electric grid. Generating energy without fossil fuels is another key benefit of net-zero energy buildings because according to the Department of Energy, 18% of nitrogen oxides, 39% of carbon dioxide, and 55% of sulfur dioxide emissions are all consequences of the more than 74 million square feet of commercial floor space in America.⁵ This opportunity to pluck the low hanging fruit of energy efficiency begs the question, why are buildings still the single greatest consumer of U.S. energy? The aim of this paper is to identify the major barriers and challenges and to present potential solutions that the Federal Government can help to initiate in order to expedite the adoption of advanced building technologies with the aim of achieving net-zero buildings (NZBs).

6.3 Net-Zero Energy Definitions

The National Renewable Energy Laboratory (NREL) published a report in 2006 that defined a “Zero Energy Building (ZEB)” in four different ways:

- **Net Zero Site Energy:** A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
- **Net Zero Source Energy:** A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building’s total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
- **Net Zero Energy Costs:** In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
- **Net Zero Energy Emissions:** A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.⁶

[For the purpose of this paper, NZB will be used (rather than ZEB) and is further defined below]

⁵ U.S. Department of Energy statistics that led to over \$76M in funding for advanced energy-efficient building technology projects and training programs ((DOE) U. D., News, 2010)

⁶ The pros and cons of each definition are also presented in the report. Nearly all of the negative aspects of site and source energy definitions referred to the measurability of use for tracking purposes. (P. Torcellini, 2006)

The primary aim of NZBs is to have increased operational efficiency and a complete separation from non-renewable electrical generation. To achieve this, I feel the goal of an NZB is to consume only as much energy as it can produce on-site on an average day. Admittedly, more energy will usually be necessary. Outside sources of renewable energy may also be considered in cases where the building footprint is incapable of generating enough energy for the comfort and work of occupants. Renewable energy comes from naturally replenishing and occurring sources such as solar energy, wind power, hydro power, geothermal energy, biomass, and biofuel. Natural gas, a low-emission fossil fuel source, is currently a cost effective energy source that can be the deciding factor in whether or not net-zero is reached in a building. Natural gas mined in an environmentally benign manner can be utilized to achieve net-zero if on-site and off-site renewable energy is insufficient. For new construction, this should be viewed as an extreme option, perhaps to the point of foregoing net-zero until solar technologies become more efficient and new panels can be added. Becoming independent of natural gas should be a major goal of newly constructed buildings.

Definition of Net-Zero Buildings:

A net-zero building utilizes passive and active energy saving techniques through energy efficient design and environmentally safe construction materials. Next, it maximizes on-site renewable electricity and heat generation, and then utilizes off-site renewable electricity for its remaining energy needs. Natural gas, mined using proven, environmentally benign methods, may also be used for heating and cooking purposes.

Figure 6-2: Definition of Net-Zero Buildings

NREL has also published a hierarchy of renewable energy supplies, shown in Table 6-1, which outlines the priority process to which renewable energy should be used to supply a building’s power. As mentioned above, for the purpose of commercial buildings, I have added natural gas as the fifth option for energy on the condition that the mining procedures used to procure the gas was proven to be environmentally benign.

Option Number	ZEB Supply-Side Options	Examples
0	Reduce site energy use through low-energy building technologies	Daylighting, high-efficiency HVAC equipment, natural ventilation, evaporative cooling, etc.
On-Site Supply Options		
1	Use renewable energy sources available within the building’s footprint	PV, solar hot water, and wind located on the building.
2	Use renewable energy sources available at the site	PV, solar hot water, low-impact hydro, and wind located on-site, but not on the building.
Off-Site Supply Options		
3	Use renewable energy sources available off site to generate energy on site	Biomass, wood pellets, ethanol, or biodiesel that can be imported from off site, or waste streams from on-site processes that can be used on-site to generate electricity and heat.
4	Purchase off-site renewable energy sources	Utility-based wind, PV, emissions credits, or other “green” purchasing options. Hydroelectric is sometimes considered.

Table 6-1: NREL Zero-Energy Building (ZEB) Renewable Energy Supply Option Hierarchy

6.4 The Importance of Net-Zero Energy Commercial Buildings

NZEB's will be as energy efficient as today's technology and design will allow, and they will generate electricity entirely from renewable energy sources. The benefits of this are somewhat obvious in this day in age, where it seems every company has a "green" agenda and society is moving towards conservation and recycling. The benefits of NZBs are listed in **Error! Reference source not found.**, and further expanded upon in section 6.4.1.

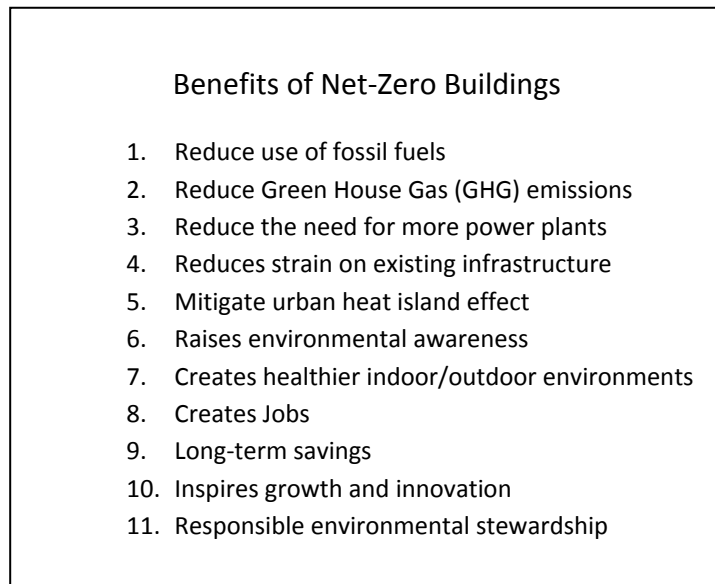


Figure 6-3: Benefits of Net-Zero Energy Commercial Buildings

It is essential to keep in mind that size, shape, location, and orientation of a building are key factors in designing on-site alternative energy systems. A 2006 study conducted by the National Renewable Energy Laboratory examined seven low-energy commercial buildings that were designed and constructed to minimize energy use and utilize alternative energy technologies. Of the seven buildings, only the four one-story units were capable of achieving net-zero energy within their roof areas. One of the two-story buildings was planning to put a solar array in its parking lot, beyond the building's footprint, in order to reach net-

zero energy. The overall analysis stated that zero net-energy was not feasible for buildings taller than one-story unless site-energy consumption was drastically reduced.⁷

6.4.1 Analyzing the Benefits

Reducing Fossil Fuels and GHG Emissions

Reducing the use of fossil fuels is vital to obtaining energy independence both as individual states and as a nation. For one, not all states possess the natural resources to be self-sustaining in the energy sector,

⁷ The 7 buildings examined were the Oberlin, Zion, Cambria, CBF, TTF, Big Horn, and Science House. The entire report is available free of charge online. (P. Torcellini, 2006)

so not only are energy costs higher, but added energy is required to transport the fuel to these states. Fossil fuels are a finite resource and they have served humanity well in advancing industry to its current state, but it is time for new innovation. Nationally, we are destroying our homeland through extensive coal mining. In 2009, 97% of coal consumed in the U.S. was mined in the U.S., producing 46% of the energy consumed nationally.⁸ Green house gas emissions are also directly proportional to the burning of fossil fuels to generate electricity. Highlighted in Table 6-2 is the 18% of total U.S. CO₂ emissions produced solely by the commercial building sector in 2006. This is nearly half of the 39% produced by the entire building sector in 2006; which, for comparison, is about equal to the combined CO₂ emissions of Japan, France, and the United Kingdom.⁹

Reduce Need for Power Plants

As the construction of NZBs increases, less electricity will be required from existing power plants. This also nearly eliminates transmission losses to buildings since NZBs primarily generate their electricity on-site. NZBs will remain “plugged-in” to the grid in order to sell back alternatively generated electricity and also as a safety precaution. Figure 6-4 shows that U.S. electricity is primarily generated by burning coal and natural gas, and the only way to reduce our emissions to hospitable levels is to demand electricity from renewable sources.

3.4.1 Carbon Dioxide Emissions for U.S. Commercial Buildings, by Year (Million Metric Tons)							
	Commercial			Growth Rate <u>2006-</u> <u>Year</u>	U.S.		Com.% <u>of Total U.S.</u>
	<u>Site</u>	<u>Fossil</u>	<u>Electricity</u>		<u>Total</u>	<u>Total</u>	
2000	235	780	1015	-	5847	-	17%
2001	227	796	1023	-	5749	-	18%
2002	229	790	1018	-	5813	-	18%
2003	238	789	1027	-	5866	-	18%
2004	234	807	1042	-	5957	-	17%
2005	230	835	1065	-	5982	-	18%
2006	212	832	1045	-	5890	-	18%

Table 6-2: CO₂ Emissions for U.S. Commercial Buildings (Department of Energy (DOE), 2009)

⁸ 2009 statistics from the U.S. Energy Information Administration

⁹ From the Environmental Data in the 2009 Buildings Energy Data Book ((EERE), 2009)

Reduces Strain on Existing Infrastructure

Ultimately, by producing more electricity through on-site renewables, strain on the existing energy system will be relieved. Fossil fuels today must be mined or drilled, and then transported; all of which consumes energy before the fuel has even made it to a power plant. Once inside the plant, the fuel is burned to produce steam, which mechanically drives a turbine and rotates a generator to

produce electricity. A significant portion of the fuel's energy content is lost due to generation inefficiencies. By this time, electricity has been successfully generated only to succumb to transmission losses as the electricity is sent from the power plant to commercial buildings and other end users. NZBs will reduce the losses in each stage of this journey from drilling to transmission because an NZB will generate its own electricity using renewable sources. The growth of NZB communities will allow the development of a network of shared electricity that would further enhance independence from the grid.

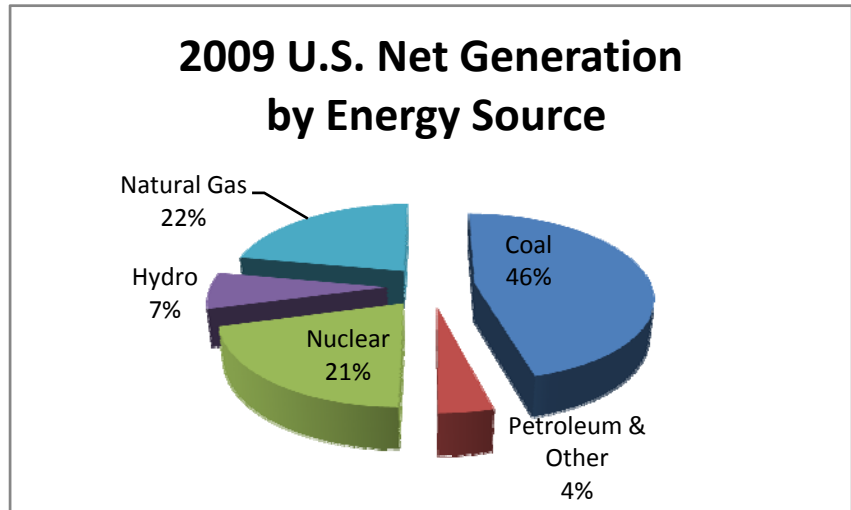


Figure 6-4: 2009 U.S. Net Energy Generation Source Breakdown

Mitigate Urban Heat Island Effect

The urban heat island effect is caused by the replacement of once permeable surfaces of earth by impermeable concrete and other building materials. Such development that leads to a city of just 1 million people can raise the average annual temperature 1.8-5.4°F (1-3°C) higher than surrounding areas. This temperature differences can be as high as 22°F (12°C) in the evenings. This phenomenon creates an unnatural environment around the city, increases heat related illnesses, and increases peak energy demand, which consequently leads to increased greenhouse gas emission, air pollution, and increased cost.¹⁰

¹⁰ The Environmental Protection Agency (EPA) has conducted studies on the urban heat island effect in order to better educate citizens, especially builders and designers, on how to mitigate this effect.

Raises Awareness while Creating Healthier Environments

As NZBs become increasingly more visible and commonplace, people will begin to notice the effects it has on their health and comfort level. It may even become socially accepted to work, shop, or dine in an NZB over a traditional building. Society today has already begun to embrace the conservation and recycling movements, and interacting with an NZB will be another way for citizens to be wary of their impact on the environment. Connecting with the environment is also a natural way to improve the mental and physical conditions for occupants. A naturally lit and ventilated structure is much more welcoming and inviting, and a green roof can be ideal for rooftop gatherings.

Creates Jobs

Yet, NZBs will not be simple to create. New jobs will be required in the form of innovative designers, engineers, and architects, new solar and wind manufacturers, and a whole array of energy efficient technology design and manufacturing necessary to achieve net zero in both existing and new buildings. This will create a market for new businesses and as such, significantly increase job availability.

Inspire Growth, Innovation, and Responsible Environmental Stewardship

The movement towards NZBs will inspire growth and innovation not only in the entire construction supply chain, but also in the energy revolution. By operating entirely off the grid, NZBs will have the ability to plug into a zero-energy network, community, or even a smart grid. As we continue to electrify our transportation, communication, and information, NZBs will become another link in the chain. Along with pushing our intelligence and creativity to the limits of electronic advancement, our connection with the earth cannot be forgotten. Ultimately, net-zero must be reached as a step towards more responsible stewardship of the natural world. No longer must a building be a place of refuge for fear of the outside elements, rather, it should begin to introduce people to their surrounding ecology; a building should not be alien to the earth, rather designed so it is naturally integrated with the environment.

Long-Term Savings

Finally, there is a cost savings benefit to the construction of NZBs. The typical building today will last 30 – 50 years, many of which will continue to operate longer. The initial cost for a building is only 2% of its lifetime cost, assuming an average lifespan. The operations and maintenance costs are approximately 6%, and the major contributor to cost are the occupants at a whopping 92% of the cost to run a

building.¹¹ The benefits of decreasing this cost and impact over the lifetime use of a building can significantly outweigh the 2% initial cost. Energy efficiency is increasingly being sold as an added benefit to occupants and those looking to reduce their carbon footprint. Soon, green buildings and an energy efficient lifestyle will not only become the norm, it will be expected by the general public and buildings that are not up to standard will suffer.

¹¹ 2009-2010 ASHRAE President Gordon Holness presented these figures during a June 2010 congressional briefing

6.5 The Tree

A building is a form of shelter and necessary for survival. People spend the majority of their lives indoors, working, living, raising families, and fostering community. This idea originated from a fear of the outdoors, a fear of the unknown which ultimately led to the separation of humans from the natural world. As today's leaders, we must adjust our perspectives to view the raw, natural power at our doorsteps as an asset, not a force to vanquish. We cannot live fruitful lives, utilizing all that the earth has to offer, from the inside of man-made buildings. Life's complexities are extremely intelligent, and to break out of our concrete isolation I propose that we tap or human innovation to create living and working spaces that are integrated with the natural world. I propose that we revolutionize the idea of *buildings* and the *built environment* to a set of structures that compliment and embrace the surrounding ecology.

Currently, talks of a Smart Grid and High-Performance Buildings are gaining growing audiences. NZBs will be one of the central pylons used to bridge the gap between a smart network and smart buildings. NZBs will have the ability to sell electricity back to the grid, while utilizing the safety of having electricity available 24/7 via the Smart Grid. In reality, NZBs will be difficult to achieve with available renewable site-generation technology. A more progressive and attainable step would be to create net-zero pairs, or even net-zero blocks, in which entire city blocks are net-zero because they are able to share electricity. Due to the orientation of city blocks, different buildings receive more solar energy at different times of the day. Using this concept, we can evolve from *buildings* to Zero-Energy Networks (ZEN). A ZEN will not be achievable overnight, but I have created a series of stages that buildings would evolve through as our society grows into self-sustaining networks.

The overall idea is based on the structure of a solar-energy harnessing habitat to many forms of life, which is able to adapt to the changing seasons, the relentless elements, and endure for decades; a tree. These stages of Zero-Energy Network (ZEN) evolution are depicted in Figure 6-5, followed by definitions in Table 6-3.

The Tactical Reach for Energy Equilibrium (TREE)

Figure 6-5: ZEN Tree

STRUCTURE TYPE	DEFINITION
ZEN	Two or greater NESTs electrically independent yet connected so that excess energy generated by one NEST can be shared with neighbors. Grid connection is mandatory for safety support and in the case of insufficient network electrical generation.
NESt	A NEST is capable of producing all of its required electrical energy and heating through on-site renewables. Grid connection is mandatory for safety support and in the case of insufficient network electrical generation.
LEAF	A LEAF is the equivalent of the Figure 6-2 definition of an NZB. In order of priority, a LEAF utilizes on-site renewables, then off-site renewables, and finally natural gas mined in an environmentally benign manner used only for cooking and heating.
SEED	A SEED is not net-zero, but has been constructed or retrofitted to be extremely energy efficient and may include on-site renewable generation. As far as building labeling, a SEED would earn a rank of A, A-, B, or C in ASHRAE's Building Energy Quotient (bEQ) program (See Appendix A for more on bEQ).
LIMB	Following the ABEL bEQ system, a LIMB will be of rating D. A LIMB will be built to a minimum of ASHRAE 90.1-2001 energy standards.
BASE	A BASE falls under the ABEL bEQ rating of <i>F</i> or <i>unsatisfactory</i> . These are buildings constructed to pre-ASHRAE 90.1-2001 energy standards.

Table 6-3: ZEN Tree Definition

7 Building Standards and Codes

7.1 The History of Building Codes

Hammurabi, the sixth King of Babylon, oversaw and enforced the first recorded building codes in 1790 BC.¹² Nearly 4,000 years later, the value of a building code system has become more robust and meaningful. The purpose of a building code is to protect the health, safety, and welfare of the general public and users of a building or structure as it pertains to design, construction, and maintenance. Today, a single governmental entity, does not dictate the codes, rather, codes are a result of various discussions between all pertinent stakeholders. In fact, the National Technology Transfer and Advancement (NTTA) act of 1995 encourages federal agencies to partner with private standards developing organizations (SDOs) to improve the effectiveness and increase the adoptability of standards.¹³

According to the Construction Dictionary, codes are regulations, ordinances, or statutory requirements of a governmental unit adopted and administered for the protection of public health, safety, and welfare. A building code is a law or regulation that sets forth minimum requirements for the design and construction of buildings and structures.¹⁴ Over time, legal differences arose between codes, standards, and guides. The next section attempts to explain the process as it exists today.

7.2 The Codes and Standards Process

In order to achieve NZBs through the current codes and standards process, one must first understand the building codes and standards process. A pictogram of the codes and standards process is displayed in Figure 7-1. The process initially begins with the SDOs who develop codes and standards through similar but unique processes. The consensus processes varies between organizations, but the point is that they, “are developed and published to define the minimum values or acceptable performance (ASHRAE, 2010).” The International Code Council (ICC) develops codes which can be directly adopted into law by federal, state, and local governments. The Illuminating Engineering Society (IES), ASHRAE, and other groups (all known as SDOs) develop standards written in code-intended language. These standards are written to enhance and compliment existing codes with the intention of being adopted as code. Governments can choose to adopt codes, standards, or even guidelines into law. Once this happens, the local engineers, architects, builders, and building owners reference their most recent local laws to ensure safety, security, and energy minimums are met for the new

¹² Safety was, and remains today, the primary reason for code development (Cote & Grant)

¹³ This act was passed just a year after the formation of the ICC and has been successful in improving government efficiency by reducing duplicative code writing and improving public/private communications

¹⁴ Definition of Building Codes (Cote & Grant)

construction or renovation. This team of players then constructs a building according to the codes and standards. The building serves tenants and occupants, while being maintained by trained operators and maintenance personnel.

A simplified breakdown of the process is as follows:

- SDOs develop standards through an approved process created by the American National Standards Institute (ANSI). This process, known as the ANSI requirements for due process and standards development, provides guidelines for the creation of fair standards through a consensus process in which all stakeholders and the general public are permitted input. ASHRAE, IES, and the American Society for Testing and Materials (ASTM) are all examples of SDOs. SDOs are also primarily non-profit organizations to further separate them from bias.
- The ICC is also a non-profit council that has the power to create model codes that can be enforced by law as regions see fit. The ICC utilizes a government consensus process to code making. Their basic steps are as follows:
 - Codes or Code changes are proposed by an individual, group, organization, or committee
 - The proposals are processed
 - A public hearing is held where interested parties may present their views
 - Public comments will again be heard at the final action hearing where a decision will be made
 - The final action consideration requires either a majority or 2/3 vote to pass (requirement varies with each situation). ICC governmental member representatives and honorary members in attendance may vote. Not all stakeholders are eligible to vote because this code will become law, and is therefore ultimately decided by government members. The stakeholders are not without a voice as they can be heard in hearings, through an appeals process, and they also have voting power through SDOs should the code be proven relevant to their interests (ASHRAE, 2010).

The stakeholders involved in the typical ANSI/ASHRAE voluntary consensus process include:

- the design community, including architects, lighting, and mechanical designers
- members of the enforcement community, including building code officials, representatives of code organizations, and state regulatory agencies
- building owners and operators
- industry and manufacturers
- utility companies
- energy advocacy groups
- the academic community
- the Department of Energy and the BECP

((DOE) B. E., 2010)

Codes and Standards Flow Chart



Standard, Code, and Regulation Developing Organizations



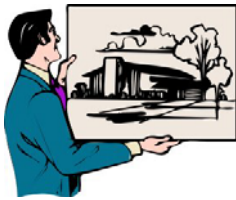
US Federal Government



State and Local Governments



Standards, Codes, and Regulations



Architects



Construction



Engineers



Building Owner Manager



NZBs



Operations and Maintenance



Tenants and Users

Figure 7-1: Codes and Standards Flow Chart

7.3 Codes and Standards: 1980 – Present

The following is a brief timeline of the development of ASHRAE Standards regarding energy in buildings, beginning in 1975 with standard 90, through the recent 2009 “stretch” standards of the ANSI/ASHRAE/USGBC/IES Standard 189.1. The purpose of these “stretch” standards is to provide a basis upon which high-performing green buildings can be designed; and although it is up to local jurisdictions to adopt this into code, because it is more stringent in certain criteria designers will have the option to use standard 189.1 to create a high-performing building.

- ❖ ASHRAE Standard 90-1975: “Energy Conservation in New Buildings”
 - 1975 marked the beginning of the “90” series of energy standards
- ❖ ASHRAE Standard 90A-1980
 - Standard 90 was published first in 1975, with revised editions published in 1980, 1989, and 1999. Since 2001, Standard 90.1 has been continuously published every three years.
- ❖ ASHRAE Product Specification File, 1982
- ❖ June 25, 1986 IES becomes official joint sponsor of ASHRAE Standard 90
- ❖ ASHRAE 169-2006: Weather Data for Building Design Standards
- ❖ ASHRAE Standard 90.1-2007 : *Energy Standard for Buildings Except Low-Rise Residential Buildings*
 - The 2010 standards are the most current, with the next standard 90.1 revised publication expected in 2013.
- ❖ ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality
 - Standard 62.1 was first published in 1973 and has since been continuously published every three years
- ❖ ASHRAE Standard 55-2007: Thermal Environmental Conditions for Human Occupancy
- ❖ ANSI/ASHRAE 135-2008: BACnet A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved)
- ❖ ANSI/ASHRAE Standard 189.1-2009: *Standard for the Design of High-Performance Green Buildings (Stretch Code)*
 - In 2009, ASHRAE, IES, and the U.S. Green Building Council (USGBC) wrote, in code intended language and using the ANSI approved process, a minimum acceptable level of performance for high-performing green buildings to be adopted by local jurisdictions.

ASHRAE standard 90.1 is an energy standard written in code-intended language that has been adopted by the vast majority of jurisdictions in the U.S. This document provides energy standards for all buildings (except low-rise residential units) on the building exterior (or *envelope*), heating, ventilation, and air conditioning (HVAC) systems, water heating, lighting, and other equipment.¹⁵

¹⁵ See ASHRAE Standards and Guidelines for more information (ASHRAE, 2010)

The International Energy Conservation Code (IECC) was developed by the ICC in 2006, and updated in 2009, as a model code defining minimum energy efficiency. The IECC also allows ASHRAE 90.1 as a compliance path. The nuances and legalities of the IECC are complex, but it is important to note that it is the start of energy efficiency codes.¹⁶

7.3.1 Effectiveness of Building Codes and Standards

It is difficult to say with great accuracy how accurate a building's design performance is to its constructed operation performance when it comes to codes and standards. Responsibility falls to local jurisdictions to enforce building codes during construction. Local code officials may visit building sites at their discretion, though they are also called to check for compliance during specific testing and review points throughout construction. Since safety is of utmost importance, it is not uncommon for an official to gloss over energy code compliance, especially because "as-designed" energy use is typically much less than "actual operation" energy consumption. An accurate measurement of a building's energy use can only be taken once the building has begun full normal operation.

Code officials are only chartered to inspect new buildings and buildings undergoing major renovations. The Fire Marshall will continue to check for safety, but as far as energy use goes there is no one assigned to ensure operational efficiency. To put this into perspective, there is no one looking out for the impact that buildings have on the environment, which as stated in section 4.2 is a major contributor to green house gasses and energy consumption. It is estimated that over 80% of the buildings constructed today will still be in operation in 2035, which is why buildings today must be constructed with strict energy efficient operation in mind. The effectiveness of building codes and standards in keeping the public safe can now extend to beginning the process of rebalancing anthropogenic change in the environment.

7.4 Energy Codes and Standards

Just as in other codes and standards, energy codes and standards provide the minimum requirements necessary for energy-efficient design and construction for new and renovated buildings that impact energy use and emissions for the life of the building. This energy efficient baseline can be surpassed by the design team if they choose, the benefits of which will last the entire life span of the building, typically thirty to fifty years ((DOE) B. E., 2010).

In addition to developing ASHRAE 90.1 energy codes and working with the IECC, ASHRAE has also begun to develop "reach" or "stretch" standards to show the public where future standards are headed.

¹⁶ Visit the ICC website for more information: <http://www.iccsafe.org/Pages/default.aspx>

ASHRAE Standard 189.1 and other stretch codes and beyond code programs are becoming increasingly popular as well. Beyond code programs include building labeling, certification and overall more rigorous requirements than minimum energy codes. Several beyond energy code programs for commercial building are listed in Appendix B. These are also adoptable by jurisdictions and can serve as a guideline for building design teams.

As codes are revised and updated, the DOE's BCEP determines whether the new standards improve building energy efficiencies. If so, the DOE provides technical assistance and incentive funding to states to:

- *Review and update their energy codes*
- *Implement, enforce, and evaluate compliance*
- *Certify extensions of adoption if states have shown good progress towards compliance*

The U.S. Department of Energy (DOE) determines whether subsequent new editions of ANSI/ASHRAE/IES Standard 90.1 will in fact improve energy efficiency in commercial buildings. This is done through the DOE's Building Energy Codes Program (BCEP) and is required by law. The Energy Policy Act of 1992 (EPA 1992) requires states to certify that their building energy codes meet the requirements of the newest standard within two years of publication should the DOE find these new standards improve the energy efficiency. For example, if the DOE issued a determination that Standard 90.1 – 2007 was more energy efficient than Standard 90.1 – 2004, states would have two years from the official DOE notification to certify that their energy codes are at least as stringent as 90.1 – 2007, or they must justify their reasons for non-compliance. Upon this issuance, the DOE must provide technical assistance and incentive funding to states to review and update state energy codes, implement, enforce, and evaluate compliance with state energy codes, and permit certification extensions if the state demonstrates good faith to comply and the state has made significant progress towards compliance. ((DOE) U. D., 2009)

Since 1995, the Federal Government has been moving towards adopting privately developed voluntary consensus standards into federal building code. The National Technology transfer and Advancement Act (NTTAA) of 1995, in conjunction with its clarifying document Circular No. A-119, dictates that the goal of this is to, "eliminate cost and redundancy by the government developing its own standards, to provide incentives and opportunities to establish standards that serve national needs, to promote efficiency and economic competition through harmonization of standards, and to further the policy of reliance upon the private sector to supply the Federal Government's needs for goods and services."¹⁷ Supporting privately developed building codes and standards is just the first step in the Federal Government assuming a leadership role in building energy efficiency.

¹⁷ From the Office of Management and Budget (OMB) Circular No. A-119, a revision to Public Law 104-113, NTTAA ((OMB), 1998)

7.5 The Federal Government's Response to Building Energy Issues

Current federal building energy codes became effective January 3, 2007 and require that all new buildings and major renovations to existing buildings achieve 30% greater energy efficiency than Standard 90.1 – 2004 when life-cycle cost-effective. ((DOE) U. D., 2010) Since 2003, the U.S. General Services Administration (GSA) has required all newly constructed buildings to be LEED certified, with the aim of achieving at least LEED Silver. As of March 2008, there are 82 LEED certified federal buildings, along with the following government agencies having passed legislation, executive orders, ordinances, policies, or incentives for new and renovated buildings to be LEED certified:

1. Department of Energy
2. Department of Interior
3. Department of State
4. U.S. Air Force
5. U.S. Army
6. U.S. Environmental Protection Agency
7. U.S. General Services Administration
8. U.S. Navy

(Energy, 2008)

Through the American Recovery and Reinvestment Act (ARRA) of 2009, the DOE provided 3.1 billion dollars to states to address their energy priorities by providing program funding to deploy emerging renewable energy and energy efficiency technologies. Aside from new renewable energy generation plants and grants for companies designing energy efficient technologies, much of this funding also went towards improving efficiency in buildings.

7.6 Basic Steps to Achieving Net-Zero

In order for energy codes and standards to have a major impact on the building industry, they require four main provisions: they must be significantly more energy efficient than the previous edition, then

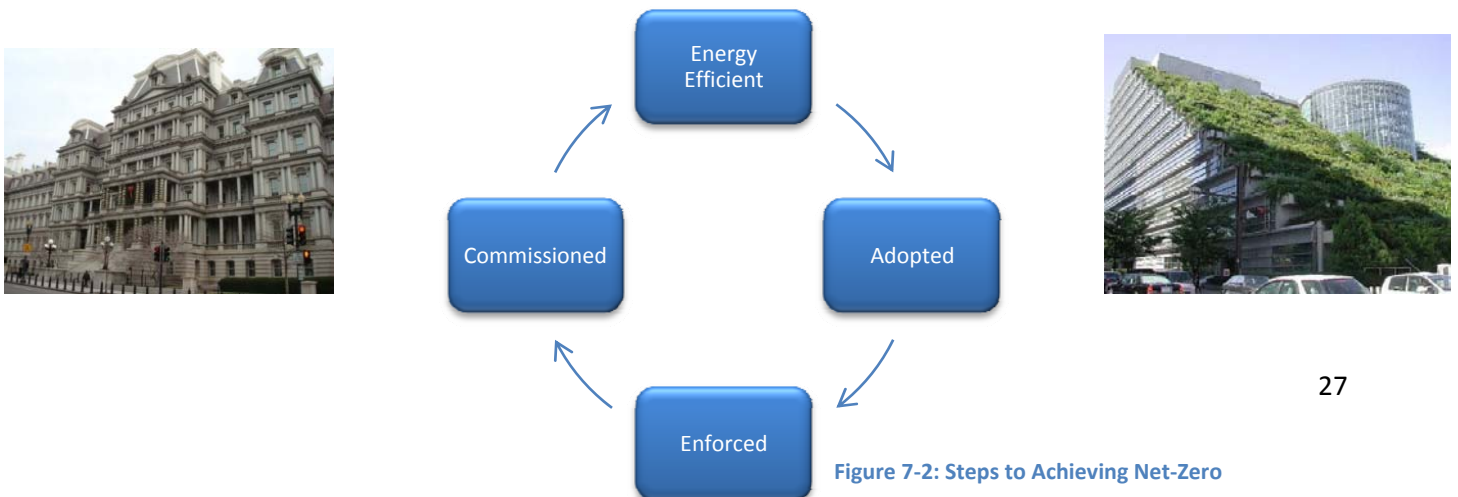


Figure 7-2: Steps to Achieving Net-Zero

they must be adopted by local jurisdictions, enforced from the start of construction, and commissioned throughout the life of the building. The key steps to achieving NZBs through the codes and standards process are illustrated in Figure 7-2.

Integrating the TREE philosophy with these four steps provides the groundwork for achieving net-zero. Again, the steps described below are the pathway to net-zero; the challenges along this path are identified in the next section.

Developing Energy Efficient Codes

Responsibility falls to the SDOs, the ICC, and the DOE to make certain that new codes and standards are significantly more efficient than the previous edition. These codes and standards will guide commercial building designers to new levels of energy efficiency, while allowing building owners the freedom to select a LIMB, LEAF, NEST, or ZEN to construct.

Promoting Energy Efficient Code Adoption

Adoption by state and local jurisdictions is the next step in the process. Nationally, some states have been very progressive in their building energy codes, while others continue to use minimum requirements. Incentivizing municipalities to adopt green codes will help guide our states and the nation towards a ZEN.

Ensuring Local Implementation

Following adoption, it is vital that new construction and renovation is properly completed to maximize the system efficiency. This will require open communication and access to information for all stakeholders. Building owners will need to be actively participating leaders during construction and also with facility and property managers.

Providing Continuous Commissioning

As previously noted, the actual operation can vary significantly from its design, especially in the realm of energy efficiency. Continual and effective commissioning is necessary to ensure prolonged efficiency.

8 Key Conflicts and Concerns

8.1 Barriers to Net-Zero

Eight challenges were identified in the codes and standards making process as listed in Figure 8-1. These challenges are the result of comprehensive research as well as discussions with various members of code making bodies, architectural firms, state energy code officials,

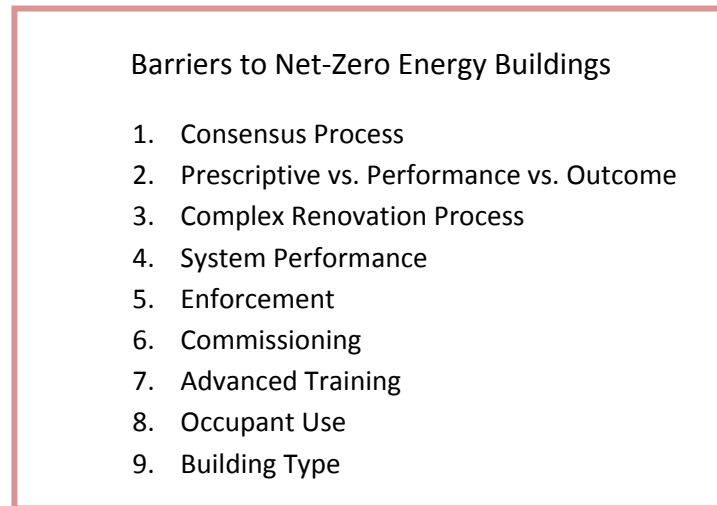


Figure 8-1: Barriers to Net-Zero Energy Commercial Buildings

8.1.1 Consensus Process

The ANSI due process for the formation of voluntary consensus standards is an efficient and fair system. Its equality, though, is its curse. At the end of the day, cost is the number one issue for each stakeholder, be they vendors, manufacturers, builders, or building owners. The consensus process allows energy codes to be developed less stringent and more affordable. The technology to achieve net-zero exists today, but the stakeholders in the consensus process are cautious to put themselves in a difficult position when it comes to initial cost. Cost is the total money, time, and resources associated with a purchase or activity, and there are many forms of cost:

- Cost of new technologies
- Initial Building Costs
- Maintenance Costs
- Cost of training
- Cost to educate occupants
- Value added to renovated building vs. increased costs
- Cost to the environment
- Cost tenants are willing to accept for net-zero
- Cost of increased oversight to ensure energy efficiency

In one sentence, economics hinders the voluntary consensus process unless we can give added value to the stakeholders.

8.1.2 Prescriptive vs. Performance vs. Outcome

There are three types of standards that are usually written with mandatory, enforceable code-intended language. They are, prescriptive, performance, and outcome-based, as described in Figure 8-2. A prescriptive standard specifically lays out the technologies and techniques necessary to achieve compliance with building codes and standards. Performance-based standards utilize building modeling to predict the level of efficiency for a building. The design team then works towards this energy target with the freedom to select the design path they desire. Outcome-based standards allow for innovation and creativity in design in order to achieve more detailed goals of energy use with the purpose of moving towards enforcement actual-energy consumption versus as-designed. The chief difference between the latter two is outcome-based standards provide a relative minimum (based on building type and location) that allows comparison between various commercial buildings.

PRESCRIPTIVE	PERFORMANCE	OUTCOME-BASED
Specifically lays out the technologies and techniques necessary to achieve compliance with building codes and standards	Predicts the level of energy efficiency to be achieved relative to a hypothetical building model. This building performance becomes the target to be reached through different options as selected by the design team	Outcome-based standards use building modeling in conjunction with a calculated minimum based on other similar building types in the same climate zones. This allows for comparisons to be made between buildings of different types located in different regions.

Figure 8-2: Comparison of Code Types

The problem with prescriptive standards is that they do not account for building type and location, making it impossible to compare even like buildings. States and local jurisdictions have been moving towards localizing their codes to account for regional climate differences and concerns, but the comparison issue persists. While performance based standards provide more accurate model of a specific building’s hypothetical energy use (location and type are included), the energy targets vary between each building so comparison is again unattainable. Another issue with performance standards is the disparity between *as-designed* and *as-operated* energy use. Outcome based standards are intended to provide a more accurate building model utilizing actual energy use data from similar buildings in the region, allowing energy consumption between commercial buildings to be compared. The next step in outcome-based standards would be to regulate actual energy use. The difficulty with this is the cost it would take to renovate or upgrade a brand new system if it did not meet its energy target.

8.1.3 Complex Renovation Process

As previously discussed, the majority of NZBs will not be built, but rather renovated. This presents several challenges because there is less incentive for a building owner to go back and renovate their property. This occurs in commercial properties because of the “split incentives” issue. Basically this issue arises from the confusion between who receives incentive funds for renovated buildings; the building owner or the tenants. There are arguments both ways but the bottom line is that this presents another challenge in achieving net-zero. Technologically, there is also the issue of whether or not net-zero is achievable in a cost-effective manner. Commercial office buildings traditionally incorporate hundreds of offices in a small area by building vertically. This reduces the roof area for solar panels with the added burden of increased tenants.

8.1.4 System Performance

The largest consumers of energy in a building are the occupants, through the mechanical systems, used for plumbing, lighting, fire safety, and thermal comfort, and also through process loads. This is why 92% of a building’s lifetime costs are attributed to the occupants. Reducing the energy consumption of these “active” systems can be a major factor in achieving net-zero. Knowing when to repair, upgrade, or completely renovate a system can save energy and lower monthly costs.

8.1.5 Enforcement

Building code officials are required to check almost every system in a building and, with safety being the priority, energy systems are sometimes overlooked. A bigger problem is that many code officials are unprepared and unqualified to inspect new, energy efficient technologies. Building code officials also need to work with local fire marshals to understand whether or not these new technologies will in any way complicate safety standards. Code enforcement also varies between jurisdictions and is therefore fractured across the nation, making communication and uniform education nearly impossible.

8.1.6 Commissioning

Commissioning, or ongoing verification of system integrity, is crucial to achieving net-zero because it deals with actual operation energy figures. Mechanical systems are often unpredictable and behave differently under different circumstances. It will be necessary to ensure that every system performs as designed to create a comfortable and healthy work environment, and also to ensure that the systems are not consuming more energy than expected. It is also important to have the passive energy saving consultants return to verify that their systems are working properly. These systems can include thicker windows, extra wall insulation, façade shading, green or white rooftops, and more. As with enforcement, commissioners also require extra training to better understand new technologies and systems, and to allow for smooth communication with the operators.

8.1.7 Advanced Training

Along with training code officials and building commissioners, it will also be necessary to train the engineers, architects, manufacturers, vendors, builders, operations and maintenance personnel, and building owners at the very least. This training will be costly and will also take time to organize, but it is a key step in successfully constructing and maintaining an NZB.

8.1.8 Occupant Use

The occupants and users of a building have ultimate control over energy consumption. Users control the lights, use the plumbing, control the temperature of their zones and also plug electronics into the receptacles. Reducing energy use when possible will start to become habit as NZBs become more commonplace, but until then users will require education on the operation of new energy efficient building technologies and energy conservation techniques.

8.1.9 Building Type

The term “Commercial Building” extends to a many different building types. The Commercial Buildings Energy Consumption Survey (CBECS) published a list of Broad Category Definitions to group different building types, as listed in Table 8-1 ((EPA), 2003).¹⁸ Codes and standards intended to govern the energy efficiency of such a wide array of buildings will fail to capture the opportunities and resources unique to each location. Building type-specific codes could be an incentive to building owners and a way to realize more economic benefits as reaching net-zero will be much easier with distinctive codes.

BROAD BUILDING CATEGORIES
Education
Food Sales
Healthcare
Lodging
Mall
Office
Public Assembly
Public Order and Safety
Retail
Service
Storage/Shipping/Non-refrigerated Warehouse
Wastewater Treatment Facility
Other

Table 8-1: CBECS Broad Building Categories

¹⁸ The entire CBECS *Building Category Definition* report can be found through www.energystar.gov

9 Policy Alternatives

9.1 Potential Solutions

Through analysis and research I have realized several solutions to overcome the challenges identified in section 6 of this report. They are listed briefly in Table 9-1 and further explained below.

IDENTIFIED CHALLENGES	POTENTIAL SOLUTIONS
Economic Challenges in Consensus Process	Revolving Loan Funds Marketing Assistance Density Bonuses Expedited Permitting
Prescriptive vs. Performance vs. Outcome	Outcome-based Standards with specified metrics to measure energy consumed as well as comfort, health, and safety. Also support reach codes to provide predictability in this rapidly expanding market
Complex Renovation Process	Federal incentives specifically for building owners will overcome split incentive. Also need to ensure that Retrofits, upgrades, and efficiency testing must account for entire system, not just unit replacements.
System Performance	Primarily affected by occupant use (see Occupant Use). Future outcome-based standards may have the ability to regulate actual energy use through codes and standards, in which case system performance can be continuously commissioned.
Enforcement & Commissioning	Federal education and training for local code officials and energy commissioners. Incentivize existing interested organizations to create an energy official position for the sole task of ensuring energy efficient design, construction, and operation. Uniform enforcement of building codes and creating auditable codes Also provide energy use for commissioners through building labeling.
Advanced Training	Utilize modern communications and federal technical assistance to train all stakeholders as technologies and techniques are rapidly advanced
Occupant Use	Empower occupants by providing access to energy conservation methods, training occupants on new technology, and addressing process loads. Also provide energy use for occupants through building labeling.
Building Type	Develop codes with unique specifications dedicated to each of ASHRAE’s weather data zones and the Commercial Buildings Energy Consumption Survey (CBECS) building types (see Appendix C)

Table 9-1: Policy Solutions Matrix

9.2 Explanation of Solutions

9.2.1 Federal Government Incentives

The following is a list of incentives for the Federal Government to implement to support and encourage the TREE.

Revolving Loan Funds (RLFs)

RLFs help to mitigate upfront costs through a low-interest loan from a designated fund. The loan is then repaid to the fund at a rate lower than the operational cost savings from the energy efficiency techniques implemented. The fund is then able to finance another project in the same manner, and continuously for subsequent retrofits or new developments.

Marketing Assistance

Supporting green building owners with marketing through signs, awards, websites, press releases, and other avenues is a low-cost method to provide cost assistance to building owners. Besides acknowledging the environmental responsibility of a building owner, marketing assistance also increases sustainability awareness of citizens and surrounding communities.

Density Bonuses

Simply put, a density bonus will allow an increased in floor area ratio for commercial buildings that achieve designated efficiency standards. This incentive offers additional units or floor space for building owners to lease, thereby increasing their monthly income and hastening return on investment.

Expedited Permitting

The commercial building review and permitting process can sometimes take months, annoying investors, delaying returns, and ultimately increasing project costs as the project hangs in limbo. Expediting this process for deserving, energy efficient designs, will cost no money to the municipality and will allow the building owner to stay on-schedule. The benefits of being on-time in a construction project are numerous as logistics and construction order is essential to a successful project. This will also help to ensure that as-designed energy efficiency techniques are incorporated as best as possible and not rushed.

Incentivize Building Owners

The building owner is the ultimate decision maker in a new building or renovation project, and as such has the power to balance the building's energy efficiency with its cost. To accurately accomplish this, building owners must work closely with designers, builders, property managers and facility managers to ensure the building energy target is achievable. Even after construction, the building owner should be hard at work ensuring that the as-designed energy savings are being reached.

Property Assessed Clean Energy (PACE) programs help building owners to finance energy saving retrofits or new equipment through city or state-organized bond programs. The cost is then paid back over time through supplemental assessments on property taxes (Kanellos, 2010). A PACE program, incentivized by the Federal Government, can then be organized by local governments.

Technical Assistance

The idea here is to draw on the Federal Government's many resources and experts in energy efficiency and to use them to educate local code officials and building stakeholders on new codes, standards, energy efficient technologies and techniques, and other ideas that are being implemented around the nation. This sharing of information helps to keep local jurisdictions up-to-date while reducing redundant research.

New Position: Energy Official

An energy official would have the time and resources to successfully check for energy code compliance in new buildings and renovations. This employee would also be able to work with design teams, operations and maintenance technicians, and commissioners to share ideas on how a building can be better designed to ensure proper energy efficient operation. Providing funding an energy official initially will save future costs associated with commissioning and renovations.

9.2.2 Code changes

The following list and accompanying descriptions are intended to be implemented by SDOs and the ICC as changes to our current codes and standards process.

Metric-specified, Outcome-based standards

Developing a common, useable outcome-based standard is essential. The key areas to develop are tables of average energy consumption based on building type and location. A simple example would be for the tables to reference CBECS' building types and ASHRAE's weather zones to create a matrix of maximum expected energy use (these tables are available individually in Appendix C).

The next major step to creating a successful outcome-based standard program is to design a system that allows as-operated energy consumption to be coupled with the building design. Because such a system will, by nature, have an increased error, I believe these will remain standards that designers and builders can choose to adopt. The point of an outcome-based system is to allow us to successfully build a structure that operates the way it was designed. Only then can we hope to ascend the TREE.

Applying Retrofits to Entire System

It is important that retrofits and renovations be not simply one-off component replacements, but that codes and standards instruct builders and commissioners to account for entire systems. Such a system already affects fire safety systems, for example, if a ventilation system is upgraded; the damper controls and actuators must be intact after completion to allow the shutting of airflow in case of emergency. Similarly, a systems' efficiency is not dependent on just one component and I believe codes and standards should ensure systems are as energy efficient as possible following renovation.

Empower Occupants

Providing lighting and thermal comfort is no longer enough for conservation-minded occupants. Designers should empower occupants to control their energy use first by providing consumption data, and then through innovative design. A large plasma screen located in the lobby of the ASHRAE headquarters in Atlanta, Georgia, shows instantaneous energy use to all who enter. Visitors will notice large spikes every time an elevator is used as these are large, intermittent consumers of electricity. By designing an inviting staircase nearby, designers may have been able to create a healthier and more efficient means to access lower levels. This same information can be available throughout the commercial space to remind occupants of their impact and perhaps suggest ways energy can be reduced. Override control should always remain an option for unexpected circumstances, such as late working nights.

10 Recommendations

10.1 Policy Recommendation

Policy Recommendation

Codes and Standards developers must focus on developing outcome-based codes and standards, concentrate on retrofitting entire systems, empower the occupants, and remain predictable through stretch and reach programs.

Federal, state, and local governments must incentivize building owners via diverse funding programs similar to, and including those proposed in this report.

10.2 Details of Policy Recommendation

10.2.1 Role of Governments

Building owners have been identified as the key players in guiding future commercial construction towards ZEN. The role of Governments will be to support the innovation of architects, engineers, builders, and managers by encouraging building owners through incentives and assistance. The benefit of this for Governments will be a more in-depth interaction with private industry, and also a more symbiotic reliance on one another. The U.S. Government has already taken leadership of constructing energy efficient SEEDs, which besides providing case studies of successful projects, has also created a vast network of information to serve as a launching point to reach ZEN.

1. Federal Revolving loan funds must begin funding projects immediately. Now that ARRA funding has kick-started the renewable energy revolution, establishing long-term revolving loan funds will ensure the continuation of advancement towards ZENs.
2. The Federal Government should request that an agency begin net-zero marketing assistance programs to share information and provide start-up funding for the advertising and promotion of LIMBs or better. Assistance can be given on basis of how near to ZEN a construction project comes.
3. The vast amount of research and discussion on net-zero that has transpired in the Federal Government should be used to inform and educate stakeholders in local jurisdictions. Raising the awareness of occupants is a cost effective way to move towards net-zero.

4. Creating incentives for building owners will be the most direct way to alleviate initial cost barriers. Every month, numerous case studies are publicized showing the positive impact of buildings coupled with relatively quick return-on-investments. By creating national awards, grant systems, and other funding opportunities for building owners, the government will continue its commitment to sustainability and working with the people of America.
5. An energy coach could serve as an informant, commissioner, and record keeper of lessons learned on the journey to a ZEN. An agency or private group should be tasked and funded with the job of creating such a position, defining the role clearly, and sending this officer out to local jurisdictions to work with, and learn from, current projects.
6. State governments will also play a vital role as they are the ultimate adopters and enforcers of local laws. Incentivizing and educating them on the benefits of density bonuses and expediting building processes for commercial construction can be cost effective for both parties and open the door for future energy saving opportunities.

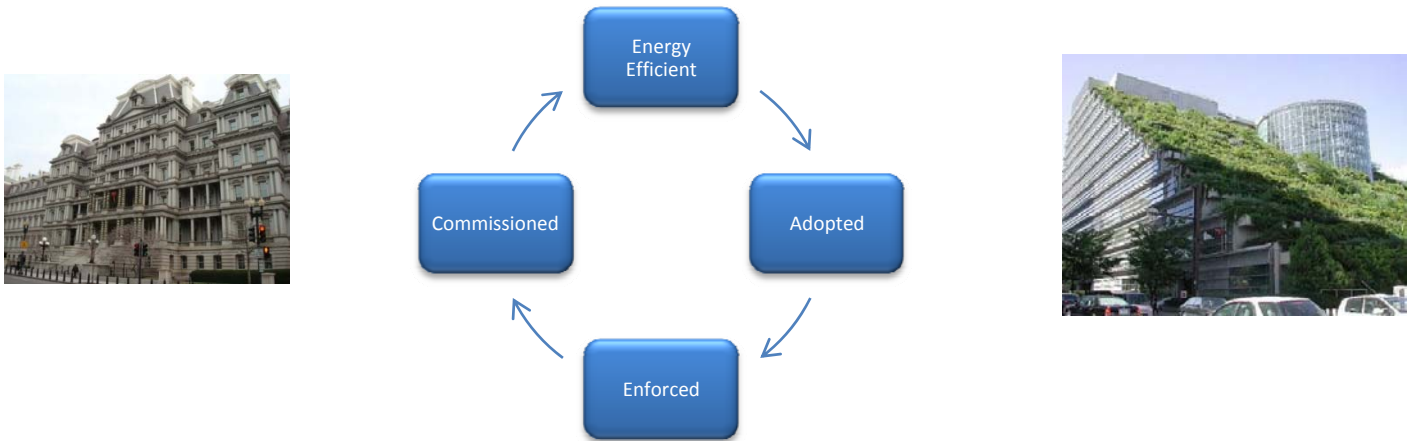
10.2.2 Role of Code and Standard Developers

The following are recommendations for SDOs and the ICC as they continue their development of codes and standards respectively.

1. Creating a well-defined and useable outcome-based standard will be pivotal in our TREE. The two points, towards which much input and analysis should be focused, are:
 - a. Measuring average energy use based on building type and ASHRAE weather zone
 - b. Measuring actual energy use accurately and empowering building owners and designers to ensure that new systems achieve as-designed energy objectives
2. Codes and Standards must indicate that retrofits and renovations must involve entire, integrated systems. Marinating the relationship of one system to the next, and ultimately to the building itself, will simplify maintenance procedures and ensure maximum operational efficiency.
3. Codes and Standards should empower occupants to take control of their energy use through new interface technologies and educational tools. Codes and standards can also guide builders to utilize building labeling as a source of management, information, and education.
4. The continued use of “reach” or “stretch” codes and standards will aid every link in the building supply chain as new, green technology companies plan for future projects and initiatives.

11 Policy Impact

The overall goal, the reason for the Tactical Reach for Energy Equilibrium, is to achieve net-zero commercial buildings. This four-step process, mentioned in section 7.6, will rely on codes and standards groups to create effective, energy efficient codes. By incentivizing states and building owners, these codes will then be adopted into law. The vast information contained in governmental research and the knowledge of code officials will be utilized to educate local jurisdictions' regulators and building stakeholders to make enforcement of energy efficient codes successful. Commissioning will come through the creation of an energy officer and the oversight of standards and codes groups.



The ZEN TREE provides a social labeling of structures that is much more meaningful than *buildings*. Incorporating this into everyday language will strengthen public drive as we work towards decreasing society's anthropogenic impact on the environment, one commercial building at a time.

The Tactical Reach for Energy Equilibrium (TREE)

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13 Appendix A

ASHRAE created a building labeling and certification program to inform all involved parties of a building, from building owners to occupants, of the potential and actual energy use of a building. The system, known as the building energy quotient (bEQ) program, utilizes a seven-step letter-grading scale from A through F. The scale range, shown in Table 13-1, assigns any building that is net-zero or generates excess energy (indicated by a negative energy consumption) a letter grade of A+. The median of the building type population is set at a grade of 100, the upper end of a C rating (ABEL, 2009). (Note again the importance of building type when it comes to energy consumption).

Scale Range	Rating	Description
≤0	A+	Net Zero Energy
1-25	A	High Performance
26-50	A-	Very Good
51-75	B	Good
76-100	C	Fair
101-125	D	Poor
>125	F	Unsatisfactory

Table 13-1: bEQ Grading Scale

ASHRAE's Advanced Building Energy Labeling (ABEL) focuses on energy through comparison of *as designed* and *as operated* figures. On-site vs. Off-site renewable generation, operational features, and commissioning activities each contributes to the overall rating of a building. The bEQ program was designed to inform building owners and design teams of a building's energy use and provide the data that will help reach energy-use goals. The ABEL bEQ program compliments the EPA's Energy Star and USGBC's LEED by focusing on energy use during actual operation. This will also help commissioners as they ensure energy codes have been met (Colker, 2009).

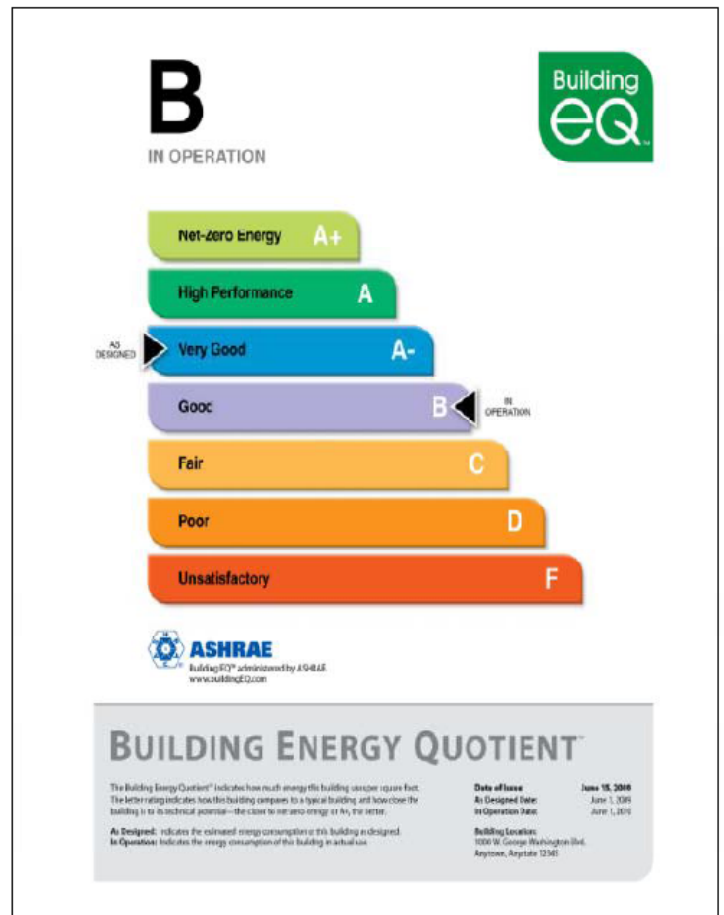
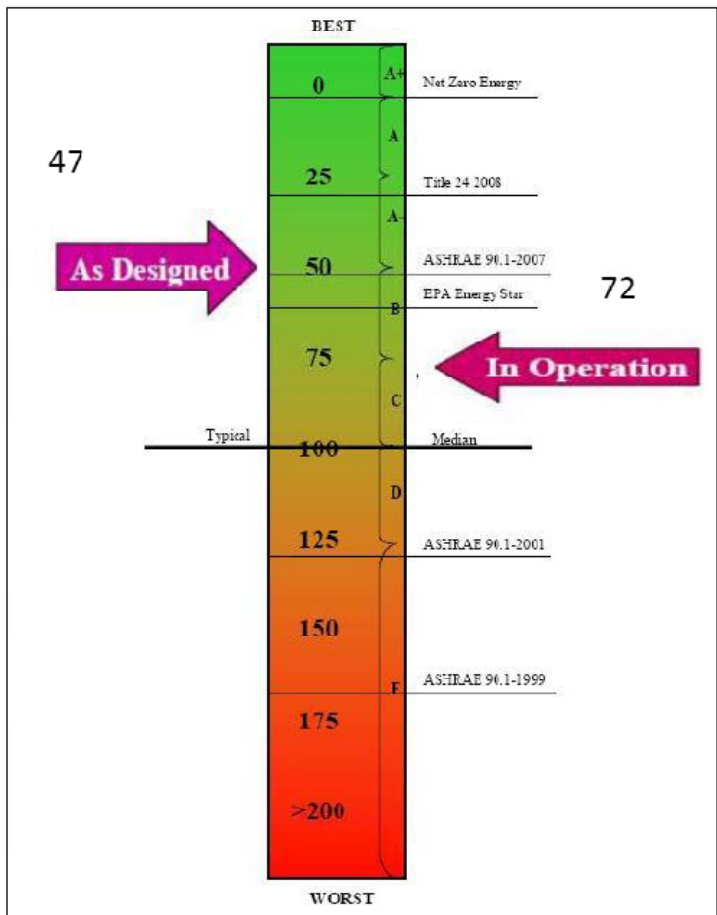


Figure 13-1: bEQ Scale (ABEL, 2009)

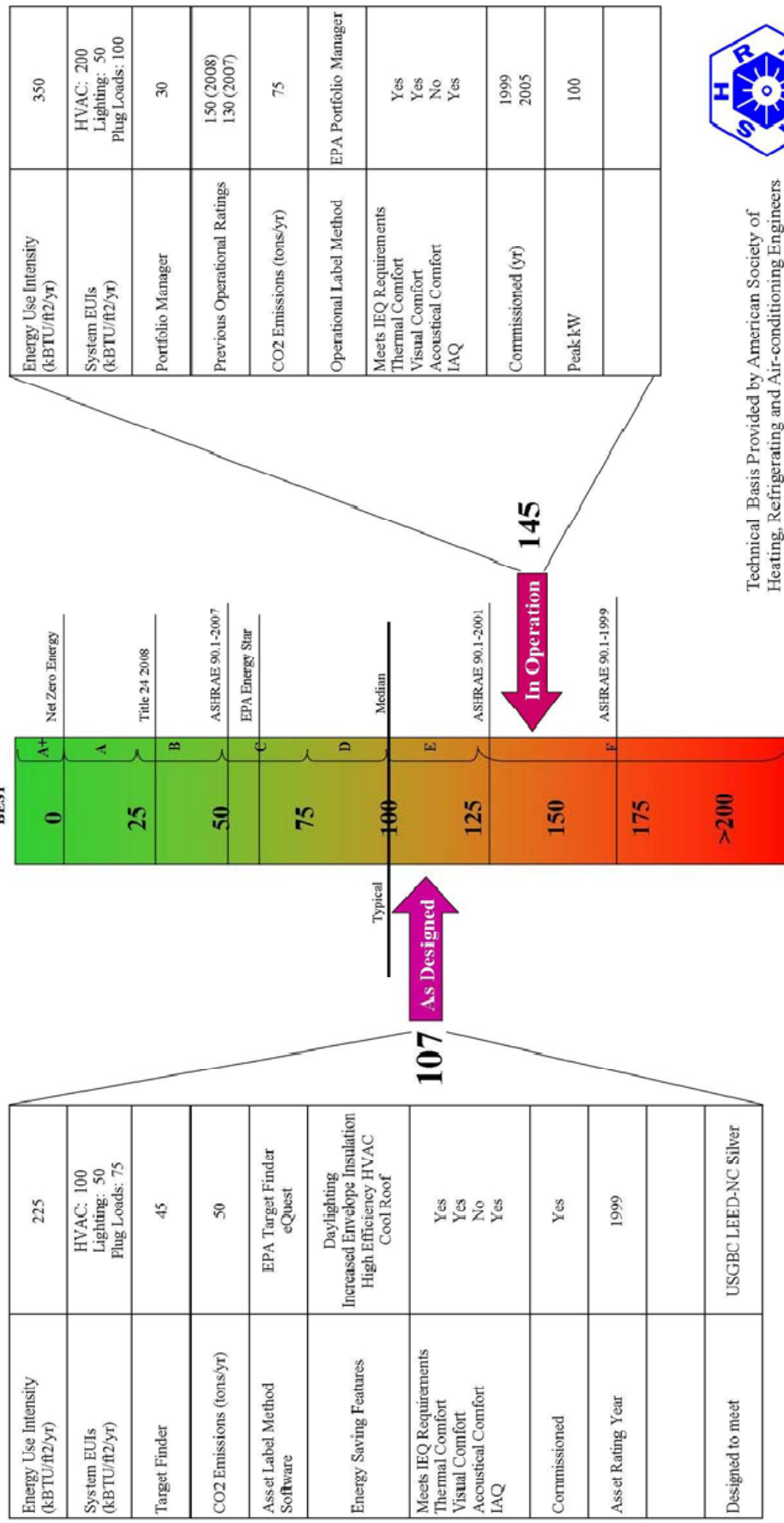
Building Energy Quotient Certificate

Galt House
100 Louisville St.
Louisville, KY 10000

Hotel

Assessment Year: 2009

ID Number: KY000001
Assessor: Jim Smith



Technical Basis Provided by American Society of Heating, Refrigerating and Air-conditioning Engineers

Figure 13-2: Example bEQ Certificate (ABEL, 2009)

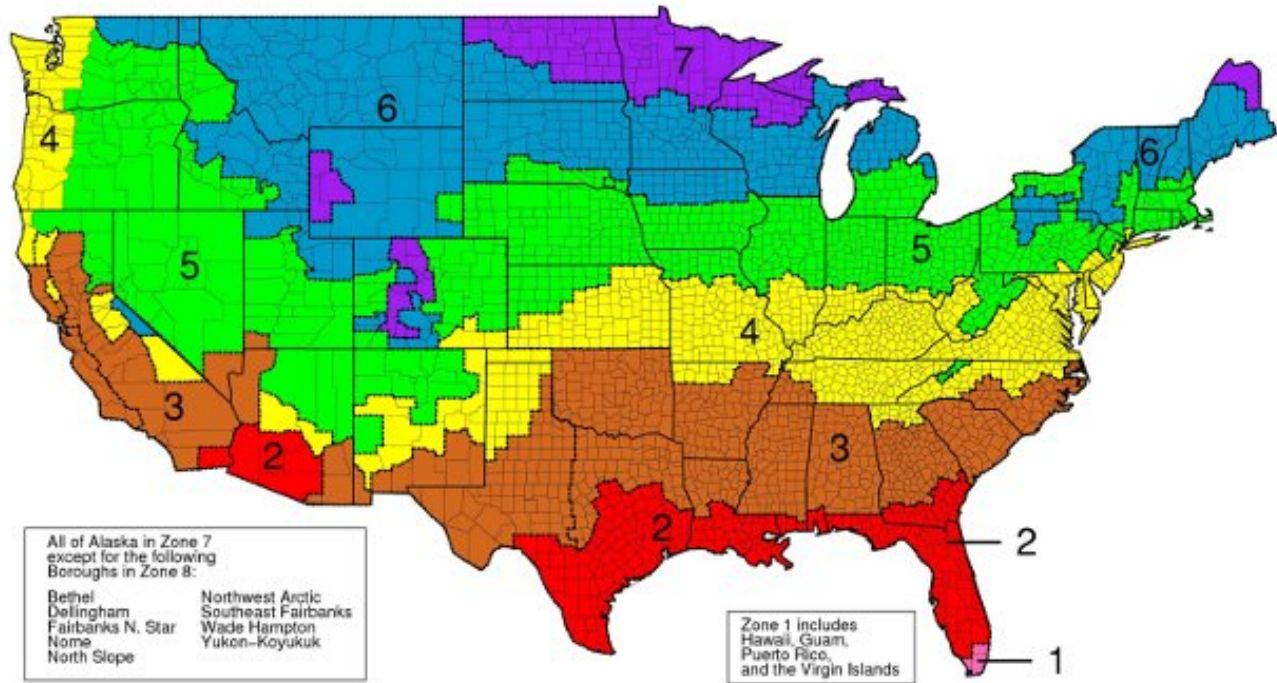
14 Appendix B

Beyond Energy Code Programs for Commercial Buildings	
Name or Acronym	Developer and Info
Energy Star	U.S. EPA – www.energystar.gov
Collaborative for High Performance Schools	Originally a California Standard, this standard mandates energy efficiency 25% above ASHRAE 90.1 – 2004. It is being revised for regional factor to be adopted by other states and school districts www.chps.net
Core Performance Guideline	New Buildings Institute: developed to design commercial buildings 20-30% more efficient than ASHRAE 90.1 – 2004. Used nationally for commercial buildings from 10,000 to 70,000 sq. ft. www.newbuildings.org
ASHRAE 189	ASHRAE, 2009. www.ashrae.org/publications/page/927
LEED	USGBC: Leadership in Energy and Environmental Design (LEED) requires minimum efficiency of 10% above ASHRAE 90.1 – 2007. LEED is a third-party green building certification system used to address various savings and design methods. www.usgbc.org
IgCC	ICC, ASTM, and American Institute of Architects (AIA): International green Construction Code (IgCC) is a performance-based program that allows adopting jurisdictions to select the applicable provisions to their needs. www.iccsfe.org
Locally Developed Programs	States and local jurisdictions are becoming more proactive in their building codes because they understand that location, building use, and occupant mentality greatly affect energy use. More locally developed programs are expected to develop unique programs to capitalize on local resources and to inspire their citizens.

Beyond Energy Codes Programs

15 Appendix C

ASHRAE U.S. Weather Zones



(Robert S. Briggs, 2002)

BROAD BUILDING CATEGORIES
Education
Food Sales
Healthcare
Lodging
Mall
Office
Public Assembly
Public Order and Safety
Retail
Service
Storage/Shipping/Non-refrigerated Warehouse
Wastewater Treatment Facility
Other

CBECS Broad Building Categories

16 Appendix D

More information is becoming available on this and similar topics. Below is a compilation of sources that can be utilized to better understand the different codes and standards making processes and the challenges involved in creating energy efficient codes and standards to help drive the reformation of America's energy economy.

DOCUMENT	SOURCE
<i>Building Energy Codes 101</i> By U.S. DOE	http://www.ashrae.org/docLib/20100301_std901_codes_101.pdf
<i>Future of Codes</i> By New Buildings Institute, Inc. (NBI)	http://newbuildings.org/sites/default/files/Future_of_Codes-ACEEE_Paper.pdf
<i>ASHRAE Building Energy Labeling Program</i> By ASHRAE ABEL Implementation Committee	http://www.sustain-rhythm.com/HPB%20Exchange/files/Energy_ABELFinal.pdf
<i>Definition of a "Zero Net Energy" Community</i> By NREL	http://www.nrel.gov/docs/fy10osti/46065.pdf