CERC-BEE Task 8-3

Review of U.S. Policies on Building Energy Efficiency, Distributed Renewable Energy and Green Buildings

Prepared by

The Natural Resources Defense Council (NRDC)

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Foreword

Task 8 of the U.S.-China Clean Energy Research Center's Building Energy Efficiency Project (CERC-BEE) calls for a review and comparison of building energy efficiency (BEE)- related policies in the United States and China. As defined in CERC-BEE's joint research plan between the U.S. and China, Task 8 includes three topics:

- Task 8-1. Comparing U.S. and Chinese building labeling and rating systems;
- Task 8-2. Researching into methodologies for setting building energy consumption quotas and carbon trading schemes; and
- Task 8-3. Examining U.S. and Chinese policies on building energy efficiency (BEE), renewable energy use in buildings and green buildings.

This report is one of two reports issued under the auspices of Task 8-3. The report was prepared by the Natural Resources Defense Council (NRDC) and is focused on U.S. policies. A separate report produced by the NRDC's Chinese counterpart, the Center of Science and Technology of Construction, Ministry of Housing and Urban-Rural Development (MoHURD/CSTC), focuses on Chinese policies and market transformation. In carrying out Task 8-3, the U.S. and Chinese teams exchanged thoughts and coordinated their approach to the project, including research on the background, history, management structure, barriers, and effects of the relevant policies in their respective countries. Both teams took into account the economic, political, cultural and behavioral characteristics of the two countries in conducting their analysis and proposing recommendations for future action.

This report on U.S. BEE policies provides comprehensive information, a critical analysis, and specific recommendations to China's policymakers, building and construction industries, and other stakeholders with a view to helping China in her pursuit of reducing carbon emissions from buildings. We discuss the three topics in the order mentioned above, because building energy efficiency should be the first strategy to be adopted to reduce energy consumption. An energy efficient building economizes the needed investment in renewable energy technologies and facilities to further reduce carbon emissions. Green building design, a more holistic and advanced concept, encompasses additional environmental factors, notably energy embedment of building materials, impact of building location on automobile use, and the efficient and sustainable use of water.

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Topic 1: Building Energy Efficiency (BEE) in the U.S.

The building sector is the largest end user of energy in the United States, accounting for over 40 percent of the country's total energy consumption. Although significant progress has been made in building energy efficiency (BEE) over the past two decades as a result of policy development and implementation at federal, state and local governmental levels, there is much room for improvement.

In this part, we review the history of building energy efficiency policymaking in the U.S., and also describe the U.S. management framework for building energy efficiency. The market barriers that inhibit the widespread, rapid adoption of building energy efficiency measures are discussed, along with an examination of available policy instruments to overcome these barriers. Finally, we identify gaps in the policy structure and suggest possible improvements.

BEE Policy Making Background in the U.S.

Energy Consumption Trends

Over the past sixty years, total energy consumption in the United States has increased by almost 240%, from 31.7 quadrillion British Thermal Units (BTU) in 1949 to 75 quadrillion BTU in 2010, as shown in Figure 1.

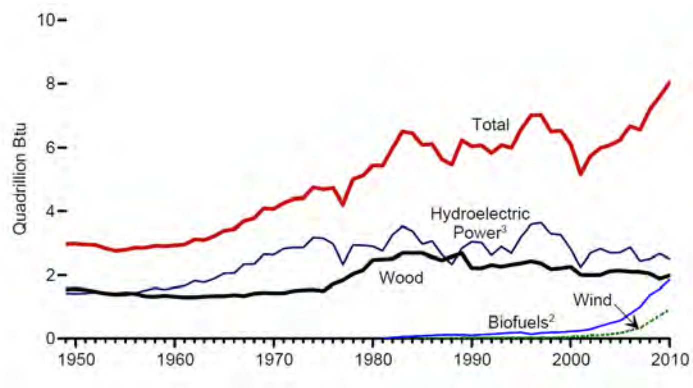


Figure 1: ***Total US consumption and major sources, 1949-2010.***
Source: *EIA Annual Energy Review 2010*

In 2010, approximately 37% of U.S. energy came from petroleum, 25% from natural gas, 21% from coal, 9% from nuclear power, and 8% from renewable energy sources.[1]

The building sector is the largest energy end user in the U.S In 2010, U.S. residential and commercial building sectors used 23% and 19% of the total energy supply, respectively, for a total of 42% (see Figure 2).

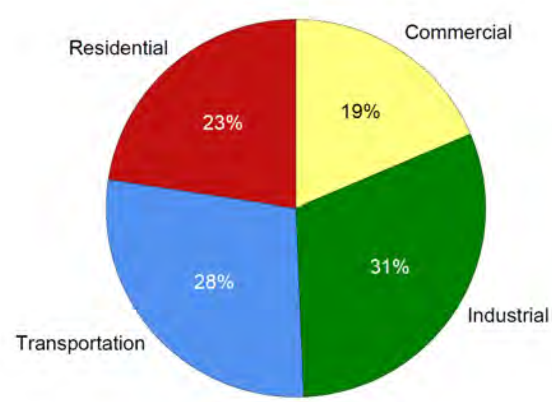


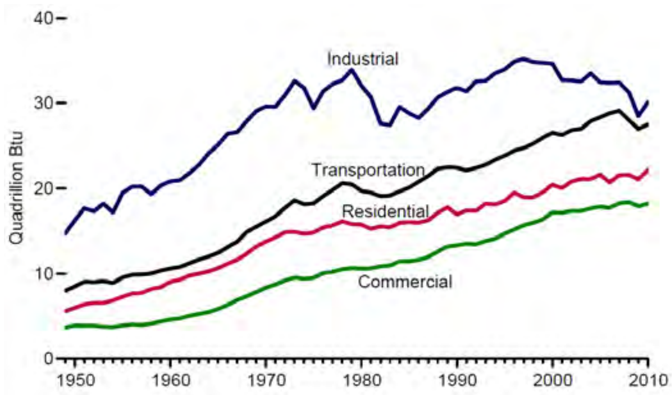
Figure 2: ***End-use sector shares of total consumption, 2010.***
Source: *EIA Annual Energy Review 2010*

From 1949 to 2010, energy use by both residential and commercial buildings increased by a factor of two to three , as shown in Figure 3. Residential energy use increased by 85%, and commercial energy use increased by 53%.

Although total building energy consumption has steadily risen since the 1950s, building energy

[1] U.S. DOE, Energy Information Administration (EIA), (Oct. 2011), Annual Energy Review 2010.

usage intensity (EUI) -- a measure of building energy consumption per unit floor area -- has leveled out (see Figures 4 and 5). Building EUI more accurately reflects building energy efficiency since it does not include the effects of increasing floor area per person or changes in population.



Although overall residential energy use in the U.S. increased by 34% since 1985, residential EUI has trended downward since 1987. Increases in residential building energy efficiency are outweighed by the fact that overall residential energy consumption has continued to rise due to an increasing number of households--from 86.8 million in 1985 to 110.7 million in 2004.[2]

Figure 3: ***Total consumption by end-use sector, 1949-2010***

Source: *EIA Annual Energy Review 2010*

At the same time, commercial building total energy use has also grown steadily, increasing by nearly 50% from 1985 to 2004. The growth in commercial building energy consumption can be attributed to a 35% increase in commercial building floor area from 1985 to 2004 as well as a 12% increase in EUI. Since 2000, however, commercial building energy usage intensity has begun to level out and slowly decline.[3]

While the U.S. has had large increases in total building energy consumption, energy usage intensity has begun to level out and decline in both the residential and commercial sectors since 1987 and 2000, respectively Since then, increases in U.S. building energy consumption can be attributed to a greater volume of building floor area, not increasingly inefficient buildings. In fact, building efficiency is slowly improving in the United States.

[2] "Residential Buildings Total Energy Consumption." USDOE. Retrieved on <http://www1.eere.energy.gov/ba/pba/intensityindicators/total_residential.html>

[3] "Commercial Buildings Total Energy Consumption". USDOE. <http://www1.eere.energy.gov/ba/pba/intensityindicators/total_commercial.html>.

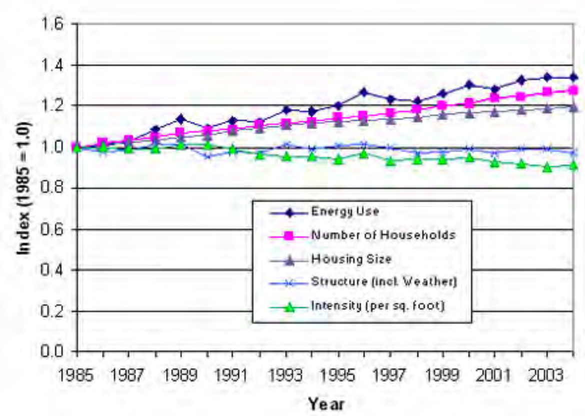


Figure 4: ***Energy intensity, 1985-2003.***
Source: *EIA Annual Energy Review 2010*

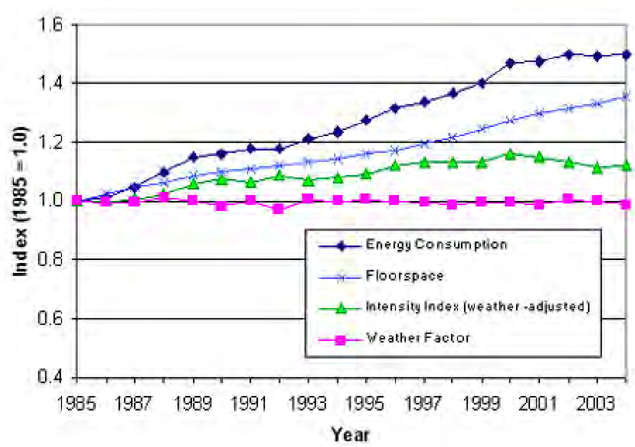


Figure 5: ***Energy consumption and intensity, 1985-2003.***
Source: *EIA Annual Energy Review 2010*

Climate Zone and Building Classifications

Climate zones

Climate influences building energy efficiency, and thus organizations such as Building America and the International Energy Conservation Code (IECC) have developed climate zones in order to guide the most energy efficient building practices. In the United States, two classifications for climate zones are primarily used: the International Energy Conservation Code (IECC) code, which takes only temperature into account, and the U.S. Department of Energy's Building America classification, which takes into account precipitation and temperature.[4]

The eight climate regions mapped in Figure 6 are developed from the climate designations used by the International Energy Conservation Code and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). This map was developed to provide a simplified, consistent approach to defining climate for implementation of various codes and was based on widely accepted classifications of world climates that have been applied in a variety of different disciplines. Climate is determined by heating degree-days and average temperatures.

The IECC also developed three zones based on moisture, which created 24 zones in total when combined with the temperature zones. In 2003, with direction from the Building America teams, researchers at DOE's National Renewable Energy Laboratory simplified the IECC map for purposes of the Building America Program into eight climate zones that take both temperature and precipitation into account. For reporting purposes, these are further combined into five climate categories: hot-humid, hot-dry/mixed dry, mixed- humid, marine, cold/very cold, and subarctic. This map is displayed in Figure 7.[5]

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[4] Residential Prescriptive Requirements - 2009 International Energy Conservation Code (IECC)." *2009 IECC Climate Zone Map*. Retrieved on Apr 28 2012. <http://energycode.pnl.gov/EnergyCodeReqs/>.
[5] Residential Prescriptive Requirements - 2009 International Energy Conservation Code (IECC)." *2009 IECC Climate Zone Map*. Web. 28 Apr. 2012. <http://energycode.pnl.gov/EnergyCodeReqs/>.

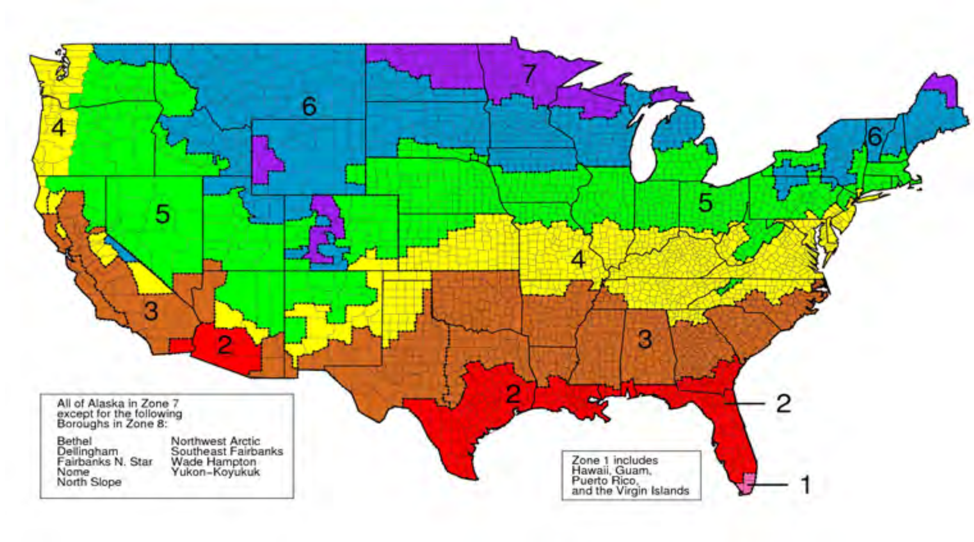

Figure 6: ***IECC climate zone map***
Source: *Building Energy Codes Resource Center*

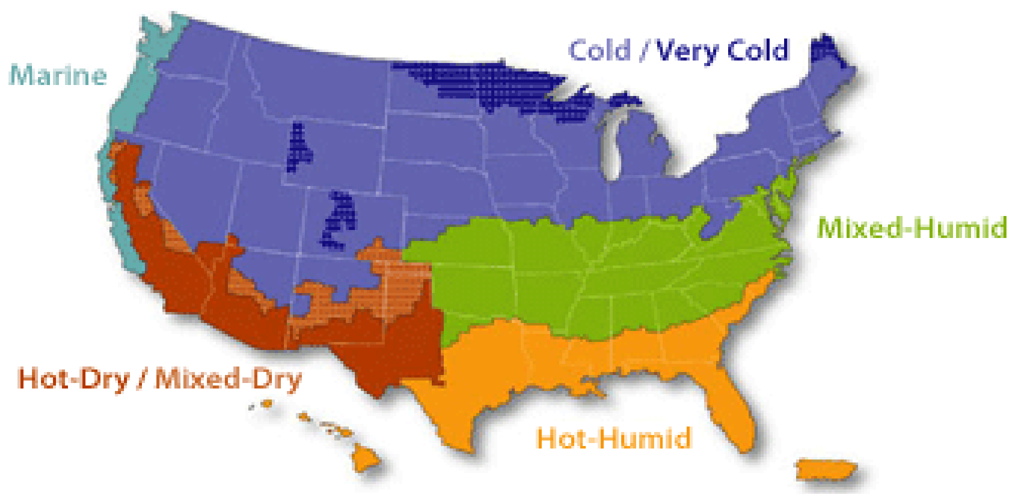

Figure 7: ***Temperature/moisture map of the U.S.*** **Source:**
Building America Climate Specific Publications

Characteristics of buildings

According to ASHRAE building classifications[6], buildings are classified into residential buildings and nonresidential buildings. Residential buildings are further categorized as either low-rise or high-rise residential buildings, with three stories in height distinguishing between the categories. Low-rise residential buildings include single-family houses, multi-family structures of three stories or less above grade, and manufactured houses (mobile homes and modular).

Residential buildings with three stories above grade include multi-family structures and any building used primarily for living and sleeping. Based on building function, residential buildings can be categorized into, but not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and fire stations.

Nonresidential buildings are all buildings other than residential buildings. Nonresidential buildings include, but are not limited to, automotive facilities, convention centers, courthouses, bar lounges ,cafeterias/fast food places, family restaurants, exercise centers, gymnasiums, health-care clinics, hospitals, libraries, manufacturing facilities, motion picture theaters, museums, offices, parking garages, penitentiaries, performing arts theaters, post offices, religious buildings, retail buildings, schools/universities, sports arenas, town halls, transportation hubs, warehouses, and workshops.

Because different types of buildings have different functions and have very different space requirements, lighting and HVAC design criteria, their energy usage can vary greatly.

BEE Management Frameworks in the U. S.

This section describes the organizational structure and management framework related to building energy efficiency in the United States. Sections 1 and 2 provide an introduction to the business-as-usual structure and the government structure, as well as to other organizations involved in building energy efficiency.

Business-As-Usual Structure

The business-as-usual structure in the building construction and management industry encompasses the following:

- Building owners, developers, and property management companies that build, own, operate, market, sell or lease property;
- Financing companies that provide financial support to building owners/developers;
- Architecture and engineering consulting companies that provide professional services in architecture, mechanical, electrical and plumbing, civil, and other engineering design and consulting services;
- Building contractors that offer a range of building construction services including project management, demolition, renovation, remodeling and new construction;
- Manufacturers and suppliers who produce and supply building materials, equipment, and systems;
- Tenants of the buildings who occupy the project after construction is completed; and

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[6] ANSI/ASHRAE/IESNA Standard 90.1-2007. Energy Standard for Buildings Except Low-Rise Residential Buildings.

- Energy service companies (ESCOs) that provide a broad range of comprehensive energy solutions in the design and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, and power generation including energy supply, risk management and financing methods.

Government Structure

The BEE government management framework includes agencies at the federal, state and local levels of government.[7]

Federal Government

The two most important federal government agencies that promote building energy efficiency are the U.S. Department of Energy (DOE) and the U.S. Environment Protection Agency (EPA). According to the DOE's website, the mission of the Department of Energy is to "ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions." DOE's subdivision, the Energy Efficiency and Renewable Energy program (EERE), is specifically designed to include the following major energy efficiency programs: building technologies, federal energy management, geothermal technologies, weatherization, and intergovernmental programs.

The EPA promotes energy efficiency through the Energy Star program, which was jointly implemented by both the EPA and DOE. Energy Star is a voluntary labeling program designed to identify and promote energy-efficient products and buildings.[8]

State Government and Local Government

The United States does not have a uniform national building code. And although the federal government has taken an active role in developing a national model of energy codes and is encouraging states to consider building codes such as those developed by ASHRAE, it remains within the jurisdiction of each individual state to decide, develop and adapt their own sets of building codes.

Implementation and enforcement of buildings codes typically falls to state and local agencies, which are responsible for code compliance enforcement and code training, while the federal government offers support through financial and logistical assistance to state and local agencies. State and local governments also promote energy efficiency through various programs, such as tax credits for energy efficient projects.

Other Entities

Non-governmental entities help to promote building energy efficiency including utility demand side management programs, as well as many non-profit organizations.

In a Utility Demand Side Management (DSM) program, utilities plan, design, implement, and monitor activities of energy efficient programs under the supervision of utility regulators in order to reduce building and industrial energy consumption, particularly during hours of peak load. Utility DSM is one of the most successful approaches to achieving building energy efficiency in the US. The Federal Energy Regulatory Commissions estimates that utilities can reduce overall energy consumption by 20% through full-implementation of DSM programs by 2019.

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[7] Elizabeth Doris, et al., 2009. National Renewable Energy Laboratory. Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government.
[8] US Environmental Protection Agency. Our Mission and What We Do". http://www.epa.gov/aboutepa/whatwedo.html. Retrieved on 3/28/2012.

Many non-profit organizations in the United States promote and advocate for building energy efficiency and provide energy efficiency information to a wide range of professionals and end users as well as to the public. Representative organizations include the Natural Resource Defense Council (NRDC), American Council for an Energy-Efficient Economy (ACEEE), and the Consortium for Energy Efficiency (CEE).

Barriers for Building Energy Efficiency in the U.S.

There are significant building energy efficiency opportunities that have lucrative financial returns, but are regularly overlooked due to various market barriers. These barriers have been listed and discussed in many publications including a report from Lawrence Berkeley National Laboratory (LBNL).[9] LBNL postulated various barriers as explanations of the difference between actual energy-efficiency choices observed in current energy service markets and markets as predicted/described in economic theory. Carbon Trust (2005)[10] and the IPCC (2007)[11] discussed market barriers in the areas of financial costs/benefits, hidden costs/benefits, real market failures, and behavioral/organizational non-optimality.

In his book titled *Saving Energy Growing Jobs,* David Goldstein gives an overview of market barriers to energy efficiency, e.g., limited information, split incentives, diffuse decision-making, private-sector regulations, the failure of price completion for new products; as well as human and institutional failures.

After our research of the existing literature and our analyses of the current barriers to building energy efficiency, we have categorized these barriers into the following five categories: 1) economic/financial barriers; 2) lack of information or technical skills; 3) policy and regulatory resistances; 4) market misalignment; and 5) behavior and motivation barriers.

Economic/Financial Barriers

This category is one of the most important barriers in building energy efficiency, as equipment upgrades, and energy retrofits usually involve high initial costs. These costs are the financial investment needed for energy efficiency systems to operate, including costs of purchasing, installation, commissioning, and personnel training. High initial costs as well as a limited access to financing are an important barrier preventing the development of more efficient buildings.

Relatively low energy costs

Energy costs in general are still a small portion of the total cost of a home or business compared to other expenditures. Subsequently, home and business owners easily overlook energy opportunities, since the savings from energy efficiency measures may be modest compared to other cost-saving measures such as reductions in force or relocation.

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[9] William H. Golove and Joseph H. ETO, LBNL, Mar. 1996. Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency. http://eetd.lbl.gov/ea/emp/reports/38059.pdf

[10] Carbon Trust, 2005. The UK Climate Change Program: Potential Evolution for Business and the Public Sector, www.carbontrust.co.uk

[11] Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino, 2007: Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lack of internalization of non-financial benefits

Energy efficiency brings significant non-financial benefits besides cost savings, including fewer GHG emissions and reduced environmental pollution; lower exposure to future energy price volatility; corporate social responsibility benefits associated with environmental responsibility; and improved employee productivity as a result of improved indoor air quality. However, most cost/benefit calculations only consider the energy cost savings, and while additional non-financial benefits are significant, they are largely ignored in any decision-making process.

Energy not considered in appraisals, valuations or financing

Appraisers and valuations of properties typically ignore energy costs altogether or treat them as constant across all properties. This is caused by under-appreciation of the importance of energy costs for a project over time, as well as a lack of information, expertise, resources and time.

Due to this barrier, residential and commercial developers and owners lack financial incentives to improve the energy efficiency of their properties. Buyers of residential and/or commercial properties may also ignore this important factor.[12]

Payback gaps

In general, businesses expect a two- or three-year payback on energy efficiency investments. Some energy efficiency products have a relatively short payback of three years or less, such as Energy Star clothes washers, refrigerators, and Compact Fluorescent Lamps (CFLs).[13] However, the majority of energy efficient products have longer payback periods, including improved Heating Ventilation and Air Conditioning (HVAC) systems, building insulation, boilers, pumps, motors, and many industrial energy efficiency measures.

Due to the payback gap between energy efficiency measures and the expected two- or three-year payback periods considered acceptable by companies, energy managers have a difficult time justifying investments in energy efficiency measures to upper management.

Lack of Information or Technical Skills

Lack of information due to an insufficient breakdown of energy consumption on energy bills and a deficiency of information or technical skills on how to implement energy efficiency measures are significant barriers to implementing building energy efficiency measures.

Insufficient energy consumption information

In the U.S., most households receive a monthly energy bill that does not provide timely cost information or a breakdown of individual end-uses. This provides insufficient feedback to consumers about their energy use and the potential impact of efficiency investments.

Furthermore, energy efficiency often has intangible benefits. Products that are energy efficient generally look the same and provide the same functions, while using less energy. Energy savings is often invisible to consumers since they seldom pay attention to the amount they are using for everyday tasks and do not have a convenient way to track their energy consumption.

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[12] Cliff Majersik, IMT. The role of information on energy costs in mortgage underwriting. October 5, 2011. http://www.rff.org/Documents/Events/Seminars/First_Wed_Seminars/111005_EE/111005-Majersik.pdf.
[13] Regulatory Economics. Mar 2008. Energy Star Appliances: EPA's savings calculator exaggerates savings. http://www.neutralsource.org/content/blog/detail/985.

Deficiency of information or technical skills

Information about energy efficiency options can be incomplete, difficult to obtain, difficult to understand, and hard to trust. It is particularly difficult to learn about the performance and costs of energy-efficient technologies and practices, since the benefits and the energy saving potential are often not directly observable.[14]

A 2006 study by the National Renewable Energy Laboratory (NREL) identified a shortage of skills and training as a leading barrier to energy efficiency growth.[15] In particular, the NREL study identified a number of critical unmet training needs, including a lack of reliable installation, maintenance, and inspection services, as well as a shortage of key technical and manufacturing skills and failure of the traditional educational system to provide adequate training in new technologies.

Lack of information and technical skills is a particular problem for small business, which do not have the financial, human, or technological resources of large corporations. Small businesses generate half of all non-farms GDP in the U.S., and thus represent an important market for energy efficiency. A 2011 study published in *Sustainability Review* found that while most small business were concerned about energy prices and interested in improving the efficiency of their operations, they did not have access to the proper information to either upgrade their buildings or technology, or take advantage of government incentive programs.

Lack of information or technical skills to compute the financial benefits of energy efficiency projects is an additional barrier. A simple payback calculation is often not enough to determine the benefits of efficiency measures; more complicated financial analysis in areas such as life cycle cost, internal rate of return, profits, and deprecation is often needed. Energy managers need to be equipped with these skills to present a convincing justification to decision makers on energy efficiency investment budgets.

Policy and Regulatory Resistance

Policy and regulatory resistance is defined as the structural characteristics of the political and regulatory system that make energy efficiency investment difficult.[16] Energy Trust 2005 has provided the following examples of policy and regulatory resistance:

- Process of drafting local legislation is slow
- Gaps between regions at different economic levels
- Insufficient enforcement of standards
- Lack of detailed guidelines, tools and experts
- Lack of incentives for energy efficiency investments
- Lack of leadership in governance
- Lack of equipment testing and certification
- Inadequate energy service levels

In addition, Goldstein's book[17] discusses the role of trade associations associated with market failure. The role of trade associations includes advocacy and regulatory decision-making to protect economic

[14] Carbon Trust. 2005. The UK Climate Change Programme: Potential Evolution for Business and the Public Sector. www.carbontrust.co.uk.
[15] http://topics.vlex.com/tags/technical-barrier-1204603
[16] Carbon Trust. 2005. The UK Climate Change Programme: Potential Evolution for Business and the Public Sector. www.carbontrust.co.uk.
[17] David Goldstein. Saving Energy Growing Jobs. 2007.

incumbency and reduce competitive pressures on their members. Trade associations play a major role in economic policy in the United States. Trade associations lobby Congress to pass legislation that defines the rules of markets; they also lobby on the content of regulations. Goldstein writes about this experience with trade associations: regulatory agencies generally propose fairly mild regulations; environmentalists advocate stronger ones, and industry associations argue against the need for regulations.

Market Misalignment

Market misalignment is the structure and constraints that prevent the consistent trade-off between specific energy-efficient investments and societal energy-saving benefits.[18] Misplaced incentives take place when agents are responsible for investment decisions but they are not benefiting from the energy savings. There are two main sources of market misalignment: landlord /tenant problems and diffuse decision-making in commercial building development. These barriers are significant, since commercial buildings use approximately one- fifth of total energy in the United States.

Landlord and tenant problems

The majority of U.S. commercial building stock is leased, and the landlord/tenant split incentives dilemma is a significant problem in making leased space truly efficient. A building is normally leased to tenants and the tenants typically pay their own energy costs. When the building is under construction, building owners do not have an incentive to increase their expense to acquire efficient equipment, since they do not bear the burden of the building operating costs.

After a building is constructed, the landlords still lack incentive to improve building energy efficiency, since they receive the same amount of net revenue from their tenants regardless of energy costs.

Unclear energy expenditures is another problem. In the U.S., it is customary for tenants to pay one lump sum to the landlord to cover their rent, utilities, and other costs, based on leased square footage. The utility bill is included somewhere in the rental, but landlords do not break down the costs to the tenants. Without this knowledge, tenants often overlook energy efficiency. In addition, energy efficiency projects may have a longer payback period than the lease contract, and some building systems cover a larger area than the leased space, which increases the complexity of any energy improvement projects.[19,20]

Diffuse decision-making in commercial building development

For any market to work properly, a single party must be held responsible for decisions that are made. However, this does not happen in commercial building development, because of its complexity and involvement with multiple parties such as building developers, architects, engineers, lighting designers, and contractors. Any change from normal practice is difficult when there are so many different stakeholders involved in the process.

Parties who are not responsible for the energy bills often decide the energy features of a building. For example, building developers make energy efficiency decisions when the buildings are in the design phase, but the tenants are the ones paying the energy bills in the future. In addition, the fee structures for

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[18] Carbon Trust. 2005. The UK Climate Change Programme: Potential Evolution for Business and the Public Sector. www.carbontrust.co.uk.

[19] Jordan, Carrie. “Efficiency and the tenant-landlord relationship.” Nov 4 2011. Rocky Mountain Institute. <http://blog.rmi.org/efficiency_and_the_tenant-landlord_relationship>

[20] Rahm, Saqid. “One Man’s Struggle to Bridge the Landlord-Tenant Energy Divide.” Oct 6 2011. New York Times. <http://www.nytimes.com/cwire/2011/10/06/06climatewire-one-mans-struggle-to-bridge-the-landlord-ten-90747.html?pagewanted=all>

building designers are generally a percentage of the individual portion of the building costs, which does not encourage energy efficiency. For example, if a mechanical designer suggests that the perimeter heating be omitted in favor of higher performance windows, he could end up with a lower design fee.

Behavioral and Motivational Barriers

This category refers to behavioral characteristics of individuals and companies that hinder energy efficiency technologies and practices.[21] We discuss four examples of this category below.

Tendency to ignore small opportunities for energy efficiency

Small but easy opportunities for energy efficiency are often ignored. Energy costs are often a small percentage of a home or business owner's financial expenditures. Although energy efficiency measures may reduce costs, the savings are generally modest. .

Organizational failures (e.g., internal split incentives)

In the Market Misalignment Section, we have discussed organizational failures such as landlord / tenant barriers. This barrier leads to participants in the market having split incentives with respect to the purchase and use of energy-efficient equipment and appliances.

Non-payment and electricity theft

Non-payment has been reported to be an issue in many areas of the United States. Besides non-payment, electricity theft has been occurring. In the United States, electricity theft has been estimated to cost utilities billions of dollars each year.[22] The failure of recipients to pay in full for energy services induces waste and discourages energy efficiency.

Tradition, behavior, lack of awareness, and lifestyle

Some barriers stem from the cultural and lifestyle characteristics of individuals. The potential impact of lifestyle on energy use is most easily seen by cross-country comparisons. For example, dishwashers, clothes dryers, and ovens are widely used in homes in the U.S., but they are rare in China. Cold water is traditionally used for clothes washing in China[23], whereas hot water washing is common in the U.S. Similarly, substantial differences exist in usage patterns of lighting, perceived comfortable temperatures, operating hours of commercial buildings, and the size and composition of households.[24]

Summary of Barriers

The barriers mentioned above are summarized in Table 1:

Table 1: Summary of barriers in the building energy efficiency market.

Category	Definition	Examples

[21] Aleksandra Novikova. Methodologies for Assessment of Building's Energy Efficiency and Conservation: A Policy-Maker View. 2010.

[22] Suriyamongkol, D., 2002: Non-technical losses in electrical power systems.
[23] Biermayer, P. and J. Lin, 2004: Clothes washer standards in China – the problem of water and energy trade-offs in establishing efficiency standards. In 2005 ACEEE Summer Study on Energy Efficiency in Buildings, ACEEE Press.
[24] IEA, 1997: The link between energy and human activity. International Energy Agency.

Category	Definition	Examples
Economic/Financial Barriers	Factors related to the ratio of investment cost to value of energy savings and capital availability	• High initial capital costs • Lack of access to financing • Relatively low energy cost • Lack of internalization of non-financial benefits • Energy not considered in appraisals/valuation and financing • Payback gaps
Lack of Information or Technical Skills	Issues caused from the lack of information or technical skills	• Insufficient energy consumption information • Deficiency of information or technical skills
Policy and Regulatory Resistances	The structural characteristics of the political and regulatory system that make energy efficiency investment difficult	• Process of drafting local legislation is slow • Gaps between regions at different economic levels • Insufficient enforcement of standards • Lack of detailed guidelines, tools and experts • Lack of incentives for EE investments • Lack of governance leadership • Lack of equipment testing and certification • Inadequate energy service levels • Trade associations
Market Misalignment	The structure and constraints that prevent the consistent trade-off between specific energy-efficient investment and societal energy-saving benefits	• Tenant - landlord problems • Diffuse decision-making in commercial building development
Behavior and Motivation	The behavioral characteristics of individuals and companies that hinder energy efficiency technologies and practices	• Tendency to ignore small opportunities for energy efficiency and conservation • Organizational failures (e.g., internal split incentives) • Non-payment and electricity theft • Tradition, behavior, lack of awareness, and lifestyle considerations

Policy Measures to Overcome the Barriers

A functioning energy efficiency market should provide incentives to companies and individuals to produce innovative energy-efficient products and services. The current market in the U.S. has numerous barriers, as previously discussed, which prevent the current market from fully functioning. In this section, we discuss a suite of recommended policies to overcome failures and make markets work more effectively.

Previous publications have identified over two dozen key policy instruments, which we grouped into three major categories: control and regulatory mechanisms; economic instruments; and information, support and voluntary actions.

Control and Regulatory Mechanisms

This category includes laws and implementation regulations that require certain devices, practices or system designs to improve energy efficiency.[25] Four areas are discussed here: 1) codes and standards, 2) public procurement regulations, 3) mandatory labeling and certification, and 4) utility demand side management programs.

Codes and standards

Codes and standards contain provisions that specify physical, performance or procedural characteristics for target component, system or processes, including building codes and appliance codes in general. Building energy codes establish minimum energy efficiency standards for design, construction and renovation of buildings. ASHRAE Standard 90.1 and the International Energy Conservation Code (IECC) serve as national building codes in the U.S. Energy codes are often considered to be an effective mechanism to improve building energy performance, although compliance can be difficult to enforce.

The movement for federal appliance efficiency standards began in the 1970s when the U.S. Department of Energy was authorized to establish mandatory energy efficiency standards for appliances and products.[26] The covered product categories include lighting, heating, cooling, refrigeration, appliances, computers and electronics, transformers and motors, and plumbing products. The appliance standards have proven to be effective vehicles for transforming markets and stimulating adoption of new, more efficient technologies and products.

Public procurement regulations

Government agencies are responsible for a large number of facilities, e.g., office buildings and schools, which makes the government the largest consumer of energy and energy-using equipment. Governments can be energy efficiency leaders by purchasing energy-efficient products and services and spearheading energy efficiency demonstration projects.

Mandatory labeling and certification programs

The purpose of labeling and certification is to provide information to end users about the energy-using performance of products such as electrical appliances, equipment, and even buildings. Certification and labeling programs can be either mandatory or voluntary. Those that are mandatory are considered to be control and regulatory mechanisms, while voluntary programs are classified as part of the Information, Support and Voluntary category, which will be discussed later.

Utility demand side management programs

Utilities plan, design, implement, and monitor activities of energy efficiency programs under the supervision of utility regulators. Utility demand side management (DSM) is one of the most successful approaches to achieving energy efficiency in the U.S.

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[25] Sonja Koeppel, Diana Ürge-Vorsatz. Assessment of policy instruments for reducing greenhouse gas emissions from buildings. 2007

[26] U. S. Department of Energy. Building Regulatory Programs, Energy Efficiency and Renewable Energy, Building Technologies Program, 2010.

In order to align utilities' interests with energy savings, the utilities' profits need to be decoupled from energy sales. This means that utilities should not make more profits from selling more energy, but instead, they should get rewarded for saving energy.[27]

Economic Instruments

Economic policy measures offer stakeholders financial incentives to adopt energy efficiency technologies in equipment replacement, remodeling, and new construction projects. The wide variety of financial incentives currently in use includes energy performance contracting, taxation on energy price or carbon emission, tax exemption and reductions, public benefit charges, capital subsidies, grants, and subsidized loans.

Energy savings performance contracting

Energy Savings Performance Contracting (ESPC) is a financing mechanism authorized by the U.S. Congress and is designed to accelerate investment in cost effective energy conservation measures in existing federal buildings.[28]

An ESPC is a partnership between a federal agency and an Energy Service Company (ESCO). An ESCO offers energy services, such as audits, energy management, retrofit project design and implementation, maintenance and operation, monitoring and evaluation of savings, property management, and energy and equipment supply.

Energy Service Companies (ESCOs) have become effective vehicles to deliver energy-efficiency improvements and are promoted by a number of policies. ESCOs guarantee energy savings and provide energy efficiency services. The U.S. ESCO market is considered the most advanced in the world. As of March 2010, more than 550 ESPC projects worth $3.6 billion were awarded to 25 federal agencies and organizations in the U.S. These projects saved an estimated 30.2 trillion BTU annually.

Taxation on energy price or carbon emissions

A few states, such as Colorado, California, and Maryland, have introduced a carbon tax, although there is no nationwide carbon tax in the U.S. Carbon taxes encourage the adoption of energy efficiency and tax revenues collected can be used for programs to reduce community-wide greenhouse gas emissions.

Tax exemption and reductions

The U.S. provides tax credits for energy efficiency. For example, for energy efficient commercial buildings a federal tax deduction of $0.30-$1.80 per square foot is provided for use of energy efficiency technologies such as equipment insulation, water heaters, lighting, controls/sensors, chillers, furnaces, and boilers.[29]

Public benefit charges

A public benefit charge is a non-bypassable surcharge imposed on all retail sales to fund research, development and demonstration projects for the public good, as well as energy efficiency activities and

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[27] "Decoupling (utility regulation)." Wikipedia. Retrieved on May 2 2012 <http://en.wikipedia.org/wiki/Decoupling_(utility_regulation)>.

[28] "Energy Savings Performance Contract." Wikipedia. Retrieved on May 2 2012 <http://en.wikipedia.org/wiki/Energy_Savings_Performance_Contract>.

[29] "Database of State Incentives for Renewables and Efficiency." Funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. Retrieved on Mar 28 2012. <http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US40F&re+0%ee=1>

some low income assistance programs. California is a pioneer in using this tool. Public benefit charges increase the price of a kWh by 2 to 3%.

Capital subsidies, grants, and subsidized loans

Rebates are offered for specific energy efficiency products or construction techniques. Grants are provided to an individual or organization for a particular energy efficiency purpose. Some program sponsors may also offer credit guarantees to reduce risk premiums charged on loans to finance energy efficiency projects. Governments encourage easy financing for energy efficiency projects by offering subsidized (low-interest) loans to finance projects.

Information, Support and Voluntary Actions

These policy measures are designed to increase awareness and understanding of energy efficiency products and services, as well as their economic and environmental benefits change market actors' behavior towards accepting energy efficiency; and provide technical information. Four specific types of policy measures in this category are discussed below.

Voluntary certificate and labeling

This measure provides information to end users about the energy-using performance of products such as electrical appliances and equipment, and even buildings. They are voluntary for producers and are different from mandatory certificate and labeling measures. These programs are discussed at length in Topic 3, Green Buildings.

Voluntary and negotiated agreements

This refers to policy instruments negotiated between national or provincial governments and facility owners, trade associations, or manufacturers to reduce energy consumption by a specified amount over a given time period. For example, the Energy Star programs in the United States have been successful in reducing standby losses and improving the efficiency of washing machines and cold appliances. Industries may favor voluntary agreements to avoid the introduction of mandatory standards.

Public leadership programs

As previously discussed before, the government owns a large number of buildings and consumes large amounts of energy and the U.S. government has been an effective and progressive leader in improving building energy efficiency and demonstrating energy efficiency technologies.

According to the USDOE's Federal Energy Management Program (FEMP), the average energy intensity in federal buildings has dropped 25% since 1985, while average energy intensity in U.S. commercial buildings has stayed at roughly the same levels.

Awareness raising, information, education and training

These policy measures consist of information delivery and awareness raising. General information can be transmitted by paid advertising and public relations campaigns designed to make consumers aware of the need to save energy.

Education concentrates on providing focused information on energy efficiency opportunities and the application of efficient technologies in particular end uses. Training focuses more on practical experiences.

Research and development

These are the technical research actions carried out by research entities to advance energy efficiency technologies. Research and development (R&D) in energy efficiency is greatly needed and both basic and market-oriented R&D are important. Research at the federal level, such as DOE's Energy Efficiency and Renewable Energy (EERE) program, is mostly fundamental research. California's Public Interest Energy Research (PIER) program supports market-oriented energy research, development and demonstration.

Summary of Policy Measures and Their Targeted Barriers

Each of these policy tools can target one or more barriers that are discussed in this report. Generally, economic policies can help break down financial barriers. Policy and regulatory resistance and market misalignment can impact control and regulation policies. Information support and voluntary actions target a lack of technical skills, as well as behavioral and motivational barriers. These measures are often more effective when combined with other measures. The policies and their targeted barriers are summarized in Appendix A.

The Evolution of U.S. Policies to Promote Building Energy Efficiency

We have previously discussed energy efficiency policy measures and their targeted barriers. In this section, we will review the history of the policies and their impact on energy savings in three areas: building and appliance standards, financial related policies, and information and R&D support.

Building and Appliance Standards

Building standards

Building codes help save energy and money over a building's lifetime by regulating aspects of the building envelope, lighting, heating, ventilation, and air conditioning system. They are an important component of governmental efforts in improving the long-term market for energy efficiency.

Prior to 1970, energy prices were relatively low and energy supply was not a concern. Building energy design in the U.S. was conducted on a "business as usual" basis.

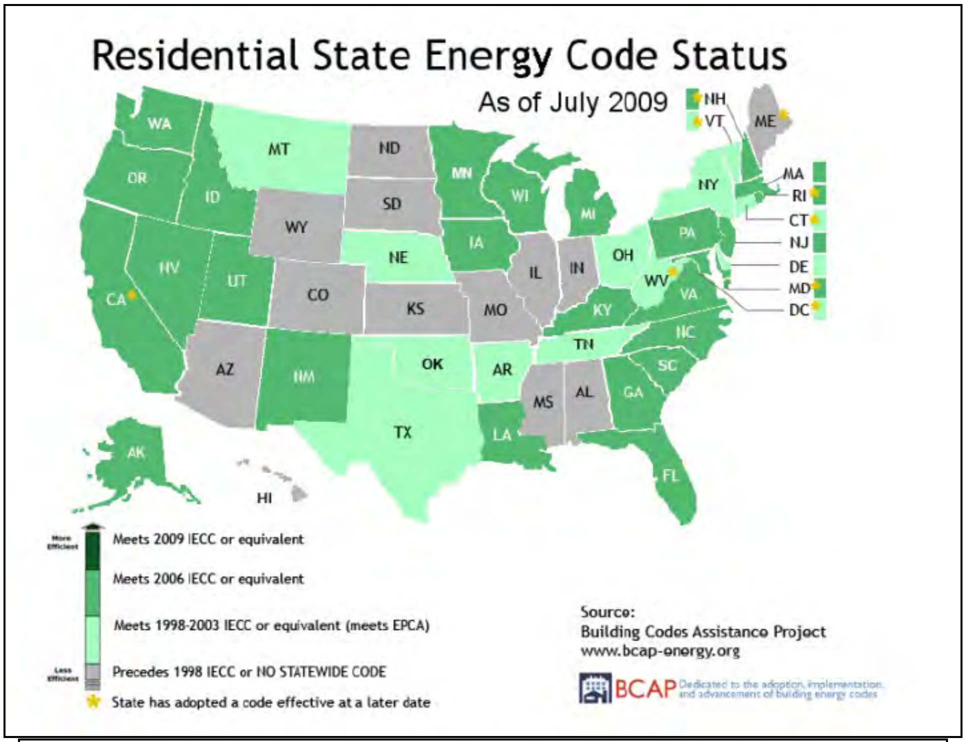
Approximately one-third of the energy consumed in the U.S. is used in building services. The energy crisis in the 1970s revealed a need for more stringent building codes and standards to reduce building energy consumption, and prompted a series of building efficiency legislation.

California's 1974 Warren-Alquist Act established and authorized the California Energy Commission to introduce and enforce environmental criteria in the production and consumption of energy. Enacted in 1978, Title 24 of the California Code of Regulations established energy efficiency standards for residential and non-residential buildings.

At the federal level, the 1975 Energy Policy and Conservation Act (amended in 1978) required that states provide energy conservation and efficiency programs (including building energy codes) as a condition to receive federal funding. As a result, through the 1980s many states adopted codes based on the ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) code 90-1075. Other states adopted the Model Energy Code (MEC) developed by the Council of American Building Officials (CABO).

The 1992 enactment of the Energy Policy Act included a provision for states to review and/or revise their residential building codes regarding energy efficiency to meet the CABO Model Energy Code (MEC). The MEC has since been revised and updated to the International Energy Conservation Code (IECC).

Building codes vary across states for both the commercial and the residential sectors. Figure 9 shows the status of residential and commercial building codes as of 2009. The difference in the status is likely determined by the willingness of state and local regulators to adopt building standards.



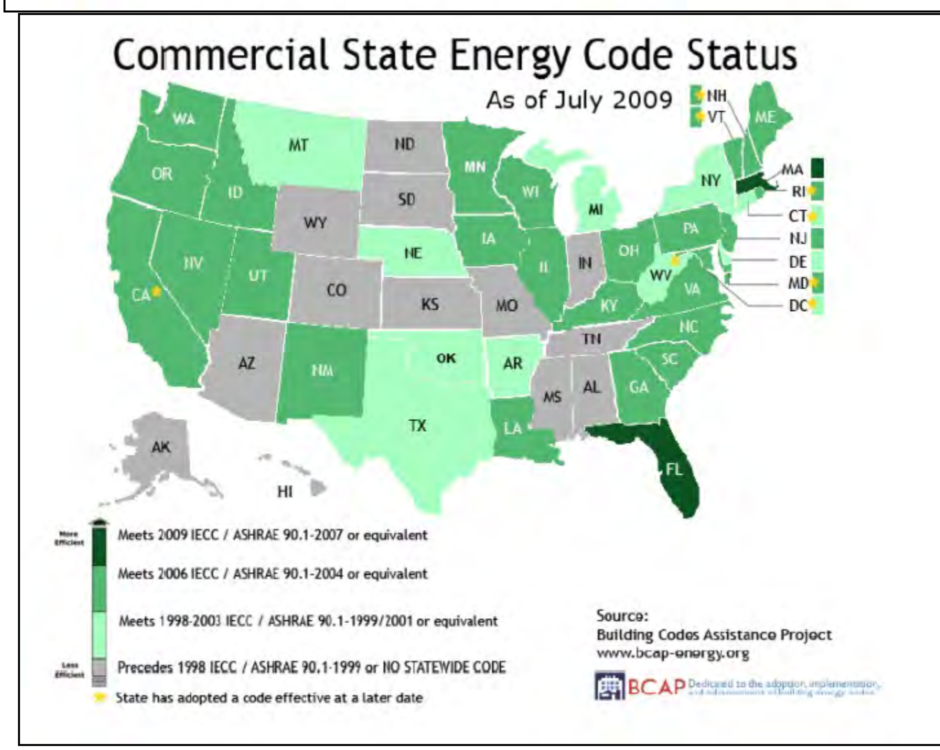


Figure 9: Residential and commercial building code status as of 2009.

The impact of building standards is significant. As shown in Figure 10, the ASHRAE standards have greatly increased code stringency over the past four decades. Energy use in new buildings has been greatly reduced due to more stringent code requirements.

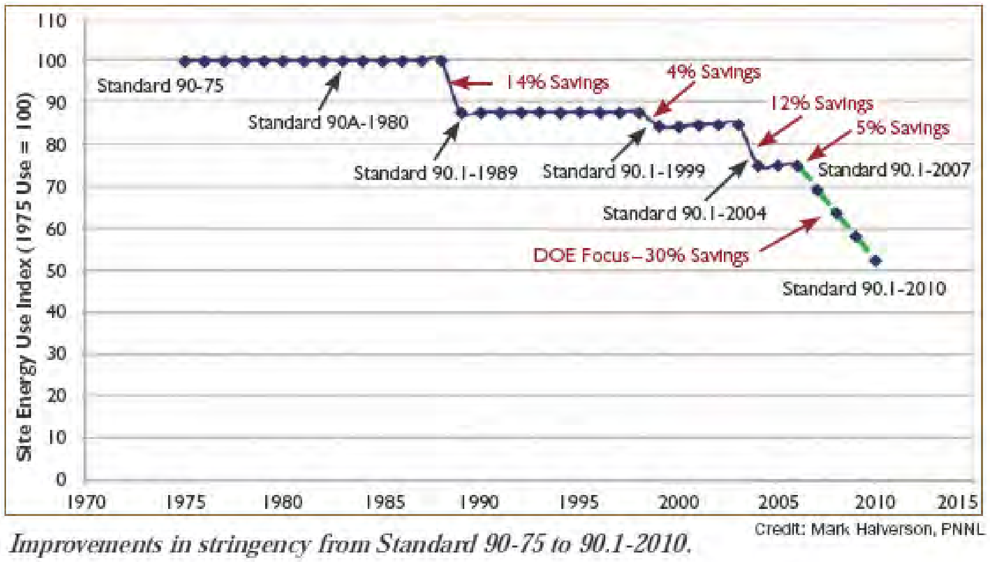


Figure 10: Improvements in stringency from ASHRAE standards.

Appliance standards

Energy efficiency standards for appliances in the United States were developed after the energy crisis of the mid-1970s. The energy crisis and increasing environmental concerns drove many states, particularly California, to consider appliance standards as a method to reduce energy demand. The California Warren-Alquist Energy Resources Conservation and Development Act, the country's first energy appliance legislation, was passed in 1974. This law established the California Energy Commission with the authority to set appliance standards. Several other states, such as New York, quickly followed. The responsibility for establishing standards falls upon the Department of State in consultation with the New York State Energy Research Department Authority (NYSERDA). Leading manufacturers began to pressure the federal government to develop national standards that would supersede many state standards.

The 1975 Energy Policy and Conservation Act (EPCA) was the first federal energy appliance legislation, which directed the National Institute of Standards and Technology (NIST) to develop standard test procedures for measuring the energy efficiency of appliances. In 1978, the National Energy Conservation Policy Act (NECPA) directed the Department of Energy to set mandatory standards for 13 residential household appliances, and gave those federal standards pre-emption over state standards under most circumstances.[30]

[30] Department of Energy. Energy Efficiency & Renewable Energy. History of Federal Appliance Standard. http://www1.eere.energy.gov/buildings/appliance_standards/history.html Retrieved on 3/28/2012.

By 1986, manufacturers realized that uniform national standards were preferable to varying state standards in terms of product planning and marketing. The 1987 National Appliance Energy Conservation Act (NAECA) established national standards for 12 categories of household appliances, with strengthened pre-emption over state standards. NAECA also contains deadlines for DOE rulemakings to update the initial standards as technology progresses. Several updates to the initial standards have occurred, including updated standards for refrigerators and freezers, fluorescent ballasts, clothes washers, clothes dryers and dishwashers.

The 1992 Energy Policy Act was the next major energy efficiency standard legislation. The act updated existing standards and established new standards for other appliances, including lamps, induction motors, and most types of commercial heating and cooling equipment. The DOE issued several updates to the federal standards in the late 1990s.

In the United States a distinctive pattern of establishing standards emerged since the 1990s. Many states, particularly California, first set new standards on unregulated appliances and, after much negotiation between industry and energy efficiency advocates, Congress set pre-emptive national standards on those appliances. In effect, appliance standards activity shifted back and forth between the states, primarily California, and the federal government. California still has statewide standards on appliances such as distribution transformers and traffic lights, which are not covered by federal standards.

On January 14, 2004, the Maryland General Assembly voted to override Governor Ehrlich’s veto of a bill that would create new energy efficiency standards on a variety of home appliances. The products covered by the bill include torchiere lighting fixtures, ceiling fans, low-voltage dry-type transformers, commercial refrigerators and freezers, traffic signal modules, illuminated exit signs, large packaged air-conditioning equipment, unit heaters, and commercial clothes washers. Attempts to implement or update state standards are also under way in Massachusetts, Connecticut, New Jersey, New York, and Pennsylvania.

Effectiveness of appliance standards

Many studies have evaluated the effectiveness of appliance standards. A study by Meyers et al. (2003) estimated the benefit/cost ratio to be 2.75, which means that each dollar spent on appliance standards brings in $2.75 in energy savings. Another study estimates 4% energy reduction in the commercial sector and 8% reduction in the residential sector resulting from the standards in place from 1987-2006 (Meyers et al., 2008). An ACEEE study estimates similar savings, with 6.5% (250 billion kWh) and 7.6% peak demand reduction in 2010.

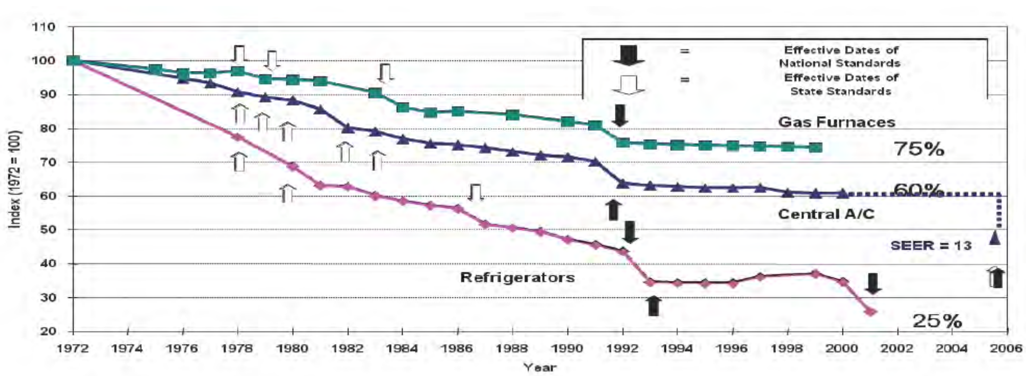


Figure 11: Impact of national and state appliance standards on energy efficiency.
Source: ***S. Nadel (2003) cited in Doris***

Figure 11 illustrates the impact of national and state standards on the energy efficiency of gas furnaces, central air-conditioning, and refrigerators. The figure shows that 75% of the reduction in refrigerators in 2001 resulted from enactment and enforcement of codes and standards.

Geller (1995) estimated the prospective total energy savings in the year 2000 from appliance standards to be 1.23 quads. Geller et al. (2001) provided similar savings estimates at 1.2 quads for the year 2000.

Economic/Financial Policies

Energy efficient products normally have high initial capital costs, especially during the early stage, as was discussed in the economic/financial barriers section of this report. Many financial incentive programs such as grants, loans, rebates, subsidies, and tax incentives, have been put in place to address these financial issues. Financial incentive programs provide either a price signal or an equipment purchase subsidy to consumers to encourage the adoption of energy efficiency technology. The two most important financial incentive programs are utility-based demand side management programs and tax credits.

Demand side management

After the energy crisis of the 1970s, federal and state regulators started to implement policies that led to the creation of utility Demand Side Management (DSM) programs. The Energy Policy and Conservation Act (1975), Energy Conservation and Production Act (1976), and National Energy Conservation Policy Act (1978) all paved the way for the initiation and development of utility DSM programs. In addition, the Public Utility Regulatory Policies Act (1978) required states to bring energy conservation considerations into their utility ratemaking, furthering the impetus for utility DSM programs (EIA 1997).

DSM programs include combined information and loan programs, rebate programs, comprehensive auditing, and market transformation programs. It was estimated that the cumulative energy savings from all utility DSM projects through 1998 range from 49,167 to 56,866 gigawatt-hours (GWh). The estimated cost-effectiveness of utility DSM programs generally use the term negawatt (a theoretical unit representing an amount of energy savings in watts) cost as a comparative performance metric, which is expressed in dollars per kilowatt-hour saved. The estimated negawatt cost for DSM was in the range of $0.019 to $0.067 in 2002 dollars. For the purposes of comparison, the operating cost of energy from new generating units in the United States was approximately $0.067 to $0.133 in 2002 dollars per kWh, which is much more costly than DSM programs.[31]

Tax credits and reductions

In the late 1970s and early 1980s, there was a tax credit at the federal level for residential energy efficiency investments. The federal Energy Tax Act of 1978 (ETA78) was passed in response to the energy crises of the 1970s and provided federal income tax credits to homeowners for specified energy conservation investments. These investments included: insulating walls and ceilings, replacing furnace burners and ignition systems, and installing storm or thermal windows and doors, clock thermostats, and weather stripping. These weatherization, insulation, and similar conservation activities received an income tax credit of 15% of the total cost with a credit ceiling of $300 and the restriction that the credits could only be taken on buildings constructed prior to 1977.

[31] Kenneth Gillingham etal. Resources for the Future. Retrospective Examination of Demand Side Energy Efficiency Policies. 2004.

From 1978 to 1985, about 30 million claims for the conservation tax credits were filed, cumulatively amounting to nearly $5 billion (nominal dollars) in lost tax revenues or approximately $166 per claim.

Conservation tax credits or deductions at the state level were occurring as well, such as Arizona, California, Colorado, Hawaii, Montana, and Oregon, Arkansas, Idaho, and Indiana.

There are number of studies estimating the effectiveness of the tax credit. The results are mixed, with some of the earlier papers suggesting that tax credits are a very ineffective policy, while some of the later papers pointing to limited effectiveness.

Information, Voluntary Programs, and R&D Policies

Information and voluntary programs as well as R&D provide information, training, develop new technology, and use demonstration projects and products to promote building energy efficiency. Voluntary programs help create and hold companies accountable for improving the efficiency of their projects or products and saving energy in their operations. In this section, we discuss information-based policies enacted in US history.

Section 1605b of the 1992 Energy Policy Act

Section 1605b of the 1992 Energy Policy Act (Public Law 102-485) mandated the creation of a national inventory of greenhouse gas emissions and a national database of voluntary reductions in these emissions. Section 1605b directed the DOE to establish a procedure beginning in 1987 for companies to annually report, on a voluntary basis, their greenhouse gas emissions and emissions reductions.

Section 1605b is intended to encourage companies to voluntarily reduce greenhouse gas emissions by providing information to the database and allowing companies to make public commitments and thereby improve their public image. The emissions reductions reported in 2001 totaled 222 million metric tons of carbon dioxide equivalents in direct reductions.

Energy star voluntary labeling

The 1992 Energy Policy Act directed the Environmental Protection Agency (EPA) to implement a program to identify and designate particularly energy efficient products and to provide estimates of the relative energy efficiency of products.

In the same year, EPA introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products. Computers and monitors were the first labeled products. Through 1995, EPA expanded the label to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with the U.S. Department of Energy in its ENERGY STAR labeling program. The ENERGY STAR label now covers 60 product categories and thousands of models for the home and office. The EPA has also extended the label to cover new homes and commercial and industrial buildings.

Through its partnerships with more than 20,000 private and public sector organizations, ENERGY STAR delivers technical information and tools to organizations and consumers. ENERGY STAR successfully delivered energy and cost savings to consumers of about $18 billion in 2010 alone.[32]

Other programs

[32] Kenneth Gillingham etal. Resources for the Future. Retrospective Examination of Demand Side Energy Efficiency Policies. 2004.

The DOE runs a series of voluntary programs to improve the energy efficiency of buildings through the development of voluntary public-private partnerships, including[32]

- Several DOE programs targeted at low income households, such as the Weatherization Assistance Program (WAP), which was created under Title IV of the Energy Conservation and Production Act of 1976 and designed to promote and finance the weatherization of homes, including low-income homes;
- Building America (launched in 1994), with the goal to conduct research to develop market-ready energy solutions that improve efficiency of new and existing homes;
- Rebuild America (launched in 1995), which establishes partnerships between local communities, state governments and private companies to improve energy efficiency;
- High Performance Buildings Initiative (launched in 2008), which was designed to improve the energy efficiency of commercial buildings;
- Zero Energy Buildings Initiative (launched in 2008), which focuses on designing and building zero net energy homes;
- Energy Assistance Program (LIHEAP), which was created under the Title XXVI of the Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35), provides a direct subsidy to fuel costs of participating households;
- PATH (Partnership for Advance Technology in Housing), a collaboration between home construction companies, manufacturers, insurers and financial companies with the goal of improving energy efficiency, which is currently providing an online resource for consumers, the homebuilding industry, and federal agencies; and
- The DOE Climate Challenge program, which is a voluntary program between electric utilities and the US Department of Energy which creates voluntary commitments for utility reductions that have economic merit.

Research and development

The federal government's support of energy R&D has historically accounted for a relatively small proportion of total federal spending on all R&D.

DOE sponsors a number of research and development programs across all sectors (buildings, transportation, industry, and power) through the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007, and the American Recovery and Reinvestment Act (ARRA) of 2009.

The DOE's efficiency R&D comprises programs on buildings, industry, and transportation. The National Research Council reported that, from 1978 to 2000, the total cumulative spending on buildings was 32 percent of the total, approximately $2 billion (in 1999 dollars). Federal support for efficiency research has contributed to or resulted in a number of key efficient technologies for buildings, including high-efficiency refrigerators, compact fluorescent and electronic ballast lighting technologies, and low-emissivity windows.

California has supported building energy efficiency R&D since the mid-1990s. State legislation created a program for energy-related research, development, and demonstration, funded by a tax collected through California's utilities, called the Public Interest Energy Research (PIER) program The California Energy Commission manages the PIER program. From 1997 through 2007, PIER funded $540 million in research, of which 34 percent was allocated for R&D in energy efficiency and demand response (PIER 2008).

Summary and Discussion

Policies related to energy efficiency at the federal and state levels and their evolution over time are discussed above. Important legislation is summarized in Table 3 in the appendix.

Critical Evaluation

After an examination of the building energy use status quo, market barriers and the policy instruments aiming to overcome the barriers to energy efficiency, we reviewed the history and current status of building energy efficiency policies in the U.S. In this section, we provide a critical analysis of U.S. building energy efficiency policies and make policy recommendations.

Leadership on energy efficiency is successful

As discussed in codes and standards policies, some states (especially California) have taken a leading role in building codes and appliance codes before the federal rules were enacted. Policies initiated at state level can lay the foundation for the federal government to establish standards on a nationwide basis. California has also pioneered demand side management programs, which set examples for other states to follow.

Leadership by the federal government is also important. The government sector is one of the biggest building energy end users. By using new energy efficiency technologies and practices and adopting higher standards, the federal government has showed leadership and demonstrated the effectiveness of new technologies and energy efficiency measures to consumers.

More work on policy evaluation is needed

Evaluating policy impact is critical, but evaluation is difficult, because it is difficult to coordinate the impact of any particular policy in isolation. More research is needed in this area to develop a comprehensive methodology to evaluate building energy efficiency policies.

Coordination among different levels of policy makers is important

Energy policies exist at different levels, including federal, state and local levels. Currently there is no comprehensive policy strategy for energy efficiency for different levels of government in the United States. If these different levels are coordinated well and planned strategically, there are opportunities to significantly improve policy performance.

Long-term policy planning is critical

Our review of the energy efficiency policy history revealed that the U.S. does not have long-term building energy efficiency planning. Many states do not have clear building energy savings goals and no roadmap for realizing these goals. A stronger push for energy efficiency policies above current levels is needed to overcome market barriers.

Sharing experience across sectors and across countries is needed

There are many similar energy policy tools employed across different sectors and across countries that vary due to different governing jurisdictions, political expediency, and technological and economic limitations. Sharing effective policy measures and research across sectors and between countries will improve energy efficiency outcomes overall.

Topic 2: Distributed Renewable Energy in Buildings

By combining distributed renewable energy systems with building energy efficient measures, it is possible to turn buildings into net exporters of energy instead of consumers. In fact, building integrated renewable energy and efficiency measures are synergistic and can compensate for each other's weaknesses. Efficiency measures can offset the upfront cost of renewable energy systems because of their much shorter payback period. In a hot sunny climate, renewable energy combined with energy efficiency measures can significantly reduce peak demand, which has benefits for the overall energy grid far in excess of the actual amount of energy produced.

Despite the inherent advantages of constant replenishment and cleaner production, renewable energy has some major disadvantages compared to conventional fossil fuel energy. The biggest disadvantage is the relatively higher cost of renewable energy versus fossil fuels. This is due to the low intensity and/or high intermittence of the renewable energy source, and the low efficiency of renewable energy conversion systems. The intermittent nature of some renewable resources such as solar and wind also causes a reliability issue. In addition, renewable energy is only applicable in specific sites. These disadvantages seriously impede the development of renewable energy sources; policy is therefore critical to encourage its growth. In the past dozen years, the development of renewable energy, particularly solar/PV and geothermal, has gained significant momentum (see Figure 10). In terms of energy magnitude, however, renewable energy sources still only contribute a very small portion to the entire building sector.

This report will first classify and analyze barriers to renewable energy development in the U.S. building sector and identify policy instruments that can overcome these barriers. Next, we review past and current policies that have successfully driven the recent building renewable energy boom in the U.S. and identify gaps that exist in the current policy structure that may impede the development of a sustainable building renewable energy future. Finally, we conclude by summarizing what lessons can be learned from the history of policy and legislation that have impacted the development of the renewable energy sector in the United States.

Renewable Energy Policy Making Background in the U.S.

Global Renewable Energy Growth

Renewable energy is assuming an increasingly important role across the world due to supply issues as well as environmental and energy security concerns. For example, despite the overall downturn of global energy consumption in 2009, renewable energy continued to grow at a strong rate, and this growth continued into 2010.

In 2009 (the latest year that comprehensive energy data has been completely collected, analyzed, and available), renewable energy supplied an estimated 16% of global final energy consumption[33] – counting traditional biomass, hydropower, wind, solar, geothermal, modern biomass, and biofuels. (See Figure 1.) Traditional biomass, which is used primarily for cooking and heating in rural areas of developing countries, accounted for approximately 10% of the total renewable energy share. Hydropower represented 3.4% and is growing modestly but from a large base. All other renewables accounted for approximately 2.8% in 2009 and are growing very rapidly in many developed countries as well as in some developing countries.[34]

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[33] Final energy designates the energy as the consumer in the different sectors receives it, be it in the primary or secondary form. Final = Primary - Loses in Transformation. http://ecen.com/eee18/enerq_e.htm

[34] "REN21, Renewables Global Status Report (2006 - 2011)". Ren21.net. http://www.ren21.net/REN21Activities/Publications/GlobalStatusReport/tabid/5434/Default.aspx. Retrieved 2011-11-21.

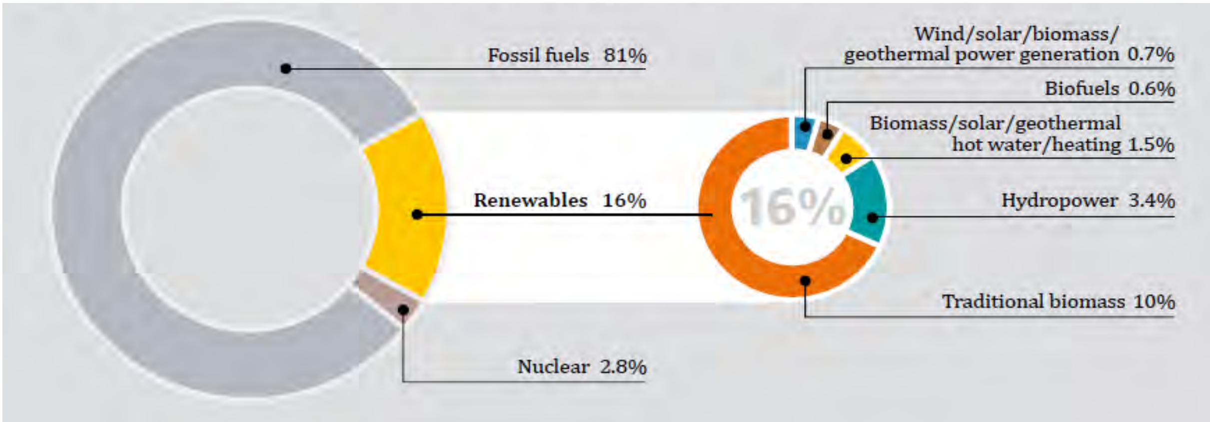
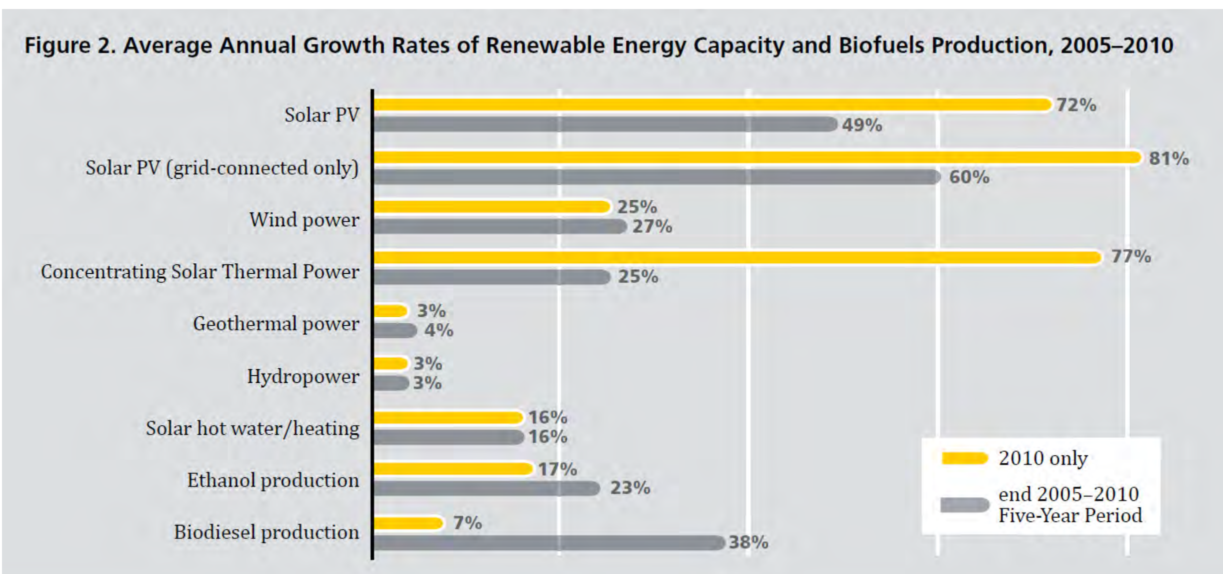


Figure 1: Renewable energy share of global final energy consumption, 2009.
Source: ***REN21, Renewables Global Status Report (2006 - 2011)***

From the end of 2005 through 2010, the total global capacity of many renewable energy technologies – including solar photovoltaic (PV), wind, concentrating solar thermal power (CSP), solar water heating systems, and biofuels – grew on the average at rates ranging from 15% to nearly 50% annually. Solar PV increased the fastest of all renewables technologies during this period, followed by biodiesel and wind. For solar thermal power technologies, growth[35] accelerated during 2010 relative to the previous four years. At the same time, growth in total capacity of wind power held steady in 2010, while growth rates of biofuels have declined in recent years, although ethanol was up again in 2010. (See Figure 2, page 2.)



[35] It is installed capacity. As the "Renewables Global Status Report" explains, "Most figures of global capacity, growth, and investment portrayed in this report are not exact, but are approximate to two significant digits." Inaccuracy is inevitable, especially for developing countries. Data for developing countries are often much older than data for developed countries, and thus extrapolations to the present must be made from older data, based on assumed and historical growth rates.

Figure 2: Average annual growth rates of renewable energy capacity and biofuels production, 2005-2010.

Source: *REN21, Renewables Global Status Report (2006 - 2011)*

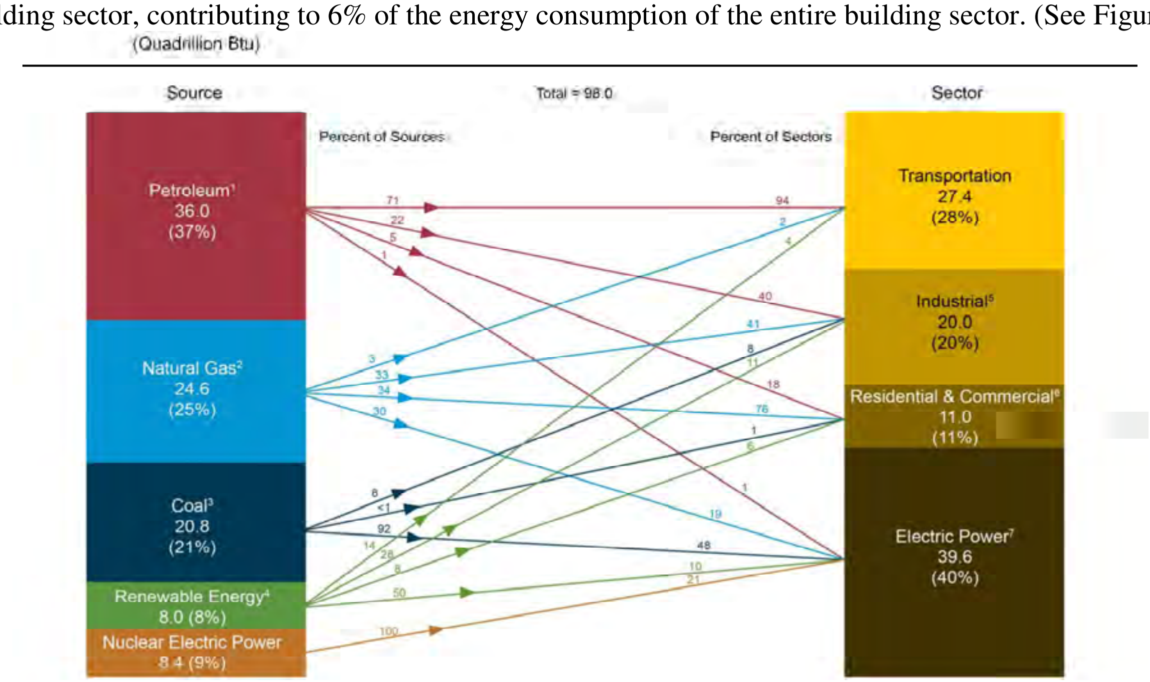
Renewable Energy in the United States

In 2010, about 83% of the U.S. total primary energy consumption was from fossil fuels, 9% from nuclear energy, and 8% from renewable energy sources[36]. Of the 8% in renewable energy sources, 31% is comprised of conventional hydropower and 11% is wind, with solar/PV as the smallest portion, accounting for 1%[2]. The magnitude of total renewable energy consumption increased 171% from 1949 to 2010. During that same period, hydroelectric power and wood energy use remained stable. Starting from 2000, biofuel and wind energy production ramped up dramatically, with a 686% and 1521% increase, respectively.

Renewable Energy in the U.S. Building Sector

Renewable energy can be used in either large or small-scale applications. Large-scale applications include PV farms, wind farms, and solar thermal and geothermal power stations. Distributed renewable energy systems deployed at an individual project site, such as rooftop solar panels, small wind turbines, micro hydroelectric systems, solar water heaters, and heat pump water heaters, are considered to be small-scale renewable energy applications. This study focuses on small-scale (distributed) renewable energy applications in buildings.

In 2010, 8% of the national renewable energy source was distributed renewable energy devoted to the building sector, contributing to 6% of the energy consumption of the entire building sector. (See Figure 3)



36 U.S. DOE, Energy Information Administration (EIA) (Oct. 2011) Annual Energy Review 2010.

[1] *Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."*
[2] *Excludes supplemental gaseous fuels.*
[3] *Includes less than 0.1 quadrillion Btu of coal coke net exports.*
[4] *Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.*
[5] *Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.*
[6] *Includes commercial combined-heat-and-power (CHP) and commercial electricity-only*
[7] *Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes 0.1 quadrillion Btu of electricity net imports not shown under "Source."*
Notes: Primary energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy (for example, coal is used to generate electricity). • Sum of components may not equal total due to independent rounding.

Figure 3: Primary energy consumption by source and sector, 2010.
Source: *EIA Annual Energy Review 2010*

Figure 4 indicates that from 1949 to 2010, the renewable energy use in the residential sector had ups and downs, but overall was relatively flat compared to other energy sources. During the same period in the commercial sector[37], renewable energy contribution was rather insignificant, as shown in Figure 5. This indicates that renewable energy in both sectors has a lot of room for growth, especially in the commercial sector.

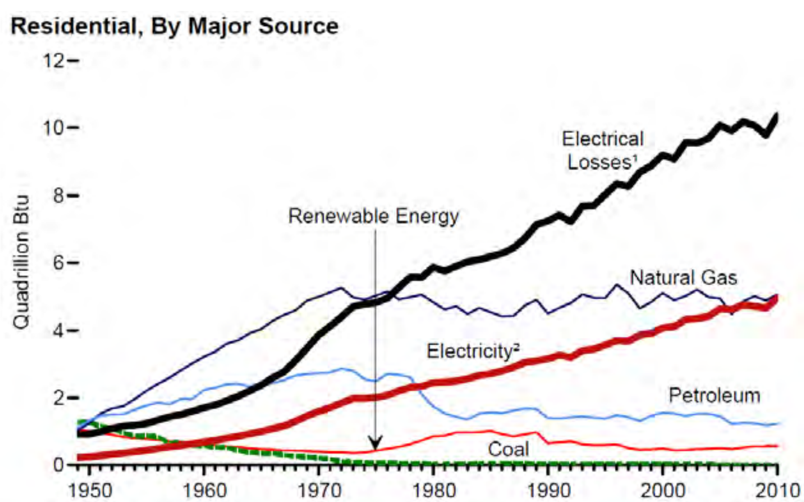


Figure 4: Energy consumption estimates for the residential sector, 1949-2010.
Source: *EIA Annual Energy Review 2010*

[37] Commercial sector biomass includes wood and wood-derived fuels; municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, and other biomass. Through 2000, it also includes non-renewable waste (municipal solid waste from non-biogenic sources, and tire-derived fuels); and fuel ethanol (minus denaturants).

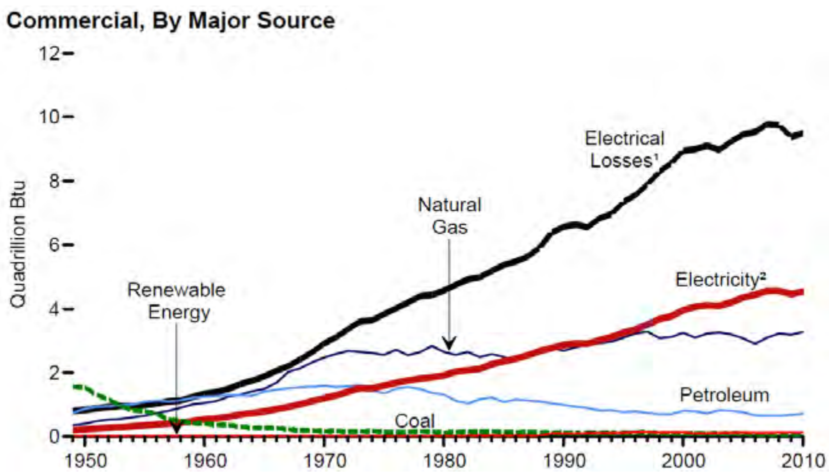


Figure 5: Renewable energy consumption in the commercial sector, 1989-2010.
Source: *EIA Annual Energy Review 2010*

Figure 6 illustrates renewable energy use in the residential and commercial building sectors from 1989 to 2010. In the residential sector, although solar/PV and geothermal account for a smaller portion, compared to the wood and wood derived fuels, these two sources have significantly ramped up since 2005. Solar/PV energy use increased 86.5% from 1989 to 2010, while geothermal energy consumption increased by 640% in the same period. A similar trend is observed in the commercial sector for geothermal energy use, which increased 5.3 times in eleven years. It should be noted that since the commercial PV data only includes commercial plants with a capacity of 1 megawatt or greater; solar/PV portion in the commercial sector is very small, and therefore its curve is not shown. Solar/PV production with a capacity less than 1 megawatt is reported in the residential sector totals.

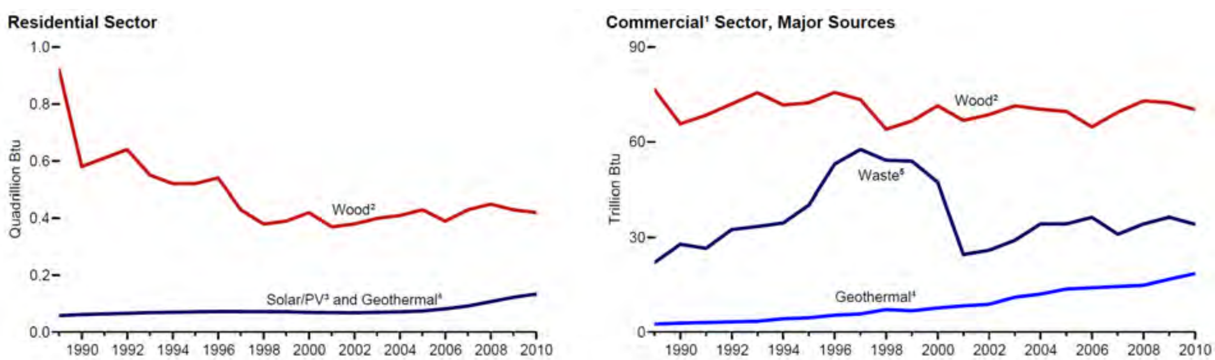


Figure 6: Renewable energy consumption: the residential and the commercial sector, 1989-2010.
Source: *EIA Annual Energy Review 2010*

[1] *Includes fuel used at combined-heat-and-power (CHP) plants and a small number of electricity only plants.*
[2] *Wood and wood-derived fuels.*
[3] *Solar thermal direct use energy, and photovoltaic (PV) electricity net generation.*
[4] *Geothermal heat pump and direct use energy.*
[5] *Municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural*

byproducts, and other biomass. Through 2000, also includes non-renewable waste (municipal solid waste from non-biogenic sources, and tire-derived fuel.

Barriers for Renewable Energy Uptake in the U.S. Building Sector

Various barriers put renewable energy at an economic, regulatory, or institutional disadvantage relative to other energy forms. Researchers (Carbon Trust (2005), IPCC (2007- forthcoming)) have proposed various systems to classify barriers to the penetration of energy efficiency in the building sector. Because renewable energy is a resource to address energy demand, similar to energy efficiency measures, they both share a lot of barriers, the roots of which impede the penetration of both resources. This report therefore builds on previous barrier analysis for both categories, improves the existing criteria, and classifies the barriers to building distributed renewable energy uptake into five main categories.

Financial Cost-Effectiveness

The cost effectiveness category has two levels of criteria: simple payback level and lifecycle level. At the simple payback level, the simplest and the most straightforward cost benefit concept is applied. The additional investment in purchasing and installing a renewable system is the cost, and the benefit is the financial value of the renewable energy generated, which in turn depends on the energy price of the conventional energy being displaced and/or the sale price of the net generation being sold to the utility.

On the cost side, typical barriers include:

- *High initial capital costs*. The cost-per-unit ($/kW) upfront cost of renewable energy sources is usually higher than that of conventional energy sources, which means that renewable energy investments generally require higher amounts of financing for the same capacity[38].

- *Lack of access to financing*. Financing building level renewable energy projects is usually not easy. It is difficult to secure capital from investors due to their small capital size and mediocre financial credits, compared to supply side renewable energy applications. Capital markets may demand a premium in lending rates for financing renewable energy projects because more capital is at risk up front than in conventional energy projects. These all add to the restricted access to financing for on-site building renewable energy projects[39].

Nevertheless, it should be noted that the issue of financing is easier for renewables than for energy efficiency projects. Renewable energy generators are usually standalone and therefore can be easily repossessed and thus serve as collateral. Many leading builders believe that renewable energy equipment providers and contractors can offer lease or finance packages that they cannot offer for energy efficiency features, even though the latter are more cost-effective.

On the benefit side, policies and practices that reduce the cost of conventional energy or do not provide full value for renewable energy lead to decreased comparative benefits of renewables. For example:

- *Energy subsidies*. Large public subsidies, both implicit and explicit, are channeled in varying amounts to all forms of energy, which can significantly lower final energy prices, putting renewable energy at a competitive disadvantage if it does not enjoy equally large subsidies. Figure 7 below illustrates the magnitude of federal subsidies to fossil fuels vs. renewable energy from 2002 to 2008[40].

[38] Fred Beck, Eric Martinot, 2004, Renewable Energy Policies and Barriers. http://www.martinot.info/Beck_Martinot_AP.pdf
[39] Ibid.
[40] Ibid.

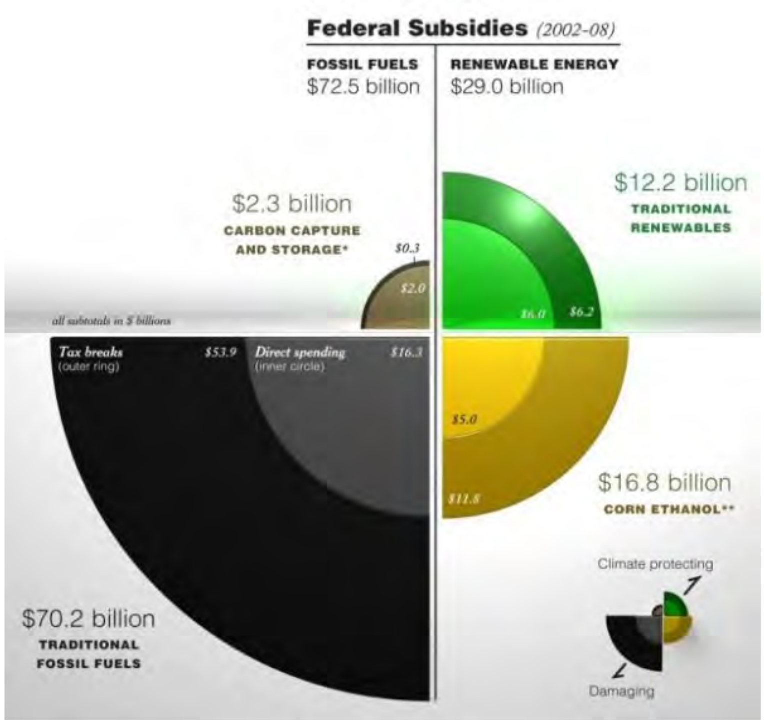


Figure 7: Federal subsidies to fossil fuels vs. renewable energy, 2002-2008.
Source: ***Estimating U.S. Government Subsidies to Energy Sources: 2002-2008***[41]

- *Unfavorable power pricing rules*. There may be times when the renewable energy system is able to produce more energy than what a building demands. If the excess power can be sold to the utility, and is paid for, the extra monetary benefit will favor the renewable energy system. However, power grids often simply do not allow the feed-in of excess power due to power reliability or security concerns. When feed-in is allowed, the renewable energy source may not receive full credit for the value of their excess power from the grid. The extra value of feed-in renewable energy, as well as the additional value of some of feed-in energy at peak load, is often not credited or realized, since it does not require transmission and distribution due to the close proximity of the renewable energy sources to the end users [42]

- *Lack of internalization of environmental, health, and other external costs*. The environmental impacts of fossil fuels often result in real costs to the society, in terms of human health (i.e., loss of work days, health care costs), infrastructure decay (i.e., from acid rain), declines in forests and fisheries, and perhaps ultimately, the costs associated with climate change. To the extent that these costs are not reflected in conventional energy prices, they distort the real cost of conventional energy and thus reduce the comparative value of renewable energy.

At the lifecycle level, there are additional barriers other than those mentioned at the simple payback level, which impact the cost and the benefit of the renewable system. These barriers include:

- *Maintenance costs*. If the renewable system is less reliable and requires more frequent maintenance, or is harder to get serviced, or both, the maintenance costs during the lifecycle of the renewable system can be higher than a competing energy system.

[41] http://www.elistore.org/Data/products/d19_07.pdf
[42] Fred Beck, Eric Martinot, 2004, Renewable Energy Policies and Barriers.

- *Difficulty of fuel price risk assessment*. Historically, risks of severe fossil fuel price fluctuations are often ignored. However, with greater geopolitical uncertainties and energy market deregulation, future fuel price volatility has been increased. Renewable energy technologies, especially heating related renewable energy technologies, avoid fuel costs (with the exception of biomass) and thus avoid fuel price risk. However, this benefit, or "risk-reduction premium," is often missing from economic comparisons.

Technical Difficulties

Typical technical problems facing this new industry include low conversion efficiency, energy storage, resource integration and evaluation, design and installation skills, and so on. Skilled personnel who can assess, design, integrate, install, commission, operate, and maintain renewable energy technologies may not exist in large numbers, and therefore are not easily accessible. A lack of familiarity with the details of these new technologies or uncertainties regarding their performance may necessitate extra time and efforts to conduct a resource assessment and develop project proposals and plans, resulting in high utility fees for engineering reviews and inspection.

Policy and Regulatory Resistance

Policy and regulatory resistance for building distributed renewable energy are the structural characteristics of the political and regulatory system that make investment on building distributed renewable energy difficult. Specific barriers of this kind are listed as follows:

- *Lack of legal framework*. Power utilities still have a monopoly on electricity production and distribution in many countries. In these circumstances, in the absence of a legal framework, independent power producers may not be able to invest in renewable energy facilities and sell power to utilities or to third parties under so-called "power purchase agreements."

- *Restrictions on sitting and construction*. Wind turbines, rooftop solar hot-water heaters, photovoltaic installations, and biomass combustion facilities may all face building restrictions based upon height, aesthetics, noise, or safety, particularly in urban areas. Wind turbines have faced specific environmental and aesthetic concerns related to siting along migratory bird paths and scenic coastal areas. Urban planning departments or building inspectors may be unfamiliar with renewable energy technologies and may not have yet established procedures for dealing with siting and permitting. There is also competition for land use with agricultural, recreational, scenic, and development interests.

- *Utility interconnection requirements*. Individual home or commercial systems connected to utility grids can face burdensome, inconsistent, or unclear utility interconnection requirements. Lack of uniform requirements can add to transaction costs. Safety and power-quality risk from non-utility generation is a legitimate concern of utilities, but a utility's interconnection requirements may be beyond what is necessary or practical for small producers. In turn, the transaction costs of hiring legal and technical experts to understand and comply with interconnection requirements may be significant. Policies that create sound and uniform interconnection standards can reduce interconnection hurdles and costs.

Market Misalignment

The fourth category of barriers includes any mismatch of interests or imbalances of strength among renewable energy market players. The most representative example of these barriers is the tenant -

landlord split, where the benefits of an investment are prevented from accruing to the party making the investment. In this case, the building owner has no incentive to undertake renewable energy investments because the saved utility costs go into the pockets of the tenants who pay the energy bill. For other types of market misalignment barriers, please refer to the same section in Topic 1 (building energy efficiency).

Behavior and Motivation

The final category of barriers is the behaviors that are not the theoretical ideal of consistent, rational decision-making that maximizes profits. These behaviors usually result from organizational inertia, lack of awareness or motivation. In many organizations, energy consumption is rarely a core business concern, and therefore the energy bill is a small portion of the entire expenditure. In addition, the person(s) making relevant decisions may have no idea about renewable energy technologies, or gain nothing from installing renewable energy devices.

The above-mentioned barriers are summarized in Table 1.

Table 1: Classification of barriers hindering renewable energy uptake in the building sector.

Category	Definition	Examples
Financial Cost Effectiveness	Factors impacting simple payback and lifecycle costs and benefits	• High initial capital costs • Lack of access to financing • Energy subsidies • Unfavorable power pricing rules • Lack of internalization of environmental, health, and other external costs • Maintenance costs • Difficulty of fuel price risk assessment
Technical Difficulties	Issues of technical nature	• Low conversion efficiency • Energy storage • Renewable energy resource integration and evaluation • System design, installation and maintenance • Issues rising from unfamiliarity and uncertainties on the technology
Policy and Regulatory Resistances	Policies and regulations that bias the renewable energy technologies	• Lack of legal framework • Restrictions on siting and construction • Utility interconnection requirements
Market Misalignment	Mismatch of interest or imbalance of strength among the renewable energy market players.	• Tenant - landlord split
Behavior and Motivation	Behaviors against the renewables resulting from organizational inertia, lack of awareness or motivation	• Organizational inertia • Lack of awareness • Lack of motivation: Energy not a core business; Energy bill and cost savings an insignificant portion of the entire expenditure of the whole business.

Policy Measures to Overcome Barriers

Many policy instruments have been constructed to promote distributed renewable energy in the building sector. These policies can be classified into three basic types: laws and regulations; financial incentives; and information, support and voluntary actions (IEA 2005[43]; Koeppel and Ürge-Vorsatz, 2007[44]).

Laws and Regulations

This category includes laws and implementation regulations that require certain devices, practices, or systems design to promote renewable energy. The most common forms of laws and regulations are:

- *Codes and Standards*: Codes and standards contain provisions specifying required physical or performance characteristics for a target component or system.

  For example, the Solar America Board for Codes and Standards (Solar ABCs) program,[45] initiated in 2007, is a collaborative effort of PV codes and standards experts who gather and prioritize input from the broad spectrum of PV stakeholders, including policymakers, manufacturers, installers, and consumers. The group administers and coordinates recommendations to organizations that establish codes and standards for existing and new solar technologies. The Solar ABCs program generates and distributes consensus 'best practice' materials, answers code-related questions, and provides feedback to the U.S. Department of Energy (DOE) and other government agencies on issues relating to codes and standards. DOE's Solar Energy Technologies Program funds Solar ABCs as part of its commitment to facilitate the widespread adoption of safe, reliable, and cost-effective solar technologies.

  The Solar ABCs program makes recommendations for improvements to a broad range of codes and standards related to solar energy technologies, including:

  - Fire safety codes and standards;
  - The National Electrical Code;
  - Grounding for solar electric systems;
  - Solar cell performance;
  - Creating standard definitions for utility capacity credits;
  - Grid interconnection;
  - Net metering; and
  - Solar access laws.

  Before the creation of the Solar ABCs program, the practice of developing, implementing, and distributing solar codes and standards lacked coordination and access to policymakers, as well as a centralized repository for information and best practices.

- *Renewable energy planning, obligations, and quotas*: These are the policy approaches that use an overall plan, or specify certain obligations or renewable energy quotas, to develop renewable energy technologies.

[43] International Energy Agency, 2005, Evaluating Energy Efficiency Policy Measures & DSM Programmes.
[44] Köppel, S., and Ürge-Vorsatz, D., 2007, Assessment of policy instruments for reducing greenhouse gas emissions from buildings. UNEP-Sustainable Buildings and Construction Initiative.
[45] http://www1.eere.energy.gov/solar/solar_america_board_codes_standards.html

For example, Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management", was signed on January 24, 2007 to strengthen key goals for the Federal Government. It established as policy that federal agencies conduct their environmental, transportation, and energy-related activities in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.

Relating to renewable energy, the Order establishes that agencies must ensure that (i) at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources, and (ii) to the extent feasible, the agency implements renewable energy generation projects on agency property for agency use;

*Utility program*s: Utilities plan, design, implement, and monitor activities of renewable energy programs under the supervision of utility regulators.

For example, the California Solar Initiative (CSI) program currently administered by PG&E provides an option of two types of incentives available through the program: expected performance-based buy-down and performance-based incentives. PG&E's distributed PV promotion efforts have resulted in over 45,000 installed PV systems, making PG&E the utility company that has connected the most solar customers to the electric grid in the country. In fact, this represents roughly 30% of PV system installations in the entire United States.

Financial Incentives

Financial incentives help reduce economic barriers to adopting renewable energy technologies in equipment replacement, remodeling, and new construction projects. The wide variety of financial incentives currently in use includes:

- *Rebates and incentives:* Rebates and incentives are offered for the documented installation of qualifying products.
For example, the Energy Policy Act of 1992 established a production incentive payment of $0.015/kWh for publicly owned utilities. The incentives are available for solar, wind, biomass (excluding MSW) and geothermal (excluding dry steam) energy.

- *Tax reduction, exemptions and credits:* They are used to provide signals promoting investment in renewable energy to end-use customers.

The Energy Policy Act of 1992 provided two types of tax credits to support the development of renewable energy resources:

1) Permanent extension of the investment credit (Section 1916), provides a 10% investment credit for most solar technologies and geothermal; and
2) Establishment of a production tax credit (PTC) of $0.015 per kWh (to be inflation-adjusted) for wind and closed-loop biomass, which is available to investor-owned utilities and non-utility generators for up to ten years for electricity produced in stations brought on-line before July 1999. The program was subsequently extended three times and was set to expire at the end of 2008.

- *Financing guarantees*: Program sponsors may offer credit guarantees to reduce risk premiums charged on loans to finance renewable energy projects.

The Energy Policy Act of 2005 (EPAct) authorized the Department of Energy (DOE) to issue loan guarantees to eligible projects that "avoid, reduce, or sequester air pollutants or anthropogenic

emissions of greenhouse gases" and "employ new or significantly improved technologies as compared to technologies in service in the United States at the time the guarantee is issued." As such, loan guarantees are another tool used by DOE to promote the commercial use of innovative technologies and thereby help reduce the country's reliance on imported sources of energy.
In 2008, the U.S. Congress authorized up to $10 billion for renewable and/or energy efficient systems, manufacturing and distributed energy generation/transmission and distribution. Technologies could include solar, wind, geothermal and biomass technology development.

- *Preferential or subsidized loans:* Governments encourage easy financing to renewables. Some organizations offer subsidized (low-interest) loans to finance projects that incorporate specified renewable energy technologies.

For example, the American Jobs Creation Act of 2004 (HR 4520), signed into law on October 22, 2004, created and extended a number of energy-related tax credits, including an expansion of the renewable energy production tax credit (see separate entry). Additionally, section 701 of the HR 4520 law placed the U.S. Environmental Protection Agency (EPA) in charge of a demonstration program to provide up to $2 billion in tax-exempt financing to green building and sustainable design projects on so-called "brownfields" at abandoned industrial sites. Tax-exempt financing allows a project developer to borrow money at a lower interest rate, because the buyers of the bonds will not have to pay federal income taxes on interest earned. The savings from tax-exempt financing must then be used to offset the costs of sustainable design and/or renewable energy technologies.

- *Grants*: Amounts of money given to an individual or organization for a particular purpose.

Since 2008, the Technology Commercialization Fund has promoted early-stage renewable energy and energy efficiency product development through prototype advancement including development, demonstration, and deployment (not scientific research). In 2008, DOE provided $14.3 million, which was divided among seven DOE national laboratories.

- *Direct procurement/investment:* A process through which a market is generated for a renewable energy related commodity, service or system by direct procurement in order to assist the industry in reaching the scale necessary to reduce production costs.

For example, the 1978 Energy Policy and Conservation Act authorizes contracts for the acquisition of such photovoltaic systems at an annual level substantial enough to allow suppliers to use low-cost production techniques. It also directed the establishment of a photovoltaic systems evaluation and purchase program designed to insure that such systems reflect the most advanced technology.

- *Net metering*[46]: "Net", in this context, is used in the sense of meaning "what remains after deductions" — in this case, the deduction of any energy outflows from metered energy inflows. Under net metering, a system owner receives retail credit for at least a portion of the electricity that is generated.

Under the provisions of the Energy Policy Act of 2005, Sec. 1251, all public electric utilities are required to make net metering available to their customers.

- Feed-in tariffs accelerate investment in renewable energy technologies by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Technologies such as wind power, for example, are awarded a lower per-kWh price, while technologies such as solar PV and tidal power are offered at a higher price, reflecting higher costs.

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[46] http://en.wikipedia.org/wiki/Net_metering

The first form of feed-in tariff was implemented in the U.S. in 1978 under the Public Utility Regulatory Policies Act (PURPA). The purpose of the Act was to encourage energy conservation and the development of new energy resources, including renewables such as wind, solar and geothermal power.

Within PURPA was a provision that required utilities to purchase electricity generated from qualifying independent power producers at rates that were not to exceed their avoided cost. In order to comply with PURPA, certain states began offering Standard Offer Contracts to renewable power producers. California's Public Utility Commission established a number of Standard Offer Contracts, including Standard Offer No.4 (SO4), which made use of fixed prices, based on the expected long-run cost of generation. The long-run estimates of electricity costs were based on the belief (widely held at the time) that oil and gas prices would continue to increase. This led to an escalating schedule of fixed purchase prices, designed to reflect the long-run avoided costs of new electrical generation. By 1992, private power producers had installed approximately 1,700 MW of wind capacity in California, some of which is still in service today. The adoption of PURPA also led to significant amounts of renewable energy generation in states such as Florida and Maine.

Information, Support and Voluntary Actions

The policy measures in this category help

- Increase the various parties' awareness and understanding of renewable energy products and services, as well as their economic and environmental benefits;
- Persuade actors to change their behavior towards adopting renewable energy products and practices; and
- Provide actors with the technical information they need to identify and adopt renewable energy related practices.

This study identifies the following more specific types of information-based energy efficiency policy measures:

- **Information, education and training:** These policy measures consist of information delivery. General information can be conveyed through paid advertising and public relations campaigns designed to make consumers aware of the need to pursue renewable energy, the means at their disposal to achieve this, and the consequences of not doing so. Education concentrates on providing focused information on renewable energy opportunities and the application of efficient technologies in particular end uses. Training focuses more on practical applications.

  For example, the Center for Geothermal Technology Transfer, established in 2008, serve as an information clearinghouse for the geothermal industry by collecting and disseminating information on best practices in all areas relating to developing and utilizing geothermal resources. The Center will make data available to the public and share information to coordinate R&D efforts among national and international partners.

- **Demonstration:** Once a new or improved renewable energy technology has been developed, this technology needs to be introduced into the market. Demonstration refers to the phase during which this new product or technique is tested in practice. This serves to generate information on the usefulness, costs and energy savings during real use or in a demonstration of the product or technique to potential users or decision makers.

  For instance, the Solar Photovoltaic Energy Research, Development and Demonstration Act of 1978 established and funded a program for R&D for solar photovoltaic energy systems.

- **Research and development:** These are the technical research actions carried out by research entities to advance renewable energy technologies.

The American Recovery and Reinvestment Act (ARRA), signed into law on February 17, 2009, is a supplemental spending bill that appropriated over $80 billion to support clean energy research, development, and deployment. Approximately $1.6 billion in funding for research is managed by the DOE Office of Science, of which $277 million is for Energy Frontier Research Centers that will pursue cost-effective alternative energy technologies.

- **Voluntary and negotiated agreements:** This refers to policy instruments under which representatives of national or provincial governments enter into negotiations with facility owners or branch organizations to obtain a commitment to reach a renewable energy percentage by a specified amount over a given time period.

Building America, an industry-driven research program sponsored by DOE and started in 2004, is designed to accelerate the development and adoption of advanced building energy technologies in new and existing homes. The goal is to develop cost-effective solutions that reduce the average energy use of housing by 40% to 100% and ultimately, produce net zero energy homes.

- **Governing by Example:** Governments choose their own buildings, appliance purchases, etc., for a program to demonstrate renewable energy.

The Environmentally Preferable Purchasing (EPP) program, initiated in 1993 with Executive Order 12873, is a federal government-wide program that encourages and assists executive agencies in the purchasing of environmentally preferable products and services.

The Evolution of U.S. Policies for Building Renewable Energy Uptake

A variety of renewable energy-related policies have been issued and enacted since 1970s in response to the 1973 oil embargo and the nation's dependence on foreign sources of petroleum. This section introduces all the major policy instruments that have been enacted since the 1970s chronologically, and analyzes the different approaches, purpose, evolution and results in an attempt to identify the gaps in the current policy regime.

Policies in the 1970s

Before the establishment of the DOE

The Solar Heating and Cooling Demonstration Act of 1974 was one of the first national renewable energy legislation efforts. It was signed into law before the establishment of the Department of Energy (DOE). In this legislation, the U.S. Congress encouraged the development and early commercial demonstration of solar heating and cooling technology by the National Aeronautics and Space Administration (NASA) and the Department of Housing and Urban Development (HUD) within three years. The central government provided funding for these projects, and states competed for the funding by responding to announcements issued by the administering agencies.

The Solar Energy Research, Development and Demonstration Act passed in the same year stated that it was henceforth the policy of the federal government to "pursue a vigorous and viable program of research and resource assessment of solar energy as a major source of energy for our national needs." The act's scope embraced all energy sources that are renewable and derived from the sun - including solar thermal energy, photovoltaic energy, and energy derived from wind, sea thermal gradients, and photosynthesis. This Act provided the first tax incentives for renewable energy. The Act also established the Solar Energy Research Institute to carry out research and development initiatives of various solar projects. This institute was later renamed the National Renewable Energy Laboratory and became a part of a national laboratory system dedicated to renewable energy research.

The Geothermal Energy Research, Development and Demonstration Act of 1974 functioned very similarly to the above-mentioned two Acts. These Acts supported the development of renewables by funding research and commercial demonstration activities, and tax incentives were deployed as a financial instrument to promote rapid commercial use of solar technology and geothermal technology.

In 1975, the first Energy Policy and Conservation Act included measures to enhance the penetration of renewables into the residential and the federal building sector. The Act authorized the Government National Mortgage Association to purchase and sell loans and advances of credit for family dwelling units for the purpose of financing the purchase and installation of solar energy systems. It also authorized increased amounts of financial assistance to be guaranteed for residential solar energy system. In the federal sector, the Act established a program to demonstrate solar heating and cooling technology in Federal buildings. Two policy instruments-- preferential loan and governing by example -- were utilized to advance renewables.

After the establishment of the DOE

The 1977 DOE Organization Act established the DOE. It has since become the administrating organization for all major national energy policies, including renewable energy.

The Energy Policy and Conservation Act of 1978 took further action by dictating that all federal agencies, when leasing buildings, should give preference to buildings that use solar energy equipment or other renewable energy resources which otherwise minimize life cycle costs. It also authorized contracts for the acquisition of photovoltaic systems at an annual level that was substantial enough to allow suppliers to use low-cost production techniques. From this point on, direct purchase has been part of national renewable energy policies. In the same year, the Energy Tax Act of 1978 constituted a program of tax credits for households and businesses purchasing alternative energy equipment. Tax credits entered the law and became a consistent and lasting financial policy for renewables.

A 1970s law with profound significance for renewables was the Public Utility Regulatory Policies Act (PURPA) of 1978. The Act required electric utilities to buy power from independent companies that can produce power for less than what it would cost for the utility to generate the additional power, called "avoided cost”. Because the avoided (marginal) cost is higher than the utilities' average cost of electricity generation, projects using renewable energy or high-efficiency fossil fuel power may be a cost competitive alternative. PURPA created a market for power from non-utility power producers. Before PURPA, only utilities could own and operate electric generating plants.

Summary of renewables policies in the 1970s

Renewables policies issued in the 1970s were among the earliest legislations and regulations on renewable energy. Solar thermal, PV and geothermal industries were the main targets of policy during this period. These technologies were promoted by grant funded research and commercial demonstration activities. However, as former President Jimmy Carter stated when he signed the Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978, “Congress also recognized the risks involved in premature commercialization of solar PV technologies. It is still too early to concentrate on commercialization of PV. Photovoltaic systems hold great promise, but in the short run we must emphasize research and development, including fundamental work on the physical properties of these systems”, to “celebrate cost reductions.” The renewable energy technologies in this age were still at their very early stages of development, and focused on research.

Highlights of the policies in the 1970s include:

- Government funded research, development and commercial demonstration programs on solar thermal/PV and geothermal technologies;
- Tax incentives, e.g., tax credits used as financial instruments in both the residential and commercial sectors;
- Preferential loans and financing in the residential sector;
- Government direct purchase policies to stimulate the growth of renewable suppliers;
- Removing barriers to the use of on-site renewable energy development by utilities; and
- Requirements that renewables be applied to the federal building sector to demonstrate their applicability and performance.

Policies in the 1980s

Despite the promise of renewable energy in the 1970s and the fear of reliance on foreign petroleum, spending on renewable energy sources in the United States declined dramatically during the 1980s. Several factors combined during that decade to weaken the federal government's commitment to solar power, including the availability of inexpensive petroleum and the skeptical attitudes of the Reagan and Bush administrations, which were both distrustful of government-sponsored initiatives and concerned about government spending.

The Wind Energy Systems Act of 1980 was enacted at the tail end of the 1970s' enthusiasm for renewables and therefore mimicked its counterparts in the 1970s, such as the Solar Energy Research, Development and Demonstration Act and the Geothermal Energy Research, Development and Demonstration Act.

Other policies in this period were mostly tax-related. The Economic Recovery Tax Act of 1981 allowed for an Accelerated Cost Recovery System (ACRS) by which businesses could recover investments in solar, wind and geothermal property through depreciation deductions. The currently modified ACRS allows wind, solar and geothermal property placed in service after 1986 to be depreciated over five years. Hence, this act reduced the tax burden of business investors on renewable energy.

The Tax Reform Act of 1986 extended the 10% tax credit for solar and geothermal to 1992. The five-year accelerated depreciation for alternative energy property was further liberalized (from a 150% to 200% declining balance method). However, under this legislation, the business energy tax credit was eliminated for wind energy systems and phased out for biomass. The standard 10% business investment tax credit was also phased out. The alternative minimum tax (AMT) instituted by this Act significantly reduced the pool of investors who could take advantage of the tax credits.

Highlights of policies in the 1980s include:

- Government funded research, development and commercial demonstration programs on wind technology; and
- An accelerated cost recovery system that reduced the tax burden of businesses investing in renewables.

Policies in the 1990s

Beginning in the early 1990s, the issuance and enactment of renewable energy policies started to increase.

Information, support and voluntary actions policies began to take shape

Since 1990, the Environmental Protection Agency's Climate and Energy State and Local Programs have assisted state and local governments in their clean energy efforts by providing technical assistance, analytical tools, and outreach support. Specific assistance includes identifying and documenting cost-effective policies and initiatives that promote renewable energy, energy efficiency, and related clean technologies; measuring and evaluating the environmental, economic, and public health benefits of clean energy initiatives; and offering a suite of national voluntary programs that provide partners with assistance and recognition for their clean energy actions. This program also fostered peer exchange opportunities for state and local officials to share information on best practices and innovative policies.

Besides the interaction between the federal, state and local governments, the federal government also enhanced their communication with the utilities and the energy service companies (ESCOs) through the Federal Utility Partnership Working Group (FUPWG) in 1994. This organization established partnerships and facilitated communications among federal agencies, utilities, and ESCOs, and developed strategies to implement cost-effective energy efficiency and renewable energy and water conservation projects through utility incentive programs at federal sites.

In 1996, the State Energy Program (SEP) was established, and provided grants to states for designing and carrying out programs that benefit renewable energy and energy efficiency through communications and outreach activities, technology deployment, and accessing new partnerships and resources. This program consolidated the State Energy Conservation Program and the Institutional Conservation Program established by the 1975 Energy Policy Act.

Realizing the need for renewables and an efficiency-related workforce, the Workforce Investment Act of 1998 established an Energy Efficiency and Renewable Energy Worker Training scheme that provides for a competitive grant program for worker training and placement in high growth and emerging industry sectors, labor exchange, and job training projects that prepare workers for careers in energy efficiency and renewable energy.

Financial incentives were further strengthened

The Energy Policy Act of 1992 (EPAct 1992), which is now the Federal Business Investment Tax Credit (ITC), permanently extended the 10% investment credit for most solar technologies as well as geothermal. The Act also established a production tax credit (PTC) of $0.015 per kWh (to be inflation-adjusted) for wind and closed-loop biomass, which is available to investor-owned utilities and non-utility generators for up to ten years. This became the Renewable Energy Production Incentive (REPI).

Energy efficiency mortgages established in 1992 helped homeowners to finance a variety of energy efficiency measures, including renewable energy technologies, in a new or existing home. The federal government supports these loans by insuring them through Federal Housing Authority (FHA) or Veterans Affairs (VA) programs. The FHA and VA programs allow lenders to add up to 100% of energy efficiency improvements to an existing mortgage loan with certain restrictions. Fannie Mae, Freddie Mac, FHA and VA have adopted special underwriting guidelines to make financing energy efficiency less burdensome.

The government's direct purchase efforts were also continued through the Environmentally Preferable Purchasing (EPP) program initiated in 1993. This program encourages and assists executive agencies in the purchasing of environmentally preferable products and services. Federal agencies are required to make environmentally-friendly purchasing decisions according to various laws, regulations and executive orders; the EPP helps agencies meet these requirements according to their needs and the costs and benefits of various products and services.

Research and commercialization of wind technology continued

DOE's Wind Powering America (WPA) program continued the nation's research and commercialization initiatives for wind energy technology. WPA is focused on reducing barriers to the use of wind energy in the United States, thus enabling dramatic wind industry growth. WPA activities include wind working groups, validated wind maps, anemometer loan programs, small wind guides, Wind for Schools Wind Applications Centers, exhibits, and workshops and Webcasts. WPA has also developed application-financial analysis tools and outreach materials, and has formed strategic partnerships in various states, regions, and communities. The program's goal was to facilitate the installation of at least 100 MW of wind in at least 30 states by 2010.

Massachusetts became the first state to adopt the Renewable Portfolio Standard (RPS), which required that 1% of electricity sales in 2003 be generated from new renewables; the requirement increased to 4% by 2009 and by 1% each year thereafter. This policy was ranked most effective in stimulating renewable energy growth based on an IEDC survey (Thorstensen, Chen and McHugh 2011[47]). However, this policy is focused on the energy supply side, instead of the end user side, and therefore is more effective in promoting large-scale renewable energy in the power supply.

Highlights of the policies in the 1990s include:

- Information, support and voluntary actions policies began to be utilized intensively and broadly;
- Government-insured residential loans for renewable energy projects emerged;
- Utilities and ESCOs worked with the federal agencies to promote renewable energy in the federal sector; and
- The 10% investment tax credit for most solar technologies and geothermal was made permanent.

Policies from 2000 to 2004

Net-zero energy buildings

In the early 2000s, net-zero buildings, also called zero-energy buildings, were the most important concept to promote renewable energy in the building sector. In general, a net-zero energy building produces as much energy as it uses over the course of a year. Net-zero energy buildings must first be very energy efficient. The remaining low energy needs are typically met with on-site renewable energy. To achieve net-zero, renewable energy sources have to be used on site. The Net-Zero Energy Commercial Building Initiative (CBI), which began in 2000, guides and coordinates public and private partnerships to advance the development and market adoption of net-zero energy commercial buildings (NZEBs). CBI works with researchers at DOE national laboratories, as well as with public and private partners, to achieve the goal of marketable NZEBs by 2025.

The concept of net-zero residential houses was also researched, tested and showcased by college and university students through the Solar Decathlon competition starting in 2002. College and university students competed to design, build, and operate the most attractive, effective, and energy-efficient solar powered net-zero house. The goals of the Decathlon are to 1) educate the student participants - the "decathletes" - about the benefits of energy efficiency, renewable energy and green building technologies; 2) raise awareness among the general public about renewable energy and energy efficiency and how solar energy technologies can reduce energy use; 3) help solar energy technologies enter the marketplace faster; 4) foster collaboration among students from different academic disciplines; 5) promote an integrated or "whole building design" approach to new construction; and 6) demonstrate to the public the potential of zero-energy homes, which produce as much energy from renewable sources, such as the sun and wind, as they consume.

In 2004, Building America, an industry-driven research program, sponsored by the DOE, was launched as a public-private partnership to work with industry research teams to conduct systems engineering research to develop technologies and strategies that achieve desired efficiency goals. The partners include leading national and regional builders who produce about 50% of all new housing, as well as local home building associations and smaller individual builders. The Building America project combines the knowledge and resources of industry partners with DOE's technical expertise to build cost-shared research and

[47] International Economic Development Council, 2011, Powering Up: State Assets & Barriers to Renewable Energy Growth - A Survey of Economic Development Leaders

demonstration homes and communities. The goal is to develop cost-effective solutions that reduce the average energy use of housing by 40% to 100%. Ultimately, Building America research aspired to produce net-zero energy homes, which produce as much energy as they use.

The U.S. collaborated with international partners on renewable energy initiatives

The Renewable Energy and Energy Efficiency Partnership (REEEP) launched in 2002 is an active, global partnership that works to reduce the barriers within policy, regulatory and financial structures that bar and limit the growth of renewable energy and energy efficiency technologies and projects. Funding from the U.S. federal government, the European Union (EU), and the governments of 11 other countries supports REEEP. Through this program, nations from all over the world collaborate to promote renewable energy technologies.

Financial measures were maintained at the federal and state levels

At the federal level, the Economic Security and Recovery Act of 2001 extended the renewable energy production tax credit. In addition, the American Jobs Creation Act of 2004 created a demonstration program to provide tax-exempt financing to green building and sustainable design projects on abandoned industrial sites called "brownfields."

Various states also began to use financial instruments to help the growth of the renewable energy in both the residential and commercial sectors. California took a leading role in this regard. The San Francisco Solar Energy Incentive Program, which began in 2001, is a municipal incentive program that encourages the installation of photovoltaic (PV) systems by both residents and businesses. Different incentive levels are available whether the property is residential, commercial, low-income residential, non-profit, or multi-family residential owned and operated by a non-profit.

California's Self-Generation Incentive Program also provides a financial incentive to customers who install new, qualifying self-generation equipment to meet all or a portion of the electric energy needs of a facility. The Self-Generation Incentive Program provides incentive funding to renewable and non-renewable self-generation units up to 1 MW in size.

Highlights of the policies in 2000-2004 include:

- Net-zero buildings were studied, researched, tested and demonstrated;
- The U.S. partnered with other countries on its renewable energy endeavors;
- Federal and state level financial incentives, including tax credit and rebates, continued; and
- State and local governments began financial incentive programs to promote de-centralized energy production.

Policies from 2005 to 2007

Utilities continued to play an important role in the renewable energy uptake

Because the end users have a natural bond with their service providers (utilities), the utility industry has a natural advantage in advancing energy efficiency and on-site renewables. Utilities have been required to carry out demand side energy efficiency programs since the 1970s. The U.S. has also been very active in getting utilities involved in the promotion of renewable energy in the building sector.

The U.S. Environmental Protection Agency (EPA) provides technical assistance to state utility regulators who want to explore greater use of clean energy for its economic and environmental benefits. EPA technical assistance allows states to learn from each other and pursue best practice policies and programs for energy efficiency, renewable energy, and clean distributed generation such as combined heat and power (CHP). Assistance is provided directly to individual state utility commissions in partnership with the National Association of Regulatory Utility Commissioners (NARUC) through their Energy Resources and the Environment (ERE) Committee.

To facilitate small generators' interconnection with the grid, in May 2005 the Federal Energy Regulatory Commission (FERC) adopted standard "small generator" procedures for the interconnection of generators no larger than 20 megawatts (MW) in capacity. The rule harmonizes state and federal practices and directs public utilities to amend their Order No. 888 open access transmission tariffs to offer non-discriminatory, standardized interconnection service for small generators. The FERC's standards apply only to facilities already subject to the jurisdiction of the commission; mostly, these are not local distribution facilities but rather systems that interconnect at the transmission level.

Utilities have to provide net metering upon customer request

Net metering is an electricity policy for consumers who own (generally small) renewable energy facilities (such as wind, solar power or home fuel cells) or V2G electric vehicles. "Net," in this context, is used in the sense of meaning "what remains after deductions" — in this case, the deduction of any energy outflows from metered energy inflows. Under net metering, a system owner receives retail credit for at least a portion of the electricity that is generated.

Most electricity meters accurately record in both directions, allowing a no-cost method of effectively banking excess electricity production for future credit. However, the rules vary significantly by country and region: if net metering is available, if and how long you can keep your banked credits, and how much the credits are worth (retail/wholesale) are all variable. Most net metering laws involve monthly rollover of kWh credits, a small monthly connection fee, monthly payment of deficits (i.e., a normal electric bill), and an annual settlement of any residual credit. Unlike a feed-in tariff or time-of-use metering (TOU), net metering can be implemented solely as an accounting procedure, and requires no special metering or any prior arrangement or notification.

Net metering is generally a consumer-based renewable energy incentive. While it is important to have net metering available for any consumer who interconnects his renewable generator to the grid, this form of renewable incentive places the burden of pioneering renewable energy primarily upon fragmented consumers. Often, over-burdened energy agencies are not providing incentives on a consistent basis and it is difficult for individuals to negotiate with large institutions to recover their net metering credits and/or rebates for using renewable energy.

In the United States, as part of Sec. 1251 of the Energy Policy Act of 2005, all public electric utilities are required to make net metering available upon request to their customers.

Several bills are pending in Congress to institute a federal requirement that utilities provide net metering. They range from H.R. 729 which allows up to 2% net metering to H.R. 1945, which has no limit but does limit residential users to 10 kW, a low limit compared to many states such as New Mexico, with an 80,000 kW limit, or states such as Arizona, Colorado, and Ohio which have limits as a percentage of the load. As of June 2011, only three states and Washington D.C. do not allow net metering, and 21 states have no limit on the number of subscribers using net metering. Only two states, Arizona and Ohio, have no specific wattage limit on the power limit for each subscriber (see table). Colorado, Maryland, New Jersey and Pennsylvania are considered the most favorable states for net metering, as they are the only states to receive an "A" rating from the Network for New Energy Choices in 2007, 2008 and 2009.[48]

PV codes and standards

[48] Wikipedia, 2012, http://en.wikipedia.org/wiki/Net_metering

Codes and standards help reduce transaction costs and boost market transformation for renewables. Few efforts were devoted to renewable energy codes and standards in the past. The Solar America Board for Codes and Standards, established in 2007, is a collaborative effort of photovoltaic (PV) codes and standards experts who gather and prioritize input from the broad spectrum of PV stakeholders, including policymakers, manufacturers, installers, and consumers. The group administers coordinated recommendations to organizations that establish codes and standards for existing and new solar technologies. The Solar America Board for Codes and Standards (Solar ABCs) generates and distributes consensus "best practice" materials, answers code-related questions and provides feedback to the U.S. Department of Energy (DOE) and other government agencies on issues relating to codes and standards. DOE's Solar Energy Technologies Program funds Solar ABCs as part of its commitment to facilitate the widespread adoption of safe, reliable, and cost-effective solar technologies.

The federal government directly helps cities promote solar technologies

Since 2007, Solar America Cities has been part of the Solar Energy Technology Program, which is a partnership between the DOE and a select group of cities across the country that have committed to accelerating the adoption of solar energy technologies at the local level. A total of 25 selected cities have received a combined $5 million in DOE funding in addition to substantial hands-on technical assistance over a two year period. The partnerships' plans include:

- Removal of market barriers to solar energy development that exist in urban planning charters, zoning regulations, building codes, permitting, and inspection procedures;
- Promotion of solar technology among residents and local businesses through outreach, curriculum development, incentive programs and other innovative approaches; and
- Integration of solar energy technologies into city energy planning.

Highlights of the policies adopted in 2005-2007 are as follows:

- Utilities continued to play an active role in promoting renewable energy;
- Utilities have to provide net metering upon customers' request;
- The Solar America Board for Codes and Standards facilitated the development and utilization of PV codes and standards;
- Federal-state and federal-local partnerships to promote clean energy were further strengthened; and
- Financial incentives, including tax credits and loan guarantees, and federal sector programs continued through this time period.

Policies After 2008

Zero-net energy buildings entered state laws

In 2008, California introduced a bill directing the California Energy Commission (CEC) to adopt standards for building design and construction as well as energy and water conservation that require new residential construction to be "zero net energy" starting in 2020, and new commercial buildings to be "zero net energy" from 2030 onward.[49] The California Public Utilities Commission (CPUC) and representatives from the commercial building, clean energy, finance, technology, and architecture sectors, as well as various state agencies, announced on September 1, 2010 the release of the state's Zero Net Energy Action Plan for Buildings. The plan provides a roadmap for transforming the state's five billion

[49] STATE OF CALIFORNIA Public Utilities Commission, 2008, AB 2030 (Lieu/Saldana) - Energy Building Standards: Commercial Zero Net Energy Buildings.

square feet of commercial property space from the largest energy consumers in the state to "net-zero" energy users, through greater energy efficiency and on-site clean energy generation by 2030.[50]

PG&E, the biggest utility in California, has a pilot program supporting the California Long Term Energy Efficiency Strategic Plan's zero-net energy goals by maintaining a portfolio of research, development, and demonstration (RD&D) projects around ZNE buildings together with complementary education, outreach and information activities. One ZNE program element is a design competition, "Architecture at Zero," targeted to raise awareness of ZNE technologies and design methods among the architectural design community. PG&E is sponsoring the competition along with the San Francisco chapter of the American Institute of Architects.

Federal funding and support for technology commercialization

Since 2008, the Technology Commercialization Fund has promoted early stage product development through prototype advancement including development, demonstration, and deployment (not scientific research). The DOE provided $14.3 million from FY07 to FY08. These funds were divided among seven DOE national laboratories. National laboratories often struggle to find post-research, pre-venture capital funding for innovations that are no longer considered research projects but are not sufficiently prototyped to attract private investment. This fund addresses this issue by awarding dollars that can only be spent on commercializing national laboratory intellectual property.

A Center for Geothermal Technology Transfer was also established in 2008. The Center serves as an information clearinghouse for the geothermal industry by collecting and disseminating information on best practices in all areas relating to developing and utilization of geothermal resources. The Center makes data available to the public and shares information to coordinate R&D efforts among national and international partners.

The cost-shared Renewable Energy Innovation Manufacturing Partnership Program, established in response to the Energy Independence and Security Act of 2007, makes awards to support R&D, demonstration, and deployment of advanced manufacturing processes, materials and infrastructure for renewable energy technologies. Eligible technologies include those for solar, wind, biomass, geothermal, energy storage and fuel cell systems.

Financial assistance expanded to support current and additional new renewable energy technologies despite the financial crisis

Signed into law in October 2008, the Emergency Economic Stabilization Act included the Energy Improvement and Extension Act, which extended production tax credits (PTCs) and investment tax credits (ITCs) for various renewable energy sources. The Act extended the PTC for wind power by one year. In addition, projects could qualify for a 30% ITC of up to $4,000 for wind turbines with capacity of 100 kilowatts or less until 2016. The bill also provided a two-year PTC extension for electricity produced from geothermal, biomass, and solar energy facilities.

Solar energy gained an eight-year extension (through 2016) of the 30% ITC for residential and commercial solar installations, as well as elimination of the $2,000 tax credit cap for residential solar electric installations.

Tax credits for fuel cells were also extended by eight years, and the fuel cell tax credit limit was tripled, to $1,500 for each 0.5 kilowatts of capacity. The Act also created a new 10% tax credit for certain combined heat and power systems and for geothermal heat pumps (up to $2,000).

[50] Vazquez, A. 2010, CA Buildings Going For Zero Net Energy, http://www.todaysfacilitymanager.com/facilityblog/2010/09/ca-buildings-going-for-zero-net-energy.html

To facilitate financing, the bill authorized $800 million in new Clean Renewable Energy Bonds for all of the above technologies. It also ended a prohibition on utilities taking advantage of the ITC.

The Act also aims for a more complete use and benefit of tax credits. To this end, it included a provision to increase the income limits for the Alternative Minimum Tax (part of the federal income tax system which limits the types of deductions certain taxpayers can use to lower their tax). It also allows unused tax credits to be carried over to the following year.

Debut of the carbon trading mechanism

The first mandatory, market-based effort in the United States to reduce greenhouse gas emissions was established in December 2005 by the governors of seven Northeastern and Mid-Atlantic states through the Regional Greenhouse Gas Initiative (RGGI). RGGI sets a cap on emissions of carbon dioxide (CO_2) from fossil fuel-fired power plants with a capacity of 25 MW or higher, and allows sources to trade emissions allowances. However, this policy targets fossil fuel-fired power stations and factories, which are on the energy supply side, and has little impact on the renewable energy at the end user side.

Highlights of the policies after 2008 include the following:

- The concept of zero-net energy buildings entered California's law and concrete steps have been taken to achieve this ambitious goal;
- The federal government has focused more on the commercialization and demonstration of renewables;
- Various financial support, including tax credits, bonds and grants, has been promoted to further encourage renewable energy, especially for new technologies; and
- The federal government continued to take a leading role in advancing the renewable industry by taking on more aggressive programs.

Summary of renewable policies and programs since the 1970s

Many of the above-mentioned policies and programs have multiple function components. Table 3 lists the components for each of the policies referenced in this study.

Summary of U.S. Policies Promoting Renewables

Several influential and consistent policies are behind the fast growth of renewables:

- *Consistent and strong financial incentives.* High cost has been one of the biggest barriers to the development and implementation of renewables. The U.S. has consistently provided financial incentives to the renewables industry, including renewable energy projects, renewable energy manufacturing, renewable energy production, and research and development. As the IEDC survey (Thorstensen, Chen, and McHugh, 2011[51,52]) indicated, financial assistance has made the largest contribution to stimulating the renewable energy industry.

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[51] International Economic Development Council, 2011, Powering Up: State Assets & Barriers to Renewable Energy Growth - A Survey of Economic Development Leaders.
[51] http://en.wikipedia.org/wiki/Net_metering
[51] International Economic Development Council, 2011, Powering Up: State Assets & Barriers to Renewable Energy Growth - A Survey of Economic Development Leaders.
[51] Wikipedia, 2012, http://en.wikipedia.org/wiki/Net_metering
[51] STATE OF CALIFORNIA Public Utilities Commission, 2008, AB 2030 (Lieu/Saldana) - Energy Building Standards: Commercial Zero Net Energy Buildings.
[51] Vazquez, A. 2010, CA Buildings Going For Zero Net Energy, http://www.todaysfacilitymanager.com/facilityblog/2010/09/ca-buildings-going-for-zero-net-energy.htm

- *Extensive information campaigns, as well as education, training, demonstration, research and development, have been carried out and continued to motivate and guide policy and behaviors.* Since early 1990s, the DOE and EPA have provided extensive and innovative informational and technical support at the federal, state, municipal and local levels to change and guide people's behaviors to embrace renewable energy technologies. These efforts target behavioral and motivational barriers to building renewables uptake, and should be continued along with financial incentives to promote further penetration of renewables.

- *Legal and regulatory supports have lifted fundamental impediments and reduced transaction costs.* The Public Utility Regulatory Policies Act of 1978 and the Interconnection Standards for Small Generators of 2005 have removed the utilities' resistance to the connection of distributed renewable energy sources, including those in buildings. The Solar America Cities program works on removal of regulatory barriers to solar energy development that exist in urban planning charters, zoning regulations, building codes, permitting, and inspections procedures. Net metering became a requirement for utilities so that the extra power generated from the renewables can be credited. These efforts, together with the codes and standards for renewable energy technologies, significantly reduce the transaction costs of pursuing renewables.

Critical Evaluation

Despite these favorable policies, several problems in the development of building integrated renewable also indicate gaps in current U.S. policy Renewable energy still only contributes a very small portion to the building sector, especially the commercial market, with a lower renewable percentage than that of the residential sector. There are two major reasons for the slower renewables uptake in the commercial sector:

- Energy is seldom a core business for most commercial end users. The cost reduction from reduced energy consumption is usually an insignificant portion of a business's total expenditure. The advantages of using renewable energy and saving energy do not compare with the benefit of other cost-cutting measures such as reduction in force or relocation of production facilities. For a residential user, on the other hand, whose utility bill usually is a higher portion of the total expenditure, energy cost savings are much more significant. In addition, a lack of ring-fenced budgets dedicated to the renewable energy is usually common to small and medium end users in this sector.
- There is no existing policy tool in the U.S. building sector that addresses the owner-tenant interest split, which discourages owners from pursuing renewables.

Suggestions on how to tackle these two problems are listed below:

- Decision makers should be better informed about the importance and benefits of pursuing renewable energy, so the inertia and lock-in mind set can be corrected to favor renewables. Then a low or no interest loan, which significantly reduces transaction costs, can stimulate efforts to promote renewable energy integration in the building sector. A combination of informational/educational policies and a subsidized loan program can help overcome existing barriers and encourage the adoption of renewable energy in commercial buildings.

- A regulatory mechanism that allows owners to benefit from reduced energy costs by saved bill sharing methods, for example, should be adopted.

Another important lesson learned is the importance of careful design of incentive mechanisms. Cost-based incentives, which are a fixed fraction of the expenditure of efficiency equipment, have proven to be much less effective than performance-based incentives.[53] The major reason is that a cost-based structure encourages contractors to charge higher prices to allow their customers to qualify for larger tax credits rather than reducing prices to attract more business, which discourages competition and market transformation. Cost-based incentives reduce the pressures to price competitively because the consumer reaps only a fraction of the benefits of the incentive. The rest of the incentive is spent on suppliers and contractors, which does not result in positive market behavior. In contrast, basing the incentives on performance establishes competition among different suppliers of goods and services to meet energy goals at the lowest cost. It is therefore wise to avoid a cost-based component in an incentive structure.

Finally, as the authors see it, the net-zero energy-building concept that emerged at the beginning of the 21st century dictates the utilization of distributed renewable energy, and may be the most powerful driving force behind the on-site renewable energy uptake in buildings. California has introduced a bill requiring new residential construction to be "zero net energy" starting in 2020, and new commercial buildings to be “zero net energy” from 2030. Action plans have been announced as well. Hopefully the federal government will take concrete steps toward net-zero energy buildings in the near future.

[53] Goldstein, D., Fairey, P., 2006, Getting it Right Matters: Why Efficiency Incentives Should Be Based on Performance and Not Cost.

Topic 3: Green Building

Green building is playing an increasingly important role in both promoting building energy efficiency and encouraging the development of building integrated distributed renewable energy in the US market. But the term "green building" is more holistic than a simple measure of building energy performance. According to the US Environmental Protection Agency (EPA):

> *"Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building."*[54]

History of Green Building in the US

While responsible design principles date back centuries, "green building" is generally thought to have been conceptualized in its current form in the late 1980s and early 1990s. EPA and many others[55,56] point to a variety of events in a 10-year period that have proven foundational to green building. Beginning in 1989, the American Institute of Architects (AIA) formed the Committee on the Environment and in 1992 published the Environmental Resource Guide. The ENERGY STAR program was launched jointly with the EPA and the Department of Energy in 1992. The U.S. Green Building Council (USGBC) was founded in 1993, the same year as the launch of the "Greening the White House" initiative of the Clinton Administration. Finally in 1998, USGBC began to pilot a green building rating system, called Leadership in Energy and Environmental Design (LEED). Currently there are a number of other green building programs active in the US, including the Living Building Challenge, Green Globes, and Build it Green. There are also an increasing number of green building codes such as the California Green Building Standard, The International Green Construction Code, and ASHRAE Standard 189.1.

Green building provides numerous complementary environmental, economic and social benefits compared to traditional construction. For example, the use of renewable building materials generates a market for sustainable green building products and minimizes a building's impact on the natural environment. Energy efficiency measures reduce environmental damage from conventional energy production and decrease building owners' operating expenses. Finally, better indoor environments improve occupant health and productivity while increasing property values.

Since the original pilot, LEED is by far the US market leader. Growth in LEED registered and certified buildings have been explosive. As of March 2012, there are more than 31,000 certified buildings, approximately 12,000 of which are commercial buildings. Total space registered or certified makes up 8.4 billion square feet.[57] States, municipalities, corporations, and government departments are now requiring green building certification, and the concept of green building has moved from a few pilot projects into one of the most important forces shaping the US building market today.

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[54] U.S. EPA. "Basic Information", Dec 22, 2010. http://www.epa.gov/greenbuilding/pubs/about.htm

[55] "White Paper on Sustainability: A Report on the Green Building Movement", Building Design and Construction. November 2003. http://www.usgbc.org/Docs/Resources/BDCWhitePaperR2.pdf

[56] Kibert, Charles. Sustainable Construction: Green Building Design and Delivery. 1st ed. Wiley. 2006.

Figure 1: LEED Commercial Certified Space
Source: USGBC Website[58]

Barriers to Green Building Growth

Many studies have identified market barriers to green building, including those driven by both perceptions and behaviors. [59,60,61,62] Consistent with previous studies, this report will analyze:

- **Over-focus on initial costs:** : Many decision makers focus too much on the initial capital cost rather than longer-term costs of operation and maintenance, leading to poor economic decisions. The expected time of ownership or occupancy strongly impacts this barrier: developers and owners with shorter time horizons can be expected to put even more emphasis on initial costs. Incentives discussed in the following sections are designed to reduce this barrier.
- **Lack of education:** Training and knowledge limitations impact every participant in the building process, including builders, developers, planners, engineers and occupants. Green building rating systems like LEED, ENERGY STAR, Green Globes, and GreenPoints Rated seek to address the barrier by establishing an easy way for customers to evaluate a building's "greenness" and to compare against one another. Such ratings systems also help create a demand for more building professionals. Furthermore, these organizations provide technical assistance and training to help consumers, owners, designers, and developers make informed decisions about green building.

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[58] http://usgbc.org//
[59] Hoffman, Andrew, and Henn, Rebecca. "Overcoming the Social and Psychological Barriers to Green Building", Organization and Environment. Volume 21:4, Dec 2008. http://webuser.bus.umich.edu/ajhoff/pub_academic/2008%20O&E%20Green%20Building.pdf
[60] Choi, Christopher. "Removing Market Barriers to Green Development: Principles and Action Projects to Promote Widespread Adoption of green Development Practices", Journal of Sustainable Real Estate. Volume 1:1, pp. 107–38; 2009.
[61] "Analysis of Cost and Non Cost Barriers And Policy Solutions For Commercial Buildings", Zero Energy Commercial Buildings Consortium. Feb 2011. http://zeroenergycbc.org/wp-content/uploads/2011/07/CBC-Market-Policy-Report-2011.pdf
[62] "Next Generation Technologies Barriers and Industry Recommendations for Commercial Buildings", Zero Energy Commercial Buildings Consortium. Feb 2011. http://zeroenergycbc.org/wp-content/uploads/2011/07/CBC-Market-Policy-Report-2011.pdf

- **Split incentives – builders and future owners:** Builders and developers often do not occupy the buildings they construct and therefore have little incentive to reduce long-term energy costs through more efficient design. Improving building energy codes and adopting mandatory green building codes alleviate this barrier by requiring practices that will be beneficial to the building occupant or owner rather than only the builder or developer.
- **Split incentives – owners and tenants**: Split incentives exist between owners and tenants of buildings in that neither party may reap the financial returns gained from investing in building efficiency. Clear communication and leasing structures that account for improvements can alleviate this barrier.
- **Low demand:** Perceived or real, low market demand does not motivate designers, builders, or developers to evolve their standard practice. Incentives discussed in the following sections are designed to reduce this barrier. Green building rating systems, by providing a trusted certification of a green project based upon a specific set of environmental performance metrics, establishes an easy way for customers to comparing buildings, increasing the market value and demand for green projects.
- **Code or process barriers**: In some cases, the green building strategy or product can be explicitly forbidden by code or other regulations, or even by generally accepted practice. Improving building energy codes to accept new innovative design approaches as well as adopting mandatory green building codes alleviate this barrier.

The Structure of the LEED Green Building Rating System

Generally, a "green building" in the US is taken to mean a building that is third party-verified as energy and water efficient; oriented intelligently with minimal impact on the land; utilizes smart material choices in design; and provides a healthy indoor environment for occupants. The predominant implementation of this definition of green building is realized in a building that has been certified to a green building rating system. The most prevalent rating system in the US is the LEED green building rating system, although there are other credible rating systems operating at a much smaller scale.

LEED

LEED certification involves the validation by the Green Building Certification Institute (GBCI) to the owner and general public of the successful attainment of the outcomes required to earn "credits" in various categories. The building is assessed for meeting pre-requisites and attaining credits in five categories: Energy and Atmosphere, Water Efficiency, Materials and Resources, Sustainable Sites, and Indoor Environmental Quality. The credits achieved and verified are tallied to determine the certification level of certified, silver, gold, or platinum. LEED is the market leader in green building certifications worldwide, with over 40,000 projects in the system and more than 8 billion square feet certified across 120 countries as of February 2012. As of April 2012, almost 10,000 projects have received ratings for new construction and major renovation in the US, and nearly 1,600 projects that have achieved the Existing Building: Operation and Maintenance (EBOM) certification.

LEED is actually a suite of rating systems derived from the same core concepts but executed differently for different applications. The LEED rating systems are presented here. The simplest way to explain the nuances of the LEED rating systems is by grouping the commercial rating systems for new construction and major renovations (BD&C, CS, CI, Retail, Healthcare) which are very similar, and then discussing EBOM, Homes, and Neighborhood Development separately.

LEED AND VOLUNTARY INFORMATIVE GREEN BUILDING RATINGS

LEED for building design and construction (BD&C)

LEED BD&C is the most well-known of the rating systems, covering new construction and major renovations. Design teams identify the credits to be pursued in order to attain the desired level of certification. Design teams and contractors upload the appropriate compliance documentation utilizing LEED Online. GBCI then reviews the documentation and requests more information when needed before providing notice to the design team of successful attainment or rejection of the credit. Once the project review is completed and appeals have been processed, a certification level is issued.

LEED for commercial interiors (CI)

LEED CI functions identically to the BD&C rating system, but is for use in commercial interior spaces, where tenants are building out a space for use. The rating system is modified to reflect the project team's scope of work, which does not include the building shell.

LEED for core and shell (CS)

LEED CS functions identically to the BD&C rating system, but is for use in buildings designed as shells with interior space to be finished upon lease by tenants. The rating system is modified to reflect the project team's scope of work, which does not include the interior spaces.

LEED for healthcare

LEED for Healthcare functions identically to the BD&C rating system, but is for use in healthcare facilities. The credit language and requirements are tailored to the healthcare industry building types, and can be applied to inpatient, outpatient and licensed long-term care facilities, medical offices, assisted living facilities and medical education and research centers.

LEED for retail

Like Healthcare, LEED for Retail is a rating system with credit language and requirements tailored to the retail sector. LEED for Retail versions are available to cover new construction of both entire buildings (like BD&C) and Commercial Interiors. The rating system is used by banks, restaurants, big box stores, etc.

LEED for schools

Like Healthcare and Retail, LEED for Schools is a rating system with credit language and requirements tailored to school construction. The LEED for Schools Rating System recognizes the unique nature of the design and construction of K-12 schools. Based on the LEED for New Construction rating system[63], it addresses issues such as classroom acoustics, master planning, mold prevention and environmental site assessment. By addressing the uniqueness of school spaces and children's health issues, LEED for Schools provides a unique, comprehensive tool for schools that wish to build green, with measurable results.

LEED for existing buildings: operations and maintenance (EBOM)

LEED EBOM applies to all existing buildings and focuses on the operations and maintenance of those facilities. Credit language and requirements are developed specifically for existing buildings. Priority areas include whole-building cleaning and maintenance issues (including chemical use), recycling programs, exterior maintenance programs, and systems upgrades. It can be applied both to existing buildings seeking LEED certification for the first time and to projects previously certified under LEED for New Construction, Schools, or Core & Shell. The energy efficiency components of this rating system

[63] http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220

rely upon the ENERGY STAR Portfolio Manager Benchmarking tool. LEED EBOM is the fastest growing rating system and in 2011 became the largest single rating system by square footage.

LEED for neighborhood development (ND)

LEED ND is for use in neighborhood planning and integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design. LEED for Neighborhood Development is a collaboration among USGBC, Congress for the New Urbanism, and the Natural Resources Defense Council. LEED-ND certification provides independent, third-party verification that a development's location and design meet accepted high levels of environmentally responsible, sustainable development.

LEED for homes

LEED for Homes functions differently than the rest of the LEED rating systems, and is tailored specifically to mirror the residential building process in the US. LEED for Homes is a voluntary rating system that promotes the design and construction of high-performance green homes, including affordable housing, mass-production homes, custom designs, stand-alone single-family homes, duplexes and townhouses, suburban and urban apartments and condominiums and lofts in historic buildings. The process uses a separate infrastructure of credentialed "Green Raters" to help the builder, owner, or other parties navigate the rating system and verify compliance. The Green Rater helps develop a preliminary rating of the home, conducts inspections of the project during the construction stage, and verifies compliance through inspection and performance tests.

Each of these rating systems mirrors the building process it was designed to influence and is tailored to the specific application.

Users and implementers of green building rating systems

In the US, owners primarily drive demand for certified buildings. LEED and other green building rating systems award a plaque as an honorary distinction at a certification level of certified, silver, gold or platinum. This plaque is presented to the building and displayed at the discretion of the owner. Certifications of design and performance are awarded plaques separately. LEED certification is valid for five years.

Green building rating systems for new construction are implemented by the project design teams. These teams are typically led by the Architect, Engineers, and other design professionals. The general contractor oversees all sub-contractors in the pursuit of construction process credits. Many design teams employ a professional experienced in producing green buildings in order to streamline compliance with the green building rating system of choice.

Why pursue green building certification

There are many reasons owners choose to pursue green building certification. The US EPA identifies the following environmental, economic, and social benefits:[64]

- **Environmental benefits**
  - Enhance and protect biodiversity and ecosystems
  - Improve air and water quality
  - Reduce waste streams
  - Conserve and restore natural resources
- **Economic benefits**

[64] http://www.epa.gov/greenbuilding/pubs/whybuild.htm

- Reduce operating costs
- Create, expand, and shape markets for green product and services
- Improve occupant productivity
- Optimize life-cycle economic performance

- **Social benefits**
  - Enhance occupant comfort and health
  - Heighten aesthetic qualities
  - Minimize strain on local infrastructure
  - Improve overall quality of life

In the commercial real estate sector, where decisions are primarily economically driven, additional reasons have been documented. These include:

- Investor requirements – As institutional investors consider commercial real estate as an attractive investment and also are committed to sustainability goals, there is increased discussion and attention paid to the certification level of a building, or groups of buildings that become part of an investment portfolio.
- Tenant demand
- Decreased lease time
- Increased rent
- Avoiding the "brown discount"
- Future-proofing the asset
- Marketing benefits
- Improved employee productivity – Multiple studies documented the existing of increased employee productivity in green buildings, but have had difficulty in consistently defining the economic benefit.[65][66]

In addition, policy either mandatory or voluntary can motivate an owner to pursue a green building certification.

Policy Utilization of Green Building Rating Systems

There are a variety of policy options that state and local governments in the US and some federal agencies have implemented to encourage buildings to achieve a green building certification. In many cases governments take a leading role by certifying both their new and existing buildings to a program like LEED, and modifying procurement and planning processes to incorporate the core components of LEED. In other cases, governments create incentives for the private sector to pursue certification, sometimes in the form of financial incentives (grants or tax incentives) or process incentives (expedited permitting or density bonuses).

Financial and market incentives:

Grants[67]

[65] Costar 2009. http://www.costar.com/josre/JournalPdfs/04-Green-Buildings-Productivity.pdf
[66] Kats, 2003. http://www.bouldercolorado.gov/files/commercial_green_building_costs_and_benefits_-_kats_2003.pdf
[67] For more examples of grants see http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2078#grants.

Grants involve cash payments to building owners for the successful attainment of green building certification. This may also be tied to a minimum certification level, most often the LEED Silver level.

Examples of cash incentives include:

- **Commonwealth of Pennsylvania**: The legislature passed an act amending school construction reimbursement rates for Pennsylvania Public Schools, specifically providing hundreds of dollars of funding per pupil for public schools within the Commonwealth with proof of LEED Silver certification or higher, or two Green Globes or higher.[68] In addition, four state funds including the $20 million Sustainable Energy Fund provide grants, loans and "near-equity" investments in energy efficiency and renewable energy projects in Pennsylvania.

- **El Paso, TX**: Grants are awarded at increasing intervals determined on level of LEED certification. Maximum grant allowance is $200,000 for LEED Platinum for new construction and $400,000 for LEED Platinum for "multistory existing buildings" that are mixed use and that have been 50% vacant for 5 years, and as further defined by the City.[69]

- **King County, WA**: King County Council established a Green Building Grants Program that offers from $15,000 to $25,000 in grant funding to building owners who meet a minimum of LEED Silver for new construction or major renovation in the county, but outside the City of Seattle.[70]

- **Los Angeles, CA**: The Los Angeles Department of Water and Power Board of Commissioners, who are appointed by the Mayor, adopted a policy that established cash incentives for commercial developments. Builders and developers can take advantage of the LADWP Green Building Incentive that offers up to $250,000 in financial incentives to assist a building in becoming more green and meeting LEED standards.[71]

Tax incentives [72]

Tax incentives involve credits on taxes owed, deduction from taxable amount, or changes to depreciable period for assets determining the taxes owed by the owner of a property. Credits, deduction, or other special tax treatments can be awarded to the owner of a project that attains certification of a minimum level.

Examples of tax incentives include:

- **State of New York**: The New York State Green Building Tax Credit Program provides an income tax incentive to commercial developments incorporating specific green strategies informed by LEED.[73]

- **State of Oregon**: A LEED Business Energy Tax Credit (BETC) is being administered by the state Office of Energy. LEED for New Construction, Core and Shell, or Commercial Interiors projects achieving a minimum Silver certification will be eligible.[74]

- **Baltimore County, MD**: The County Council has passed a bill incentivizing both residential and commercial building in the county via tax credits. New residential construction that earns a

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[68] http://www.pde.state.pa.us/constr_facil/cwp/view.asp?a=11&Q=47064
[69] http://www.ci.el-paso.tx.us/muni_clerk/agenda/09-11-07/09110714A.pdf
[70] http://www.cityofseattle.net/dpd/stellent/groups/pan/@pan/@sustainablebldg/documents/web_informational/dpdp_018427.pdf
[71] http://www.ladwp.com/ladwp/cms/ladwp008821.jsp
[72] For more examples of tax incentives, see http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2078#taxcr
[73] http://www.dec.ny.gov/energy/1540.html
[74] http://oregon.gov/ENERGY/CONS/BUS/BETC.shtml

minimum of LEED Silver certification is eligible. Projects earning LEED Silver will earn a 40% property tax credit, 60% for LEED Gold, and 100% for LEED Platinum. The tax credits will be in effect for 3 years or up to $1 million in total incentives.[75] For commercial buildings, tax credits are granted for projects achieving LEED for New Construction, LEED Core and Shell, and LEED for Existing Buildings. LEED for New Construction will earn a 50% property tax credit for Silver, 60% for Gold, and 80% for Platinum. LEED Core and Shell Silver will receive 40%, Gold 50%, and Platinum 70%. LEED for Existing Buildings Silver will earn a tax credit for 10%, 25% for Gold, and 50% for Platinum. The duration of the LEED NC and LEED CS tax credits are for five consecutive years; whereas the duration of the LEED EB tax credit is for three years.[76]

Expedited permitting [77]

Buildings pursuing LEED certification can be given expedited or other favorable treatment in the permitting process of the governing body. Defaults on that commitment may trigger penalties. Expedited permitting can be awarded for successful certification of new buildings (BD&C, CS, Homes, Healthcare), and new developments (ND).

Examples of expedited permitting policies include:

- **State of Hawaii**: The state legislature amended its provisions to Hawaiian counties with HRS 46 19.6, requiring priority processing for all construction or development permits for projects that achieve LEED Silver or equivalent.[78]

- **Costa Mesa, CA**: The city improved an incentive program that includes expedited permitting processes for green buildings, which includes LEED certified buildings.[79]

- **Dallas, TX**: The City of adopted a green building ordinance requiring energy and water efficiency improvements for new residential and commercial buildings. Starting in October of 2009 and prior to 2011, new residential construction must submit a residential green building checklist (LEED for Homes, GreenPoint Rated, Green Communities, GreenBuilt North Texas or equivalents) and new commercial construction greater than 50,000 sq. feet must attempt a number of priority LEED credits. Expedited permitting is available for all covered projects.[80]

- **Gainesville, FL**: The County is providing a fast-track building permit incentive and a 50% reduction in the cost of building permit fees for private contractors who use LEED.[81]

Density bonuses [82]

Many localities limit the density allowable in developments to control the use and impact of a facility. Jurisdictions may allow additional units above and beyond the traditional allowable amount for those projects that commit to attaining certification. Penalties for default may be outlined.

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[75] http://www.baltimorecountymd.gov/countycouncil/legislation/08bills.html
[76] http://www.baltimorecountymd.gov/countycouncil/legislation/07bills.html
[77] For more examples of expedited permitting policies, see http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2078#exp
[78] http://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0046/HRS_0046-0019_0006.htm
[79] http://www.ci.costa-mesa.ca.us/council/agenda/2007-09-04/090407BuildGreen.pdf
[80] https://www.usgbc.org/ShowFile.aspx?DocumentID=4046
[81] http://www.usgbc.org/ShowFile.aspx?DocumentID=1979
[82] For more examples of density bonuses, see www.usgbc.org/DisplayPage.aspx?CMSPageID=2078#density

Density Bonuses can be awarded for successful certification of new buildings (BD&C, CS, Homes), and new developments (ND).

Examples of policies providing density bonuses include:

- **Cranford, NJ**: The ordinance established a Green Building Density Incentive program whereby redevelopers who achieve LEED certification and comply with the specific program requirements may earn a development density bonus from the Township.[83]

- **Nashville, TN**: The Nashville Planning Commission approved a density bonus for applying LEED to construction projects in certain neighborhood districts. Various bonuses are awarded based on the district where the development is taking place and the level of LEED certification achieved. The details are found on pages 11 and 12 of the staff report.[84]

- **Pittsburgh, PA**: Approved an amendment to The Pittsburgh Code entitled "Sustainable Development Bonuses", granting a density bonus of an additional 20% Floor Area Ratio and an additional variance of 20% of the permitted height for all projects that earn LEED for New Construction or LEED for Core and Shell certification. The bonus is available in all nonresidential zoning districts.[85]

Mandates for Government Buildings (e.g., all new government buildings shall be LEED Silver)

In the United States, 25 states, 120+ localities, and 14 federal agencies have policies in place to certify their buildings are LEED standard or above. Notable examples include:

- **Department of Navy**: LEED Gold for new construction projects;

- **Kansas City, MO**: LEED Gold for new construction projects;

- **Puerto Rico** – LEED for new construction or substantially funded buildings, including schools and LEED for Existing Buildings for state-owned buildings. Both policies require LEED Silver for 30,000 sq. ft. or greater projects and LEED Certified for 10,000 – 30,000 sq. ft.

These policies are predominantly new construction focused, but many states and localities are considering certifying existing buildings. A long-term approach is best when seeking to impact an entire portfolio of buildings, ideally through a rolling regular assessment of all facilities, where baseline improvements are made and those that are highest performing pursuing certification. A commitment to certifying and increasing percentage of the portfolio by specified dates would be an ideal execution of a government green building policy in existing buildings.

Mandates for Private Sector Buildings

In rare cases local governments have mandated that all private sector construction in that jurisdiction certify to LEED. The areas include:

- **Tiburon, CA:** On October 1, 2008, the Town of Tiburon passed Ordinance 512 establishing green building requirements for residential and commercial developments. New non-residential projects from 3,000 to 19,999 sq. ft. must employ a LEED AP and submit a LEED checklist. New construction commercial projects of this size are required to achieve LEED Silver certification. Projects 20,000 sq. ft. and greater must employ a LEED AP, submit a LEED checklist and achieve at least LEED Gold certification. Town sponsored projects shall achieve LEED Gold certification at

[83] http://www.usgbc.org/Docs/News/News1952.pdf
[84] http://www.nashville.gov/mpc/pdfs/meetings/2007/022207s.pdf
[85] http://legistar.city.pittsburgh.pa.us/detailreport/Reports/Temp/48200916593.pdf

a minimum. Non-residential construction projects achieving LEED Platinum certification will receive expedited building permit plan checks as well as official recognition from the Town.

- **Normal, IL:** The Town of Normal passed Ordinance 4825 (Section 15.17-14) on March 18, 2002 requiring LEED certification in the Central Business District for public or private new construction over 7,500 sq. ft. at ground level.[86]

- **Huntington, NY:** In 2008, the Town of Huntington adopted Green Building Commercial Standards (Chapter 197 of the Town Code) requiring commercial new construction projects 4,000 sq. ft. or greater to achieve a minimum of LEED Certified status.[87] All building permit applicants must submit a Green Building Project Checklist and pay a fee of $1.00 for every square foot of the project, not to exceed $200,000 to the Huntington Green Building Trust and Agency Account. All projects achieving LEED Certified status shall have the fee refunded except for an administrative fee of $0.01 per square foot. Historic structures, existing projects, town sponsored projects and examples of hardship or infeasibility are exempted from the green building requirements. Under Chapter 198 of the Town Code, main buildings in Light Industry Districts must achieve LEED Silver certification.[88]

These mandates have not yet been disruptive to the market, as owners in the area already demanded LEED certification as a matter of course although implementation is still difficult. LEED (and any other above-minimum-code rating system) was not designed to function as a mandatory minimum code, and as a result USGBC has partnered with the leading national code development organizations to release the national model "green" building codes that present green building in code language sufficient for use as mandatory minimum requirements. These products will be outlined in the following section.

Green Building Codes

California green building code

In 2010, the State of California, a leader in promoting energy efficiency and green building, adopted a statewide green building code, referred to as the CALGREEN code.[89] This code defines mandatory minimum green building requirements for energy and environmental performance for all new buildings constructed in California from January1, 2010. There is a separate code for both residential and non-residential construction. Similar to the LEED and the Built it Green rating system, the building code not only defines minimum requirements but also provides a framework for heightened levels of achievement or "tiers". At their discretion, cities may adopt the more stringent tier 1 or tier 2 criteria, or other higher levels of achievement such as LEED.[90] The adoption of California state wide building code represents a transition from green building as a limited number of projects providing market leadership, to a system where green building principles become codified law for all new construction.

IGCC

The International Green Construction Code (IGCC) is a wide-scoping code document that provides minimum code guidance for designers, builders and code officials to design, build and oversee the

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[86] http://www.normal.org/code/ord4825.asp
[87] http://www.ecode360.com/?custId=HU0566&guid=12185304&j=23
[88] http://www.ecode360.com/?custId=HU0566&guid=7230622&j=23
[89] 2008 California Green Building Standards Code California Code of Regulations Title 24, Part 11 California Building
Standards Commission ISBN: 978-1-58001-769-5
[90] "State and Local Government Green Building Ordinances in California", State of California Department of Justice. Accessed at: http://ag.ca.gov/globalwarming/pdf/green_building.pdf

construction of greener commercial buildings (similar to Standard 189). The code is written and maintained by code officials, for code officials. The code is written in mandatory language and intended to serve as an overlay to base building codes, and not as a stand-alone document (i.e. you still need a building code, a plumbing code, a fire code, an electrical code, etc.) The IGCC is applicable to the construction of commercial buildings, structures and systems, including alterations and additions.

ASHRAE 189.1

ASHRAE Standard 189.1 (Standard 189) is a standard that was developed with the intent of codifying the voluntary, aspirational LEED credits into a format that could be adopted and referenced as alongside a minimum building code. Similar to the IGCC, Standard 189 provides guidance for designers, engineers, builders and code officials to design, build and oversee the construction of greener commercial buildings. The code was written and is maintained by an esteemed community of building industry experts. The Standard is applicable to the construction of commercial buildings, structures and systems, including alterations and additions.

Policy Issues and Gaps: Green Codes and Green Building Rating Systems

Market Confusion

It is difficult for governments to navigate the ever changing and ever expanding world of building regulation. The process of adopting and implementing new building energy codes is now expanding to more comprehensive "green" codes, which greatly increase the requirements on a local code office and expand the core competencies of code officials. Leading building owners who wish to pursue ratings in above existing building codes with systems like LEED may still be required to meet mandatory minimum green codes, so there is the potential for duplicative requirements to be placed on both code officials and the building construction industries. The regulatory structure for buildings has changed so drastically over the last 10 years that it is the source of much anxiety among regulators and those they regulate.

Fundamentally, these tools were created to perform different functions in the marketplace; codes are adopted as mandatory minimums for all buildings and rating systems encourage performance and assessment above and beyond those minimums. Unfortunately, the applications are often confused in the US, leading to sub-optimization and confusing requirements. Communication difficulties, differing technical development processes and compliance procedures amongst not only the code development and implementation organizations but also rating system developers like USGBC compound this problem. All involved parties are actively addressing these barriers.

The politically charged process of code adoption in most states and localities is responsible for most of this confusion. Sometimes advocates of green codes intend to reference their employer's product wherever possible in legislation and regulation regardless of appropriate context, in order to increase sales of technical material. In other cases, advocates who wish to lower the requirements for compliance with incentive programs that reward green building will advocate for establishing equivalency between the beyond-code instrument and minimum code compliance. This action conflates the value of green building rating systems with minimum code compliance, so the very meaningful value of an asset like the dependable third party validation provided by LEED and other rating system is lost. Examples include: the State of Rhode Island and the State of Florida, where green building codes and rating systems are listed as equivalent options for compliance with the green public buildings laws in the state.

When applied to the private sector, the confusion multiplies. Providing incentives for compliance with codes offers a surprising reward for an unsurprising result: extra expense to reward buildings that are minimally code compliant – and no better. It is difficult to be confident that these buildings are actually compliant with the law at all since code officials are stretched so thinly and largely focus on only a handful of building and fire safety regulations. There just isn't time or money for much more oversight. When incentives are tied to performance on a sliding scale inherent in rating systems like LEED, a variety of achievement levels are reached and the suite of buildings as a whole compare favorably with the group of minimally code complaint buildings. Human nature tells us that a heavy-handed approach can only go so far towards achieving a goal. For such a positive and forward-looking outcome, rating systems like LEED are instruments that are intentionally designed to inspire and engage better outcomes.

The down side in the marketplace to this confusion is also clear: if building owners are told they are getting a "green" building which they assume to mean full third party verification of what was done in their building design and construction process when in reality they are receiving a building designed to a code and passing minimum code inspections, then the value of certified buildings and the value of the services provided by the designers and contractors is negatively impacted. Similarly, it may be counterproductive for policy makers who wish to promote excellence in building energy efficiency, water efficiency, and the other aspects of green buildings to incentivize buildings built to a green code; they will likely be disappointed to see a host of minimally code compliant buildings, or worse, if the oversight is deficient, rather than the range of outcomes supported by flexible green building rating systems.

Similar drawbacks exist in mandating certification of a green building project, as the rating systems were not designed to be inherently achievable by every project. This type of non-mandatory language and structure makes a rating system a difficult tool to enforce uniformly like a mandatory, minimum code. Many projects will never meet the pre-requisites and will not be able to continue under a mandate.

Additionally, projects that fail to attain the promised certification level must document the reason for this failure, and the variety of actors responsible for certification makes this a tricky legal proposition that is difficult to enforce. For example, the general contractor could be legally responsible for a subcontractor using a small amount of unacceptable building materials such as paints or sealants that eliminate the project from attaining the IEQ credits targeted, through no fault of the general contractor. Similarly, the mechanical engineer may design an extremely energy efficient building but the owner does not comply with the minimum program requirements for energy consumption reporting, resulting in a loss of certification through no fault of the engineer.

The Ideal World – Green Codes and Green Building Rating Systems

Ideally, the jurisdictions across the United States would move to adopt "green" building codes that were comprehensive in their scope: covering energy, water, location, materials, and indoor health. These mandatory minimum codes would define the "floor" for the worst building that is legally permissible to build. This regulation should bring standard practice in the building industries to a new minimum level of responsible design in terms of impacts on human and environmental health. This is the situation in California where the California Green Building Standards Code is the minimum law of the land. There is potential for this new paradigm to be realized in many states across the US. This policy change must be followed by implementation support of the code offices and code officials as they work to provide education to code officials on their expanded core competencies and responsibilities. This will also require increasing the number of code officials to reflect additional time requirements.

The mandatory minimum code for new construction should be coupled with policies designed to encourage leadership above and beyond the code minimums in all buildings. These policies should be tied to a third party verified, green building rating system like LEED and should include incentives of the type that will generate the most demand in the industry and match the budget available, for new and existing buildings. Like many large companies in the U.S. and around the globe, governments should also lead by example and commit to certifying their all of their new construction and some increasing portion of their existing space in a leadership-focused green building certification program.

Big Opportunity: Streamlining Process and Coordinating Technical Development

The ideal policy scenario outlined above requires compliance with a mandatory minimum code and establishes infrastructure to fully encourage beyond code achievement through a rating system. This situation presents significant opportunities to leverage the strength of each of these tools. The two major opportunity areas are to streamline the process for compliance with both the code and the rating system and also to link the technical development of codes and rating systems in a way that facilitates a mutually beneficial evolution.

Streamlining compliance documentation will eliminate redundancy in material preparation in the building process, saving time and money. Both the code office and the national certifying body could accept documentation from the other in order to streamline required inspections, scope of inspections, and other verification requirements. A major benefit is the removal of both real and perceived barriers to the next levels of efficiency, innovation and green building excellence. Fewer barriers mean a greater opportunity for all to participate in building a more sustainable future.

Coordinating technical development also provides the opportunity to streamline code requirements and rating system pre-requisites. Metrics used to assess compliance and performance should be the same, and changes in code stringency should be reflected in the rating system. This would not only enable clear communication of the differences between a code compliant building and a certified building (or even buildings that go beyond code but decline to certify) but also aid in assessing buildings built to the out–of-date building codes after multiple cycles of code development. Using one measuring stick is a far more effective means for comparison.

As more code products are developed, their adoptions into law will follow in different localities and times. It will be crucial for rating systems to flexibly respond to this lag in adoption, the variations in codes from area to area, and the technical differences between the different requirements of the code products so that the rating system awards credit for outcomes that are required by code and exceed relevant prerequisites without redundant documentation requirements. This harmonization of requirement is true of other certifications, such as a potential net zero energy certification.

Rating systems should be coordinated closely to mandatory green building codes so that the process to meet the requirements of both is clear and streamlined. Rating systems should then be constantly evolving to challenge innovative project owners to continue to push the envelope and drive market transformation towards even greener buildings. Building codes then can be made increasingly challenging as a new normal is defined. In this way, green building will continue to transform the US building marketplace to provide healthier indoor environments, more livable communities, and reduced environmental impact through increased energy efficiency and renewable energy production.

Recommendations for CERC Task 8-3

China is at a Different Economic Development Stage than the U.S.

The United States is an economically developed country with building energy accounting for nearly half of the country's energy use. In contrast, the building sector in China currently only consumes approximately 25 percent of the country's energy resources. Today, the average energy consumption per unit building area in China is similar to that of the U.S. in the 1950s. For every type of buildings in the same climate zone, the average building energy use is much higher in the U.S. than in China. China is a developing nation whose economy is continuing to expand, resulting in improved living standards. In contrast, economic growth in the U.S. is fairly steady. Differences in social and economic development between the two countries results in variances in building sector growth patterns and energy needs.

In addition, there are huge discrepancies in lifestyles, building usage patterns, and building indoor environment requirements between China and the United States. These factors also greatly impact building energy use in the two countries.

The U.S. and China Differ in Their Financial Policies and Practices

Various financial incentives, including tax reduction, exemptions and credits, rebates/incentives, preferential loans, financing guarantees, grants, and so on, have played a significant role in the uptake of building energy efficiency, distributed renewables, and green buildings in the U.S. since the 1970s. These financial incentives have spurred the development of building energy efficiency technologies and measures, and have greatly facilitated the establishment of a market mechanism in these fields. Market forces have become the major driver behind the penetration of building energy efficiency efforts. For example, the RESNET labeling system has been well accepted by different energy markets, and has gained significant popularity due to its effectiveness in helping customers pursue energy efficient tax credits and mortgages.

Similar financial incentives have been offered in China in the past couple of years, and have played an important role in several aspects of the building energy field such as the rapid growth of the energy service company industry. However, these incentives are typically less versatile than those in the U.S., targeting certain types of activities, measures, and beneficiaries. If made consistent and extensive, the incentive mechanism in China could push the transformation of the building energy efficiency market as it did in the United States.

Structural Barriers Have Presented Different Challenges and Have Been Dealt with Differently

Utility companies in the United States have been mandated and/or motivated to adopt building energy efficiency practices since the 1970s. Utilities have played a tremendous role in promoting energy efficiency by implementing various demand side management programs which are often motivated by governmental legislation. For example, the Public Utility Regulatory Policies Act of 1978, as well as the Interconnection Standards for Small Generators of 2005, arguably removed utilities' resistance to distributed renewable energy sources, including those in buildings. Net metering became a requirement for utilities so that the extra power generated from renewables could be credited. These efforts removed structural barriers, such as the reluctance of utilities to pursue efficiency and renewables, while significantly boosting the uptake of these resources.

In China, utilities and the power sector are parallel to the building sector and are administrated by separate authorities. In addition, no ordinance has been issued to address the problem of selling excess power produced from renewables back to the grid. As a result, utilities have no incentive to pursue building energy efficiency technologies and policies, and are certainly an obstacle in promoting distributed renewable resources in buildings. China can learn from the U.S. and be more creative and aggressive in motivating utilities to pursue building energy efficiency and distributed renewables by removing existing structural and regulatory barriers.

Educational and Technical Support is Needed to Promote Building Energy Efficiency

Since the early 1990s, the DOE and EPA have provided extensive and innovative educational and technical support at the federal, state, municipal and local levels to change and guide people's behaviors to embrace energy efficiency and renewable technologies. These efforts have targeted and addressed behavioral and motivational barriers to the building energy efficiency and renewables uptake. State and local authorities have also seen the importance of educational and technical support and have carried out various actions to provide such support. This support should be continued along with financial incentives to promote further penetration of renewables.

In contrast, China does not have a central energy efficiency agency like the U.S. DOE that assumes these responsibilities. While MoHURD is performing a great deal of information outreach and propaganda related to building energy efficiency and distributed renewables, their limited human and technical resources impede them from executing this type of work as intensely and extensively as the DOE. Systematic, persistent and extensive educational and technical support practices have been a weakness in China's endeavors in pushing for energy efficiency and distributed renewables. More efforts in this regard from all related government agencies would address behavioral and motivational barriers that other policies cannot impact.

Building Energy Codes

The Energy Policy Act of 1992 mandated that DOE work closely with state and local governments and building code development agencies on developing and implementing building energy codes. One year later, DOE's building energy code department was established. ASHRAE Standard 90.1, developed by ASHRAE, and the International Energy Conservation Code (IECC), developed by the International Code Council, comprise the national building codes in the U.S.. These codes are revised every three years. The revision process is open to the public; comments and suggestions to the revisions are collected from the general public and addressed. There are also public hearings where consensus is sought from all parties involved in a building process, including designers, code enforcers, building owners, operators, occupants, equipment producers, and so on. Besides energy conservation performance and scientific considerations, code revisions also consider market feasibility and building costs. How well these factors are reflected and addressed in any code revision determines how extensively the updated codes will be adopted by each state.

To assist each state in adopting and implementing the codes, the DOE Building Energy Codes Program has developed free software and tools and carries out numerous outreach activities, including education, training, and technical support.

In China, building energy codes are updated at a much slower pace. When codes are revised, the revision process is not open to the public and revisions do not consider market feasibility or building costs. This leads to difficulties in code implementation and compliance. However, it is reported that the code implementation rate for the design and construction phase at the end of 2010 reached 99.5% and 95.4% respectively, a 42% and 71% boost from 2005 levels. The reasons behind such a significant increase are not easily explained, although one could surmise that it is a direct result of the mandatory, non-market nature of China's building code industry.

In this regard, the U.S. should learn from and understand the measures China has taken to implement building codes, and adopt whatever measures are deemed appropriate for the U.S. building sector. Meanwhile, to ensure a lasting effect on code enforcement and implementation, China should factor in market feasibility and building costs as well as interact with stakeholders in the form of public hearings in the code revision process. These measures will ensure that the updated codes are as reasonable as possible to all stakeholders in the building energy efficiency industry.

Long-Term Goals of Energy Efficiency

China has clear and focused long-term energy efficiency goals. Energy consumption per unit of GDP decreased by 20 percent in the 11th Five-Year Plan (2005 - 2010), and China expects to achieve another 16 percent reduction during the 12th Five-Year Plan (2010 - 2015). China's energy conservation targets serve as the nation's economic and social development guide. In order to achieve the 12th Five-Year Plan, China developed a comprehensive work plan that included controlling high emission industrial projects, conducting energy-saving evaluation and monitoring systems, eliminating smaller industries, supporting the construction of key energy conservation projects, subsidizing energy efficient products (such as air conditioning and lighting), establishing pilot cities, restructuring the price of electricity and oil, reforming financial subsidies to encourage energy-saving technologies, promoting resource tax reform, and developing the energy-saving services industry.

In contrast, the United States lacks clear emissions reduction targets. Also, because of the democratic political system, energy conservation policies tend to progress and regress based on changing political views and ruling parties. The Reagan and Bush administrations did not believe that the federal government needed to initiate large-scale energy efficiency programs or encourage renewable energy programs, and feared that these programs would increase government spending. On the other hand, President Obama strongly promotes the development of the green economy, and integrated green energy policies into the 2009 economic stimulus package. A total of over $700 billion was appropriated for the American Recovery and Reinvestment Act (ARRA), in which new energy was one of the main focus areas, including developing efficient batteries, smart grids, carbon capture and storage, renewable energy (wind and solar), and so on. However, the main purpose of the ARRA legislation was economic development as opposed to specific energy-saving goals.

China has made energy conservation an important development goal, with integrated planning, formulation of strategies, implementation, and examination of results post-implementation. The power of the Chinese government and the effects of its policies are evident. The United States should learn from China in the areas of formulating clear energy-saving targets, maintaining the continuity and stability of these targets, and accelerating energy conservation efforts. This would give a clear message to the market for faster and wider deployment of energy conservation technologies and practices while promoting economic development at the same time.

The Development of the Energy Service Company (ESCO) Industry

The U.S. has been a world leader in ESCO practices. The first group of ESCOs was formed in the 1970s after the oil crisis. The current ESCO market in the U.S. is mature and has many success stories, especially in the building sector. China began the ESCO business much later, but has experienced a boom in recent years, especially after the central government issued a series of policies in 2010 to encourage the ESCO industry. In 2011 alone, the number of registered ESCOs quadrupled in China. However, most ESCO projects have been carried out in industries, and few on building retrofits. The main barriers to ESCOs working effectively in the building sector include:

- Absence of standards for baseline-setting, lack of common guidelines, and lack of Measurement and Verification (M&V), resulting in uncertainty in energy savings;
- Difficulty in project financing, partly due to the uncertainty of M&V, partly due to an insufficient value of fixed assets in a single building; and
- Lack of ESCOs that can provide integrated solutions. Most Chinese ESCOs do product-based projects, e.g., specializing only in lighting, HVAC, or in one renewable solution.

The United States has strong expertise in M&V and in providing integrated solutions. We recommend that China learn from a suite of best practices and tools developed during the forty years of ESCO history in the U.S., which can help China overcome obstacles. It may be useful to encourage entry of the sophisticated U.S. ESCO industry into China, whose service providers are experienced, have qualified personnel and financial capabilities, and are capable of providing high standard integrated solutions.

Green Building Systems

The development of green buildings in China and the United States are different in many ways. Compared to other countries, the United States established a green building rating standard (LEED) very early. LEED is a fairly comprehensive evaluation system, including LEED NC (new construction), LEED CI (commercial interior design), LEED CS (architectural design and housing), LEED School, LEED EBOM (Existing Building), LEED ND (Community Development) and other systems.

In designing a green building, it is important to carefully consider all of the different stakeholders in the construction market, as well as their relevant roles and responsibilities. For example, in LEED NC, the system evaluates the energy consumption of a proposed building during the design stage rather than evaluating it after the building's completion. This is because during the design stage of new buildings, the design engineers are only responsible for construction, with a much lesser emphasis on the specific operational aspects that need to be addressed post-construction. That should be the property management's responsibility. Therefore, design engineers are more likely to fully accept LEED, since LEED NC does not demand action outside of the design engineers' control. Another example is LEED ND. Tailored specifically to neighborhood development, LEED ND's requirements make it possible to evaluate development at the community level that would otherwise be difficult to do. The fact that LEED is designed to take various construction conditions and market forces into account has led to its widespread recognition in not only the United States, but worldwide as well.

Green building development in China is a relatively new phenomenon. The building rating system is not yet ideal, and the only evaluation system developed to date is for new buildings, with less than 300 buildings rated. We believe that there are many aspects of the U.S. LEED experience that can be applied to China's green building industry, especially the in-depth understanding that LEED has of the construction market and the different criteria required for different construction projects.

Zero-Net Energy Buildings

Both China and the United States have different understandings and applications of zero-net energy buildings. The concept of zero-net energy generally refers to a building achieving flat energy consumption within a year of construction by returning more electricity (generated through solar PV) to the grid than it consumes. The first element of zero-net energy buildings is designing it to be as energy efficient as possible, then using solar PV to fully meet the energy requirements of the building.

In the U.S., the concept of zero-net energy is a reflection of the attention paid to energy conservation and distributed renewable energy, especially the development and application of solar PV and ground source heat pump technologies. In China, many experts reject the concept of zero-net energy buildings, reasoning that they are not suitable for development in China because 1) China's high-intensive construction often does not have enough space for distributed technologies such as solar PV and ground source heat pumps, and 2) China's residential units use individual air conditioners as opposed to central AC, thereby consuming much less energy and making zero-net energy inappropriate for residential buildings.

The state of California announced in 2009 that all of its new residential and commercial buildings will achieve zero-net energy consumption in 2020 and 2030, respectively. California's ambitious goals are not only meant to bring results, but are also meant to motivate and inspire the construction market. The announcement of these goals created a ripple effect. Public utility companies' (including electricity and gas companies) demand side management departments have been actively carrying out zero-net energy building projects. R&D departments have explored implementation of zero-net energy buildings and building energy efficiency. Renewable energy companies have accelerated the development and promotion of new technologies, while developers and construction engineers have quickly learned about energy-saving technologies and renewable technologies. This goal also greatly promotes construction standards and building energy consumption labeling and standards, as well as related financial assistance policies. Zero-net energy buildings also greatly promote social responsibility and encourage developers and practitioners to be more environmentally responsible.

Zero-net energy buildings generally look at individual buildings to achieve zero-net energy consumption. However, in order to encourage a wider range of technology applications, zero-net energy building principles can also be applied to include district heating and air conditioning in a number of small-scale renewable energy generation projects. This line of thinking is inspiring. Because of China's large population, the building density is high, and many single buildings have huge constraints in achieving zero-net energy. But China can learn from California's experiences by setting ambitious targets for zero-net energy buildings to encourage social responsibility and inspire the construction industry to take initiative. China should do research on the definition and implementation of zero-net energy and make appropriate adjustments, such as allowing buildings to buy points, using these points to offset energy usage, and pay for the development of renewable power generation. Such adjustments could lead to building practitioners embracing the concept of zero-net energy buildings in China.