Building Energy Codes Best Practices Report

For APEC Economies

APEC Energy Working Group

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BCAP Dedicated to the adoption, implementation, and advancement of building energy codes

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Introduction

Objectives

This paper was developed for the purpose of encouraging continued progress and innovation on building energy codes among APEC economies. As the energy intensity of buildings steadily increases, energy codes and standards are understood to be important to reducing energy consumption and pollutants by making new construction more energy efficient. The built environment not only accounts for the highest portion of overall energy consumption in most countries, but it also has been identified to contain some of the most cost effective improvement opportunities.[i] However, it is only by mandating standards which capture the energy savings potential in every building, through a code, that large scale energy efficiency can occur.

Much of the international discussion on energy codes in the past has been on the technical requirements; however, there is growing recognition that other important policies and programs are equally important. This paper seeks to fill that gap by identifying best practice areas and highlighting examples from among the APEC economies. While there is no one example to point to, there are certainly many economies making great progress on different best practices. The primary objective of this paper is to share information on the activity that is taking place, increase awareness of opportunities among APEC member economies, and encourage ideas and strategies to be shared and leveraged for the benefit of each member.

Background & Research Basis

This Best Practices Report was developed as a part of a larger project to update information on building energy codes in APEC economies, and was funded by APEC through the APEC Energy Working Group (EWG) and Expert Group on Energy Efficiency and Conservation (EGEE&C). The key objective of this project was to build on prior work that had been carried out to survey the current status of building energy codes in APEC economies, and compare the scope, level of stringency, and enforcement mechanisms of the current building codes, with particular focus on identifying effective programs and strategies that can be shared.

Prior studies include a 2003 report, "Energy Efficiency Programmes in Developing and Transitional Economies", published by the Asia Pacific Energy Research Centre and the Institute of Energy Economics, Japan. The report covers programs in the following 12 APEC economies: Chile; China; Hong Kong, China; Indonesia; Malaysia; Mexico; Peru; Philippines; Russia; Chinese Taipei; Thailand; Viet Nam. The report covers building energy codes, as well as numerous other building, industrial, and transportation sector programs, and provides an excellent overview of the types of broad efforts underway to curb energy consumption through efficiency measures.

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[i] "Curbing Global Energy Demand Growth: The Energy Productivity Opportunity," McKinsey Global Institute, 2007.

More recently, the Asia-Pacific Partnership (APP) conducted detailed studies of its partner countries. These reports, completed in 2009 by the Pacific Northwest National Laboratory, are detailed accounts of the energy code requirements, relevant policies, enforcement procedures, and market-based voluntary programs in Australia, Canada, China, India, Japan, Korea, and the United States. Because the APP partner countries account for half of the world's energy consumption, these reports sought to survey energy codes and develop recommendations for improvements to reduce energy use in buildings. While the separate economy reports were important to gathering the available energy code research on APEC economies, the final summative paper was not yet available to inform this best practices report.

In completing this project, the Building Codes Assistance Project (BCAP) conducted independent fact-checking research to confirm, expand, and update the information contained in existing reports, and also developed new economy-specific reports for Brunei Darussalam, New Zealand, Papua New Guinea, and Singapore (economies not covered in the prior APEC study or the APP economy reports). To support information-sharing among all the APEC economies, BCAP developed economy-specific sections on its resource website, the Online Code Environment and Advocacy Network (OCEAN; http://www.bcap-ocean.org/code-status). These sites each link to code documents and resources, detail the code adoption and change process in each economy, and provide information on the economy, energy data, climate concerns, and green building initiatives. The sites also highlight best practices currently in place and, based on opportunities to strengthen the code or related polices, recommends other APEC economies as models for those improvements.

Many of the views on best practices presented in this report come from BCAP's experience of over 16 years working on code adoption and implementation in the United States. Though a single economy, the mix of local policies, full reliance on state authority to put codes in place, responsibility of local authorities to conduct enforcement, along with a variety of climates capture the majority of what is being experienced elsewhere in the world. BCAP has also conducted energy code support work in India, held a recent international workshop on energy codes, and participated in the World Bank's meeting on energy code compliance. These and other interactions have reinforced the value of sharing best practices across the world by emphasizing the common goals and struggles that exist among countries.

The Role of Building Energy Codes

- In Building Construction

Energy codes are generally adopted as a subset of a broader group of codes which govern the design and construction of buildings and provide safeguards for the health and welfare of occupants. They are established to set a minimum baseline for acceptable practices, whether they relate to electrical systems, plumbing, structural elements, or mechanical equipment. Typically, codes reflect common practice, as well as materials and equipment which are readily available.

In their most complete form, building energy codes cover the design and construction of all energy-consuming elements and systems. This includes the building envelope – the wall and ceiling insulation, window and door specifications, roofs and foundations. Also included are heating, ventilation, and air-conditioning (HVAC) equipment efficiency, as well as water heating, lighting fixtures, and controls. Increasingly energy codes address natural ventilation, shading, and renewable energy components.

Building codes are important because they represent a unique chance to impact the life of a building. This is particularly important for energy efficiency. Once a new building is constructed, it is very expensive and often impossible to achieve the level of efficiency that can be built in economically at the time of construction. Adjusting building orientation and configuration in an existing building is not possible without a major reconstruction and improving wall insulation, as an example, can be a costly undertaking. It is vital to make energy efficiency a fundamental part of the building design and construction process. The objective of energy codes is to protect consumers, improve occupant comfort and business productivity, save energy and money and, for many, achieve large-scale carbon reductions through reduced demand for energy from buildings. This is very different from the role and evolution of other types of building codes such as plumbing, electrical, and fire – where the innovations in energy far outpace those in other areas and the goal reaches beyond safety and welfare.

- In Economy Policy

A review of policies across APEC economies reveals the importance of addressing climate change. The following are examples:

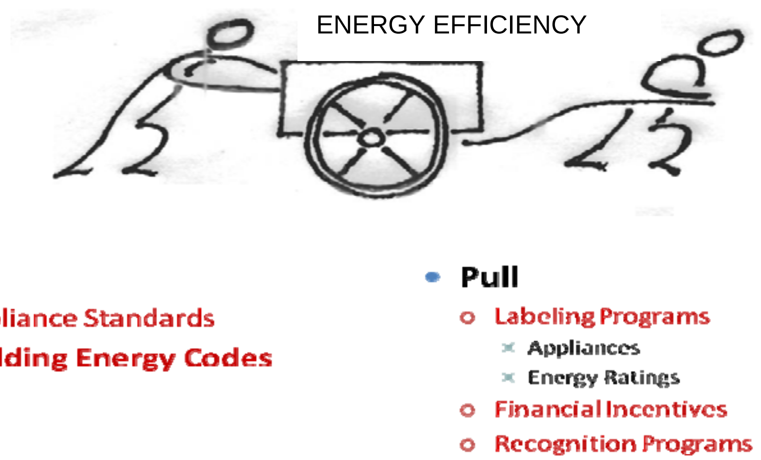
- National Biodiversity and Climate Change Action Plan 2004-2007 (Australia)
- National Climate Change Programme 2007 (China)
- National Energy Plan 2008-2030 (Korea)
- New Zealand Energy Strategy to 2050 (New Zealand)
- National Climate Strategy (Singapore)
- Action Plan on Climate Change (Viet Nam)

Since energy codes establish the minimum allowable level of energy efficiency in the building sector, they can be a powerful strategic policy to use in curbing emissions linked to climate change. Atmospheric emissions from the use of energy can lead to acid rain, ground-level ozone, smog, and global climate change. Because of these fundamental environmental issues, in addition to the increasing cost of energy, it is vitally important to consider the adoption and implementation of energy efficient building codes as sound public policy in any rebuild effort. Strengthening this link can also be beneficial to improving code adoption and compliance by adding domestic importance to the codes. For reasons discussed above, building codes are not typically linked to issues outside the immediate health and safety of building occupants. In addition, it is the voluntary programs and green buildings which are usually discussed by the media in moving society to become more energy efficient. However, fully implemented strong energy codes, while not often as exciting in their effect on a single building's design, can achieve major shifts in the efficiency of the entire building sector.

Due to the scale of change potentially caused by codes, other benefits can be demonstrated, as well. Countries that import resources such as oil, gas, and coal can increase energy security and reduce their risk to price volatility by decreasing overall demand. Reduced burning of fossil fuels in countries with their own resources improves public health, and can reduce the drain on distribution systems, increasing utility system reliability. And where energy costs are high, efficiency can improve the economy by lowering the operating expenses for home and building owners.

- In Partnership with High-Performance Building Programs

There is a lot of attention paid to programs that promote either high levels of energy efficiency or green technology in buildings. These are important activities and through them the ability of what can be achieved in buildings is expanded. These programs test and prove new approaches and technologies, and establish costs and benefits. However, it is only through mandates or laws that establish requirements for all buildings that significant changes can occur and large scale energy savings can be achieved. Countries can benefit by utilizing programs that pull the building sector forward and energy codes the push the market to keep up. In fact, the adoption of codes and standards can support the expansion of product availability, the development of improved design and construction practices and services, and increase uptake of high performance building practices. However, this relationship is not commonly developed and codes and voluntary programs typically operate without any relationship to share market-ready practices, cost-benefit data, or to achieve long-term energy efficiency goals.



Source: (modified from US Department of Energy)

Code Status Summary

Across the APEC economies, there are three with no known energy codes – Brunei Darussalam, Papua New Guinea, and Peru. However these countries do have opportunities to utilize existing activities to adopt and implement energy codes. The other economies have a mix of residential and commercial, system-only and whole-building regulations. These function in an even more complex environment of mandatory and voluntary compliance requirements, mixed levels of enforcement, and varied supporting policies. In our effort to assemble best practices, this paper addresses the practices and policies of APEC economies with a focus on those with leading and progressive activities. Keeping in mind that all elements need to be in place for a significant change to the building stock over time, evaluating each separately provides the best opportunity for improvement. *[See table on following page for summary]*

Defining Best Practices

There is no single energy code or set of requirements suitable for all economies; the main objective of energy code efforts is to set up a system within each economy that provides progressive standards for building practices, encourages market innovation, and supplies strong enforcement. Codes have their own unique hurdles. Unlike voluntary programs aimed at producing green or high-performance buildings, stakeholders are often not motivated or educated as to the energy and cost savings they can achieve through codes. Though codes appear quite simple and straight forward, the details of setting the right scope and stringency, capturing market-ready products and services, and providing training, among many other activities, requires a large-scale view and a great deal of coordination.

This paper highlights best practices from APEC economies that are transferable. All economies have the opportunity to benefit to some degree from policies and best practices, including the United States, Canada, and other countries that may be farther along on the technical development of codes but are falling short on effective implementation and market acceptance. There are three areas of activity observed among the APEC economies that relate to energy codes and their role in setting an effective baseline for energy consumption: 1) technical requirements, 2) enforcement policies and practices, and 3) code implementation and support. These each function as key supports to strong effective energy codes and play important and unique roles.

Breaking apart these three areas and highlighting activities and best practices provides an opportunity to evaluate potential improvement strategies for individual economies. It is clear that while there is a common need for improvement, there are also examples of effective solutions and a significant opportunity to learn from others.

Technical Requirements

Until recently, much of the focus on energy in buildings has not been on setting minimum technical requirements through codes but on highly visible, voluntary programs (see later section on *Code Implementation Support*). These programs demonstrate what is achievable, but large scale energy savings are achieved by improving mass construction. This means setting the minimum allowable level of efficiency for all buildings, through codes, and strengthening those requirements over time to reach specific energy and climate goals.

Setting technical specifications in code is not an easy task. The nature of a code, as opposed to a voluntary program, is such that it must be achievable by all. Not only must the right materials and products be available, but skilled services among architects, engineers, contractors, and other building professionals need to be accessible to owners. In conducting research for this paper, the issue of availability, and what it may mean in different countries was a particular point of interest. Some APEC economies have well developed transportation networks where products can be moved easily throughout different areas, as well as have markets that offer a large selection of building materials from domestic and international sources. Others economies have regions which rely on local products for reasons of cost and/or availability – limiting their choices and opportunities. Code requirements must also appropriately address climatic conditions and, because there are no financial incentives for codes, requirements should also be cost effective to implement.

The complicated nature of setting technical standards, which must fit all of these parameters to be effective, makes the task of comparing requirements between countries especially difficult. While a economy may have an opportunity to increase the stringency of their code, requirements borrowed from another economy may not be appropriate in a different market situation. For this reason, and because the technical stringency is only one component of achieving an energy efficient building sector, this paper offers an evaluation framework based on a set of related best practices and broader policies.[ii] To improve technical requirements and increase the stringency of codes, we recommend countries look to others with similar climate zones, and more recently set/updated codes for possible examples. We also suggest that efforts to strengthen codes are combined with an examination of the product and service market so that training and support activities can be undertaken, where appropriate.

The actions and characteristics listed and discussed below are recommended as best practices for improving the technical requirements of building energy codes:
Best Practices:

- ✓ Regular updates
- ✓ Whole-building scope
- ✓ Residential and commercial requirements
- ✓ Recognition of climatic variations

[ii] Detailed technical reviews of code requirements can be found in separate APEC economy reports; see www.bcap-ocean.org/code-status

Regular updates

As energy codes become updated, drifting away from common practice and even farther from innovative building solutions, they quickly lose their effectiveness. It is important that codes reflect cost-effective energy-saving practices and products and keep up with market developments. If not, builders and contractors who pursue least-cost construction options will continue to prevent a portion of the building market from improving. The table below lists the most recent date of development or updates for residential and commercial energy codes in place in APEC economies.

Date of most recent development or update	Residential	Commercial
2009	Australia, Chinese Taipei, United States*	Australia, United States*
2008	Korea, Singapore	Korea, Singapore
2007	Chile; Hong Kong, China; New Zealand	Hong Kong, China; New Zealand; Chinese Taipei; United States
2005		Viet Nam
2004		China (lighting), Mexico (lighting)
2003	Russia	Russia
2001		Mexico (envelope)
1999	Japan	Japan
1997	Canada	Canada*
1995	China*	Thailand
1992		Indonesia
1989	Malaysia	Malaysia

* These codes are currently undergoing updates. In the United States, a 2012 residential code is under development for release in 2011; a 2010 commercial code update is being finalized for release in late 2010. In Canada, an update to the commercial code was launched in 2008 for release in 2012. China was updating their residential code with an expected release date in 2008; status information was not found.

Although codes in China, Canada, and the United States are all undergoing updates, there are no available examples of mandatory revisions. Code and standard-setting organizations in the United States release revisions approximately every three years, providing state governments with new national model codes and the opportunity to adopt updated requirements. Some individual states have their own policies that call for mandatory updates, based on the release of new national model codes or on their own long-term goals for energy efficiency improvement in the building sector. However, without mandatory adoption for the economy, there is an irregular effect on overall construction from these code updates. Nevertheless, the result of constantly developing new standards, and the increased savings achieved within each revision, provides the United States with updated model requirements and is a good source of information and data for others seeking to revise their own codes.

Looking at the table above, several economies have an opportunity to look to others for more updated code requirements. For example, the recent requirements released in Singapore and Viet Nam may be able to inform updates to codes in other parts of Malaysia, Thailand, and Indonesia, which have similar climates.

Whole-Building Scope

Codes that cover the majority of energy-consuming building systems will, generally, achieve a higher level of overall efficiency that those that only address single systems. This is important, not only to capture the most energy savings opportunities as possible, but also for cost effectiveness. A code that sets strict efficiency requirements for HVAC systems in the absence of reducing energy leaked through the envelope will not be cost-effective, overall, to the owner. Australia; Canada; Hong Kong, China; Japan; Korea; New Zealand; Singapore; and the United States all set energy codes which cover most systems. Typically, codes cover the envelope, lighting, HVAC, service water heating, and electrical power.

Singapore's code is noteworthy in its extension beyond the scope of energy efficiency. The Code on Environmental Sustainability of Buildings (2008) is for residential and commercial construction, sets standards on energy efficiency, and develops checklists for both types of buildings. The code contains requirements for the building envelope, indoor air quality, lighting, ventilation, and HVAC, as well as water efficiency and other environmental quality measures. Bonus points are awarded for use of renewable resources.

Emulating the Green Mark building rating system in Singapore, this code sets out the minimum environmental sustainability standards for buildings for all new building projects that involve a "gross floor area of 2,000 m^2 or more", as well as additions or extensions to existing buildings which involve "increasing the gross floor area of 2,000 m^2."[iii] The code motivates building designers to be environmental stewards by incorporating eco-friendly materials, eco-conscious construction practices, water and energy efficiency, natural lighting, as well as building life-cycle concerns. To further establish these new environmental initiatives, amendments were made to the Building Control Act that set a minimum fifty point Green Mark score for both residential and non-residential new building work.[iv]

Residential and Commercial Requirements

Codes that do not address all major building systems lose opportunities to save energy, but so do codes that cover only part of the building sector. The following APEC economies all have building energy codes for construction in both their commercial and residential sectors: Australia; Canada; China; Hong Kong, China; Japan; Korea; Malaysia; New Zealand; the Philippines; Russia;, Singapore; Chinese Taipei; and the United States.

Like some of the other factors related to energy codes that are discussed in this paper, the economy-specific situation is significant when determining an area of focus. While Canada and the United States both have a greater amount of the market taken up by residential buildings than commercial, the energy

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[iii] Building and Construction Authority (BCA) 2008. Code for Environmental Sustainability of Buildings. http://www.bca.gov.sg/EnvSusLegislation/others/Env_Sus_Code.pdf

[iv] Building and Construction Authority, Building Control Environmental Sustainability Regulations. http://www.bca.gov.sg/BuildingControlAct/building_control_env_sus_regulations.htm

use of both sectors is relatively the same. However, from 1995 to 2005, China's residential energy consumption was 90 percent of its total building energy consumption.[v] Only Chile, among APEC economies, has a residential code as its only energy code. Also, code requirements typically have differences between low-rise commercial, multi-family housing, public and private, and the type of commercial use, so it is important to assess the construction market in order to target energy conservation efforts where they can have the greatest impact.

Responsive to Climate Conditions

We found that all of the APEC economies with energy codes in place, and different climates within their borders, appear to recognize the need for differences in efficiency requirements. Japan was the puzzling exception – adjusting for six climate zones for their residential energy code but none for the commercial code. While the climate zone delineation appears appropriate, it may be that commercial construction is more geographically concentrated.

China has developed energy codes for its different climate zones over the last 15 years: the Regional Residential Design Standards for severe cold/cold zones (1995), the version for hot summer/ cold winter (2001), and hot summer/ warm winter (2005). These codes cover the entire economy except for the temperate zone, a small southeast region of the economy. There are also a long list of other standards that relate to energy efficiency including the a design standard for public buildings (2005) and standards for lighting design in buildings (2004), residential renovation (2001 in heating zones), ground source heat pump systems (2005), solar water heating systems in civil buildings (2006), energy consumption surveys in civil buildings (2007), and energy efficiency inspections of buildings (2007).[vi]

The United States addresses 8 climate zones in the residential and commercial energy codes. Climatic differences are contained together within the prescriptive requirements, and updated together. While this process does not give one region priority over another, the efficiency of the code, overall, does not increase efficiency uniformly across the climate zones.

Enforcement Policies and Practices

To understand how well energy codes are implemented, the rate or frequency of compliance is useful data to analyze. However, compliance data is not easy to find and it is often based on self-reporting or on design reviews rather than site inspections during construction. As a proxy for compliance rates, we assume that compliance does not fully occur without adequate enforcement. In the United States, building professionals reported that strong enforcement was in fact a motivation for code compliance.[vii]

[v] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.
[vi] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.
[vii] "Commercial Building Energy Codes–Usability and Compliance Methods," Building Codes Assistance Project, 2008.

The following are best practices that have been identified as significant elements of enforcement that lead to compliance.[viii]

Best Practices:

- ✓ Mandatory compliance
- ✓ Thorough enforcement procedures
- ✓ Penalties for lack of compliance
- ✓ Tracked compliance rates

Mandatory Compliance

Strengthening policy to require energy code compliance is a clear opportunity for some APEC economies to increase energy savings in the building sector. A voluntary code is much like a voluntary program, without financial incentives, recognition, or any of the other typical elements found in these programs. The intent of codes to set a minimum baseline for new construction also implies that the level of efficiency is such that it is in the best interest of all citizens. Nevertheless, we have classified several APEC economies as having voluntary codes: Canada; Hong Kong, China; Indonesia; Malaysia; Philippines; and the United States (residential).

It is interesting to take a closer look at the United States in this category and what the government has done to work within strong local government constraints. The US law requires that states adopt the equivalent of the most recent commercial energy code, whereas the residential code must only be evaluated and can be deemed inappropriate by a state.[ix] However, the scope of state government in the economy is strong and several do not adopt codes, passing the responsibility on to their cities, while others establish codes as voluntary. At the same time, it's important to note that a few states exceed the national model codes and are highly innovative. The situation is changing quickly in the United States as national policy has been proposed to tighten the freedom of states by mandating adoption of codes for both sectors and imposing a timeframe. The government has also linked economic recovery funding to the states to their adoption, and demonstrated compliance, with energy codes.[x] States that previously sidestepped the issue of code adoption are now close to statewide adoption for the first time.[xi]

Thorough Enforcement Procedures

There is not a great deal of readily-available information that evaluates the effectiveness of enforcement procedures across the APEC economies. In general, code compliance is viewed as a serious problem. The World Bank held a two-day workshop in December 2009 on energy code compliance in

[viii] Presented by BCAP at the World Bank workshop, "Mainstreaming Building Energy Efficiency Codes in Developing Countries"
[ix] EPAct 1992, United States policy
[x] The American Recovery and Reinvestment Act, 2009.
[xi] The US states of Alabama, Wyoming, Montana, and Missouri all have efforts underway to adopt their first energy codes.

developing countries. But the word from developed countries was that they also needed to make significant improvements.

There are many strategies to enforcement, but also some essential elements. A review of the design plans to check for code compliance catches problems before construction and can facilitate low cost fixes. Additional site inspections during construction are essential to checking on the quality of installation and the accuracy of following through on design details important to efficiency and the code requirements. The detail needed during plan review and site inspections require that there are available and knowledgeable inspectors available for such work. Code inspectors, or building officials, need to be trained on energy code requirements and how to inspect for compliance.

In addition to inspectors who know how to inspect for efficiency, the building sector must also know how to demonstrate compliance. Clearly defined policies/tools for demonstrating code compliance are essential. In Canada, specifications for software to use in showing compliance are set forth within the code itself.[xii] China has a separate document, the *Code for Acceptance of Energy Efficient Building Construction*, which was released by the Ministry of Housing and Urban-Rural Development in 2007. The code includes construction quality and acceptance requirements for the building envelope, water heating, HVAC systems, lighting, monitoring and controls; it applies to new construction and existing building additions and retrofits.[xiii] In the United States, the Department of Energy releases new versions of residential and commercial compliance software to coincide with updates to the codes. These are used to demonstrate compliance with prescriptive standards and can be mandated for use by the states or used as on a voluntary basis.[xiv]

The Department of Mechanical Engineering of the National University of Singapore, in collaboration with the Building and Construction Authority (BCA), created a modeling tool called the Building Energy Standards (BEST).[xv] This modeling tool was designed for professionals in the building sector to demonstrate compliance with prescribed energy standards.[xvi]

BEST is capable of the following:

- "Calculation of the envelope thermal transfer value (ETTV) and the roof thermal transfer value (RTTV) for prescriptive standard compliance.
- Estimation of the annual energy consumption of buildings.

[xii] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.
[xiii] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.
[xiv] REScheck and COMcheck: available at http://www.energycodes.gov
[xv] Chou, S.K. 2001. Energy Efficiency in Building Design - Building Energy Standards, paper presented at the Seminar on Energy Efficiency in Building Design, organized by the Building and Construction Authority (BCA) of Singapore, April 2001, Singapore.
http://www.bdg.nus.edu.sg/BuildingEnergy/publication/papers/Paper2.html
[xvi] Chou, S.K. 2001. Energy Efficiency in Building Design - Building Energy Standards, paper presented at the Seminar on Energy Efficiency in Building Design, organized by the Building and Construction Authority (BCA) of Singapore, April 2001, Singapore.
http://www.bdg.nus.edu.sg/BuildingEnergy/publication/papers/Paper2.html

- Estimation of the peak design loads for air-conditioning equipment sizing and zone thermal comfort design.
- Calculation of the building's lighting power allowance and receptacle power density using user-defined design values.
- Prediction of effects of multi-parametric changes on the energy use of buildings.
- Selection of energy saving options to reduce annual energy consumption of buildings."[xvii]

Singapore also has available a description of compliance methods in the various *Codes of Practice*[xviii] handbooks. For recent amendments, the Commissioner of the BCA promptly releases *Acceptable Solutions*[xix]. This lists the objectives of each regulation and how it can be achieved using an acceptable solution, which enables the design community to be freely innovative.[xx]

Penalties for Lack of Compliance

Several APEC economies impose penalties for noncompliance with building energy codes. In Canada, where the responsibility of adoption and enforcement is given to provinces and territories, penalties for not complying with the energy code can include stopping construction, and withholding permits, and levying fines. [xxi] The Building Construction Authority in Singapore operates under the Ministry of National Development and is accountable for building regulation enforcement. Non-compliance with the Building Control Act and subsequent regulations results in a significant penalty– an individual is found to be guilty of an offense and can be fined (not more than $20,000 Singaporean) or imprisoned for up to six months.[xxii] Continuing failure to comply may result in additional fines (not exceeding S$500 for each day).[xxiii]

Tracked compliance rates

Unless code compliance is measured, it is difficult to make improvements, understand where gaps exist in education, and account for related energy savings. There are not many examples on methods for tracking compliance but a few approaches are highlighted below.

In China, as in many large countries, local governments have the responsibility for adopting national codes. City governments are in charge of enforcing the requirement for designs reviews and site inspections. Since 2005, these must be carried out by a certified independent organization. If this

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[xvii] Chou, S.K. 2001

[xviii] Codes of Practice are available on: Envelope Thermal Performance for Buildings, Energy Efficiency Standard for Building Services and Equipment, Mechanical Ventilation and Air-Conditioning in Buildings, Artificial Lighting in Buildings, Lighting of Work Places – Indoor, Structural Use of Concrete, for Foundations, Structural use of Timber, etc.

[xix] Released in May 2009, this Acceptable Solutions focuses on the Fifth Schedule of the Building Control Act of http://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf

[xx] Leng, Ong Chan 2002. Building Control – Singapore Experience, speaker at the Asian Forum Conference, Singapore 2002.
http://www.asian-forum.net/conference/ppt/17-2002PPTSingaporeOD0A.pdf

[xxi] "Country Report on Building Energy Codes in Canada," Pacific Northwest National Laboratory, 2009.

[xxii] Building and Construction Authority, Building Control Act 1989
http://www.bca.gov.sg/BuildingControlAct/building_control_act.html#946439071-000193

[xxiii] Building and Construction Authority, Building Control Act 1989

process is not complied with, construction will be prevented or suspended, if already started. If the building is complete and out of compliance, it will not be allowed to be sold or used.

City governments must provide reports to the provincial branches of the Ministry of Housing and Urban-Rural Development (MOHURD). MOHURD conducts annual compliance inspection surveys of building energy efficiency, sending survey teams out to the cities. In 2008, teams went to 55 large cities. They review a complete inventory of building projects submitted during the past year and randomly select 12. Of these, half of the projects receive reviews of their design drawings, and the other half receives site inspections. Any compliance violations are sent to the appropriate projects failing inspection, and construction administration departments are also scored high to low using this information.[xxiv]

Under Japan's Energy Conservation Law (2005), a mandatory report is required to be submitted on energy conservation to local authorities on all new construction, additions, alterations, major repairs, and remodeling for homes and buildings over 2,000 square meters. Penalties are incurred if the project is not compliant; however, the process does not involve site inspections. The submission rate is reported to be 100% by the Ministry of Land, Infrastructure, and Transport and compliance is reported to have gone up between 2000 and 2005.[xxv]

In Korea, building owners must submit an energy-saving worksheet signed by a licensed professional, such as architects and mechanical and electrical engineers, for approval. This office has the option to audit the buildings after construction and revoke the permit or order the building to be rebuilt if elements of the energy-saving worksheet have not been implemented.[xxvi]

Code Implementation Support

Along with technical requirements, or stringency, of the energy code and its enforcement policies, the third factor important to effective energy codes is implementation. This area captures programs and activities that provide education and training, policies that provide a framework for improving the energy efficiency of buildings, and programs that develop and test new practices to achieve efficiency. Among APEC economies, there are many impressive examples of comprehensive building programs aimed at improving energy efficiency. There was much less activity apparent in the area of training and certification requirements specific to energy codes. This appears to be a significant gap and area for improvement.

Best Practice:

- ✓ Code Training and Certification
- ✓ Voluntary high performance incentive programs

[xxiv] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.
[xxv] "Country Report on Building Energy Codes in Japan," Pacific Northwest National Laboratory, 2009.
[xxvi] "Country Report on Building Energy Codes in Korea," Pacific Northwest National Laboratory, 2009.

Code Training and Certification

There are no examples found to demonstrate required training or certification on the energy code for building officials or builders and design professionals. However, there does appear to be training available in many countries. In Japan, the Institute for Building Environment and Energy Conservation is very active in providing training seminars and resources to support the *Energy Conservation Law*. Seminars include training on building design, construction techniques, insulation requirements, and calculating energy efficiency.[xxvii] In the United States, there are examples of state-sponsored code training programs for code officials, builders, designers, and engineers. Their frequency and scope vary and depend on the specific state.

Voluntary High Performance Incentive Programs

Among the many voluntary programs offered in APEC economies, China and Korea each have elements to their programs that address different opportunities and strategies. In addition, New Zealand and Singapore offer impressive comprehensive programs. This section is organized to highlight the best practices observed within these voluntary programs.

Goals to reduce energy consumption. China's National Development and Reform Commission issued the *China Medium and Long Term Energy Conservation Plan* (2004) to set long-term goals for reducing energy use in new buildings. The 2010 goal for all cities is to reduce energy use in new construction by 50 percent, and by 65 percent by the end of 2020. The plan also sets 2010 goals for existing residential and public buildings: for large cities, 25 percent of existing residential and public buildings will be retrofitted to be greener, 15 percent in medium cities, and 10 percent in small cities. The plan additionally has a goal of powering over 80 million square feet of building space with renewable energy.[xxviii]

Incentives. Korea's *Relaxed Zoning Restrictions on Building Size* states that if a building is constructed to exceed required building standards, it can surpass allowable zoning restrictions allowed. This provides a significant incentive to improve energy efficiency. Korea also has its own voluntary rating system and high rating buildings are eligible for financial incentives. A further incentive is that the compliance with the rating system provides an exemption from the government's mandatory energy audits (conducted every 5 years of buildings with annual energy use over 2 thousand tons of oil equivalent (ktoe)). A sampling of buildings between 2003 and 2005 showed about half the buildings in compliance.

Comprehensive programs – New Zealand

ENERGYWISE

The government's Energy Efficiency and Conservation Authority runs ENERGY WISE, a public education program and clearinghouse for information on residential energy saving strategies. The program functions with the support of suppliers, installers, manufacturers, and retailers and offers information

[xxvii] "Country Report on Building Energy Codes in Japan," Pacific Northwest National Laboratory, 2009.
[xxviii] "Country Report on Building Energy Codes in China," Pacific Northwest National Laboratory, 2009.

on product rebates, driving tips, appliance rating and labeling, and funding opportunities for efficient equipment such as solar heat pumps.

Residential e & Green Star.
Interest-free loans are available for participants in Residential e – "a comprehensive, national, voluntary environmental rating scheme that evaluates the environmental attributes and performance of New Zealand's buildings using a suite of rating tool kits developed to be applicable to each building type and function."[xxix] The New Zealand Green Building Council (NZGBC) has also developed a rating scheme called Green Star in partnership with the building industry, which is a parallel program for commercial buildings. It uses a suite of rating tool kits which are applicable to different building types and functions.[xxx]

HERs
The Home Energy Rating (HERs) program focuses on cost-effective retrofits to improve efficiency and comfort. A home energy rating is an assessment of the energy efficiency performance of a home and examines how the building's design, materials, construction and orientation affect comfort and efficiency.[xxxi] A qualified assessor[xxxii] evaluates the home and then generates a report containing star ratings from zero to ten showing the home's energy performance.[xxxiii] The assessor offers homeowners professional recommendations on the most appropriate actions to improve the home's rating. HERs is a joint activity among the Energy Efficiency and Conservation Authority (EECA), the Ministry for the Environment, and the Department of Building and Housing.

Comprehensive programs – Singapore
BEEMP
Singapore's Building and Construction Authority (BCA) established the Building Energy Efficiency Master Plan (BEEMP) in 1998 to "address concerns over increasing energy consumption.[xxxiv] Specifically, BEEMP is made up of six programs which involve 1) reviewing energy efficiency standards, 2) updating energy efficiency standards, 3) conducting energy audits, 4) encouraging performance contracting, 5) creating

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[xxix] New Zealand Green Building Council. Green Star New Zealand http://www.nzgbc.org.nz/main/greenstar
[xxx] New Zealand Green Building Council. Green Star New Zealand
[xxxi] New Zealand Energy Efficiency and Conservation Authority. Energy Wise Website http://energywise.govt.nz/ratings-and-labels/home-energy-ratings
[xxxii] Assessors use a computer modeling tool called AccuRate NZ to generate accurate and comparative ratings across New Zealand. Originally developed by Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO), AccuRate NZ is a sophisticated tool that allows the assessor to model the energy efficiency performance of a home.
[xxxiii] New Zealand Energy Efficiency and Conservation Authority. Programmes Section. http://www.eeca.govt.nz/eeca-programmes-and-funding/programmes/homes/home-energy-ratings
[xxxiv] National University of Singapore. Centre for Total Building Performance. BEEMP Section. http://www.bdg.nus.edu.sg/BuildingEnergy/energy_masterplan/index.html

building performance benchmarks, and 6) greater collaboration with the National University of Singapore (NUS) and Nanyang Technical University (NTU)[xxxv] in favor of research and development.[xxxvi]

Energy Smart

Energy Smart is a building efficiency benchmarking and award system for commercial office buildings, hotel buildings, and factories. Buildings in these categories may submit an application for the Energy Smart Label award which promotes energy efficiency and resource conservation by annually recognizing the highest performing building in each category. To be eligible, buildings must be in the top twenty five percentile in terms of energy efficiency for their respective building stock. Air quality, thermal comfort, ventilation, and lighting levels are also evaluation considerations.[xxxvii] Champions are inducted into a distinctive group, currently at fifteen, of celebrated and renowned buildings.[xxxviii] The program was developed by the National Environment Agency (NEA) along with the Energy Sustainability Unit (ESU), a branch of NUS.

Best Practice Summary & Recommendations

APEC Economy	Best Practices	Opportunities
Australia	Recent mandatory codes throughout the economy; economy framework for energy efficiency	*Establish a regular code update process*
Brunei Darussalam	Well-developed construction and permitting process in place	*Adopt commercial and residential codes*
Canada	Current update activity; green program leading the market forward	*Adopt policies to strengthen provincial adoption*
Chile	Recent mandatory residential codes throughout the economy, economy climate action plan	*Expand scope of residential code; add commercial requirements*
China	Updated economy policy on energy codes, green building evaluation standard	*Expand scope of residential and commercial codes to capture whole-building opportunities*
Hong Kong, China	Voluntary green rating system, Greenhouse Gas Reporting and Removal Building Program	*Move away from voluntary standards to mandatory codes*
Indonesia	Policies - plan for energy conservation and separate law on energy	*Work with others to update requirements for climate zone; add residential requirements; mandate compliance*

[xxxv] In 1980, the National University of Singapore was established by a merger of two predecessor institutions: University of Singapore and Nanyang Technical University (NTU), however, they continue to be listed distinctively for easier reference to benefit those in the buildings sector.

[xxxvi] (as above)

[xxxvii] E^2 Singapore. About Energy Smart Building Labelling Programme. http://www.e2singapore.gov.sg/buildings/energysmart-building-label.html

[xxxviii] E^2 Singapore

Japan	Policies on energy, incentives for efficiency homes and businesses, green building rating system	*Update*
Korea	Recent mandatory codes throughout the economy, mandatory building design criteria (BDCES), economy energy policy, tax incentives for efficient homes and businesses, green building certification	*Establish a regular code update process*
Malaysia	Building energy benchmarking program	*Work with others to update requirements for climate zone; move away from voluntary standards to mandatory codes*
Mexico	Green mortgage program, green building rating system	*Expand scope of commercial code; add residential requirements*
New Zealand	Recent mandatory codes throughout the economy; economy energy efficiency and conservation strategy	*Establish a regular code update process*
Papua New Guinea	Existing department overseeing construction permits	*Adopt commercial and residential codes*
Peru	Law promoting energy efficiency	*Adopt commercial and residential codes*
Philippines	Economy energy efficiency and conservation plan, green recognition program	*Expand scope of codes to capture whole-building opportunities; move away from voluntary standards to mandatory codes*
Russia	Long-term economy energy strategy	*Update; expand scope of residential and commercial codes to capture whole-building opportunities*
Singapore	Recent mandatory codes throughout the economy, economy climate strategy, green building programs	*Establish a regular code update process*
Chinese Taipei	Recent mandatory residential codes throughout the economy long-term goals for energy efficiency; green building rating system	*Expand scope of codes to capture whole-building opportunities*
Thailand	Mandatory energy efficiency measures for businesses, broad energy conservation program	*Work with others to update requirements for climate zone; add residential requirements; expand scope of commercial code to capture whole-building opportunities*
United States	Updated model codes, many green and high-performance voluntary programs	*Adopt policies to require state adoption of codes*
Viet Nam	Economy energy conservation program	*Update commercial code; add residential requirements; expand*

		scope of commercial code to capture whole-building opportunities

Code Reference List

AUSTRALIA	Building Code of Australia (2009)
CANADA	Model National Energy Code for Buildings (1997) Model National Energy Code for Homes (1997)
CHINA	Design Standard for Energy Efficiency in Residential Buildings in HSCW (2001; undergoing 2008 update) Energy Conservation Design Standard for Residential Buildings in Heating Zones (1995, with 2008 updates) Design Standard for Energy Efficiency in Residential Buildings in HSWW (2003) Standard for Lighting Design in Buildings (2004)
CHILE	Chile Residential Building Code, Article 4.1.10 (2007)
HONG KONG, CHINA	Hong Kong Energy Registration Scheme for Buildings (2007)
INDONESIA	Indonesia Commercial Building Energy Code (1992)
JAPAN	Energy Conservation Law (2008) Criteria for Clients on the Rationalization of Energy Use for Buildings (1999) – CCREB (insulation, HVAC, lighting, water heating) Design and Construction Guidelines on the Rationalization of Energy Use for Houses (1999) – insulation, HVAC, water heating, guidance on O&M – DCGREUH
KOREA	Korea Building Design Criteria for Saving Energy (2008)
MALAYSIA	Malaysia Guidelines for Energy Efficiency in Buildings (1989)
MEXICO	Mexico Thermal Insulation Standard, NOM-018-ENER (1997)
NEW ZEALAND	New Zealand Department of Building and Housing’s Building Act (2004)
PHILIPPINES	Philippines National Building Code (2005)
RUSSIA	Russia Thermal Performance of Buildings (2003)
SINGAPORE	Code on Environmental Sustainability of Buildings (2008)
CHINESE TAIPEI	Non-Residential Energy Efficiency Standard (1995)

UNITED STATES	International Energy Conservation Code (2009); ANSI/ASHRAE/IESNA Standard 90.1-2007
VIET NAM	Viet Nam Energy Efficiency Commercial Code (2005)