Worldwide Status of Energy Standards for Buildings

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Background

Buildings consume a significant share of electricity in both developed and developing countries. In 1989, they accounted for 57 percent of OECD (Organization for Economic Cooperation and Development) electricity use--31 percent in the residential sector and 26 percent in the commercial sector (OECD 1991). In developing countries, buildings account for 38 percent of total electricity consumption, and electricity use in this sector grew more than 11 percent per year over the 1980s (Levine 1991). As less-developed countries raise their standards of living and services, building electricity use is expected to continue to increase, especially in the commercial sector.

Since the second half of the 1970s, governments in both developed and developing countries have initiated policies to reduce energy consumption in buildings. The most common form of regulation for this sector is a building energy code or standard. Currently, there are at least 30 countries with some form of voluntary or mandatory standard for energy use in new buildings. The majority of these standards apply to new residential buildings, perhaps because this sector tends to use a higher overall percentage of energy than the commercial sector. On a per building basis, however, energy-intensive non-residential buildings present a ripe target for further savings, especially for electricity. As the commercial sector grows, opportunities for energy conservation are being lost in countries without effective energy standards.

Although differences in climate and construction practice complicate the direct transfer of some building efficiency approaches, the methodology of energy standards is more easily shared. In addition, some modern buildings, especially large offices and hotels, can share general physical characteristics and energy consumption patterns. As a result, our project had three goals: (1) to understand and learn from the experience of countries with existing building energy standards; (2) to locate areas where these lessons might be applied and energy standards might be proposed and developed effectively; and (3) to share the information gathered with all countries expressing interest in the results.

There are several barriers to gathering useful information about existing standards. The main barrier, especially to cross-national comparisons, is that building energy standard activities are difficult to classify and complicated to assess. No established nomenclature clearly identifies policies that might be considered "energy standards." A single country may have several such standards published by different entities, and they may be self-contained or subsumed within another document (such as a general building code). Standards that are stringent for one country may be ineffective in another country, depending on climate conditions, existing building stock, and construction practices. A standard's ultimate impact also depends on compliance: without appropriate enforcement mechanisms, even a well-designed, mandatory standard will not save energy.

Despite these difficulties, a handful of studies have attempted to pull together information across national boundaries. Both the United Nations Economic Commission for Europe (ECE 1984) and the European Economic Community (Uyttenbroeck 1987) have sponsored cross-country comparisons of energy standards for buildings in Europe. The UN study looked at a broad range of energy efficiency regulations but did not specify to which building sectors the regulations apply. The EEC studies are thorough, but they have a narrow technical focus on thermal insulation and ventilation requirements, excluding energy-efficiency provisions useful in other climates. Other comparative work has addressed residential energy standards and policies in a handful of OECD countries (Wilson 1989) but only one project, which involved five South-East Asian countries, has focused specifically on energy standards for non-residential buildings (Deringer 1992). One other organization has surveyed 44 countries' building regulations, but energy efficiency was not one of the topics covered in the questionnaire (Byggdok 1989). The need for better cross-national information about building energy standards, especially for non-residential buildings, is further demonstrated by the fact that both Australia (Enersonics 1991) and Hong Kong (Chan 1991) commissioned studies of the energy standards in other countries to support the development of non-residential standards at home.

Survey

Because of the highly variable published information available on energy standards, we developed a 15-page informal survey to help us gain information about activities undertaken specifically for the purpose of increasing energy efficiency in buildings, particularly in non-residential buildings. The survey asked about the status of non-energy building standards and requested descriptions of other programs designed to increase energy efficiency in buildings (e.g., energy utility initiatives, energy awareness campaigns, energy audits). Respondents from countries with existing (or proposed) energy standards were asked to clarify the standard's geographic coverage and legal status; identify the applicable building types and vintages; and note its provisions for specific building elements. Respondents were also asked to specify the entities involved in the process of developing and revising this standard, and to describe issues pertaining to its implementation and enforcement.

The survey was sent to over 150 contacts in government, research, and professional positions in sixty countries. The number and distribution of these contacts reflects recommendations solicited from researchers knowledgeable about energy standards rather than a specific selection criteria or sampling methodology. Contacts in countries where published information about energy standards does not exist were pursued more vigorously than contacts in countries covered by previous reports.

Selected Results

Information gathered from survey respondents in 30 countries was added to published information to develop a database of information containing: (1) the status of energy standards for buildings in each country; (2) basic provisions of existing energy standards; (3) approaches to standards development; (4) implementation and compliance; and (5) other methods of increasing energy efficiency in buildings. Given the extent of the information gathered, this paper covers only a few highlights.

General Overview

Six out of the 30 countries responding to the survey have no energy standards for any sector (Bangladesh, Brazil, Botswana, Costa Rica, Djibouti, and Venezuela). Bangladesh and Costa Rica were the only countries that reported having no building standards of any kind. A partial list of countries with building energy standards applying to non-residential buildings includes Canada, Hong Kong, France, Jamaica, Japan, Kuwait, New Zealand, Pakistan, the Philippines, Singapore, Sweden, the United Kingdom, and the United States. Some of these standards are mandatory (Sweden, France, United Kingdom, some U.S. states) and others are voluntary (Australia, the Philippines, other U.S. states). Some standards are national (Kuwait, Pakistan) while others have been adopted only in specific regions (Canada, U.S.).

Contents of the Standards

Most countries combined both prescriptive and performance approaches in designing their energy standards. Achieving energy savings was the principal intent in promoting energy standards in a majority of countries, over other goals such as achieving peak demand savings, reducing operating costs, or enhancing comfort. Nearly all respondents indicated that their energy standards incorporated provisions for the building envelope which influenced design choices for the roof, walls, and fenestration. To a lesser extent, mechanical and lighting provisions were also included. Eleven countries with energy standards responded that their countries had at least one provision for lighting efficiency. Six countries had both lighting control and power density provisions, two countries had one of each, and three countries reported that lighting was covered but contained in a separate standard.

Standard Development Process

In some countries, such as Australia and the United States, professional associations of building owners or engineers published the first widely applicable building energy standards. Increasingly, however, governments at the local, state, or national level are adapting these energy standards or developing their own versions. All survey respondents indicated their governments were involved in the energy standards development process. The survey also showed that energy standards developed by ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) have been used as source material for standards in Hong Kong, Jamaica, Saudi Arabia, Singapore, Thailand, the Philippines, and Malaysia. Jamaican standards served as a source for standards in the Ivory Coast, and English standards were referred to in Hong Kong. Fifteen of the countries followed a consensus approach in developing their standards, while six indicated that their standards were adopted essentially as an agency mandate.

Implementation and Compliance

Seven countries listed their energy standards as being set at a level of stringency that was about equal to current construction practice, while seven others indicated that their energy standards were more stringent than current practice in order to promote technical development and a higher level of efficiency. Most countries report that compliance mechanisms occur in the early stages of construction, and only a few countries such as Sweden have procedural checks after construction is completed. Estimates of the percent of buildings checked for compliance ranged from 31% to 100%, and respondents expressed an average confidence level of 3.7 on a scale of 1 to 5 on the effectiveness of compliance.

Further Information on Energy Conservation

Some respondents from countries without energy standards, such as Botswana, Brazil, and Djibouti, expressed an interest in developing them. Other countries responding to the survey do not have energy standards and do not expect to develop them.

Conclusions

These brief results show some ways in which the information gathered by the survey can characterize the worldwide status of energy standards for buildings. It should be reiterated that the database itself and information gathered is not definitive. No attempts have been made to verify the information or "correct" discrepancies between respondents from the same country. (In South Africa, for instance, two respondents said there were no energy standards of any kind, while a third mentioned a voluntary standard for offices, government facilities, and hotels. All three respondents were certain, however, that energy efficiency was not a high priority, given current excess electric capacity and indigenous energy supplies.)

While it is difficult to generalize from the information gathered, however, these survey responses (and the database behind them) provide a wealth of information on how energy standards for buildings are developed and structured for individual countries. This information is useful to countries contemplating policies for increasing energy efficiency in buildings, particularly in countries at similar stages of development and/or in similar climates. As more information is compiled, we intend to report on the detailed findings.

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