NONRESIDENTIAL ENERGY CODE COMPLIANCE AND MARKET TRANSFORMATION ISSUES

A Review of Nonresidential Energy Code Impacts 1987 - 1997

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Background

Since 1989, Ecotope has been involved in reviewing and evaluating the Washington State Energy Code (WSEC) for nonresidential construction (NREC). In this process, we audited a sample of 25 large office buildings in 1988, as well as a random sample of buildings permitted in 1990 and again in 1995 (totaling 160 buildings). These audits were aimed at characterizing energy usage and components in each building, and at establishing compliance with the Energy Code in effect at the time the permit was issued. While these two sample frames do not allow a description of long-term trends, it is clear that the shift in building characteristics due to the impact of energy codes has been both striking and reassuring, and indicates the viability of using energy codes and enforcement as a market transformation mechanism. The sample drawn for the 1994 NREC review included buildings permitted or beginning construction in 1995, soon after enforcement and training related to the new requirements had begun. The 1990 sample was based on an energy code that had been in place at that point for more than four years.

Both reports on compliance have been supplemented by an additional DOE-2® analysis. This analysis was based, in part, on a handful of prototype buildings with characteristics set by the findings in the sample. The energy impacts were set by the saturation of particular building types in each sample. In this sense, the samples are comparable (based on energy use), because they were designed to reflect the characteristics applied to these prototypes and not the energy use characteristics of the individual buildings.

In the second part of the analysis the impact of the code and code compliance is applied to the Northwest Power Planning Council's (NPPC) economic forecast. This forecast standardizes the energy impact predictions to the estimated distribution of all non-residential space additions. The result of applying the Council's forecast to the impact estimates is to increase the total impact by about a factor of two. This is because the F.W. Dodge sampling frame is restricted to new buildings only and renovations or remodels were not included.

Comparisons Between the 1990 and 1995 Samples

While overall energy code compliance between the two samples did not differ appreciably – approximately 50% in 1990 versus about 60% in 1995 – the differences in total energy usage were much more dramatic. The slight increase in compliance rates does not adequately capture the actual impact of the Implementation Plan and other state efforts to improve compliance. Several important points are relevant to understanding the information presented by these two reviews:

Building Characteristics Improvements

While compliance with codes regulating individual building components went up only marginally, the improvement in energy use represented by these components was substantial. For example, the 1994 WSEC represented about a 30% improvement in.

overall lighting power densities (LPDs). Therefore, a building minimally meeting LPD requirements in 1995 was 30% more efficient than a building minimally meeting the 1990 WSEC requirements for the same component. Furthermore, the use of energy efficient electronic ballasts increased from about 9% of the fixtures in the 1990 sample to about 91% in 1995. A similar transition occurred for T-8 lamps. Part of this can be attributed to appliance standards and other market forces. However, the impact of the 1994 NREC cannot be discounted. The impact of this change alone was much greater than the impact of non-compliance in either the 1990 or the 1995 sample.

Impact of Energy Code Compliance

Comparability between the two samples is not straightforward. In 1990, two use groups (offices and schools) dominated the sample, while the 1995 sample was dominated by retail and warehouse end uses. The office/schools group had lower LPD requirements than the retail sector; thus, the average code requirement for the 1990 sample was reduced somewhat from that seen in the 1995 sample.

A review of the cost of noncompliance was conducted on the 1990 sample, which suggested that approximately 1 MW of average energy was available if every building in the sample were made compliant with the WSEC. In the 1995 sample, approximately the same amount of impact was observed due to noncompliance. A cursory interpretation might indicate no real change had occurred; however, this conclusion would be extremely misleading. When comparison is made between the 1990 and the 1995 samples, approximately 4 MW_a of savings were realized between the two populations. That means that approximately 80% of the potential savings possible if every building complied with every aspect of the NREC were actually realized. This analysis was repeated using the NPPC building additions. The estimates of new non-residential building areas in the State of Washington is about twice the areas used in the sample frame. The result is that the estimated impact of the NREC is 10.2 MW_a and a 1.9 MW_a impact from non-compliance.

Compliance Improvements

The impact of the energy code on changing building characteristics in the 1995 sample has largely replaced the efficiency improvements achieved by state- or utility-financed conservation programs available to buildings in the 1990 sample. We believe this is largely due to the Implementation Plan. In 1990, it was obvious from our interviews that little significant enforcement efforts were taking place in most jurisdictions. Consequently, utility and state conservation programs provided virtually all the code support available in many areas. Almost 30% of the complying buildings in the 1990 sample were constructed under utility programs, and a similar number were built under the Washington State Energy Conservation Review (ECR) guidelines. When these two sets of buildings are removed from the 1990 sample, compliance levels fall from more than 50% to less than 30%.

No similar situation exists in the 1995 sample. None of the buildings were built under utility programs, and only about 6% of the entire sample went through the ECR process. Compliance in buildings in the 1995 sample not associated with a utility or ECR program has improved by a factor of 2 over the 1990 sample.

Impacts of the Implementation Plan

The primary indication of our review is that the Energy Code has provided a substantial improvement not only in compliance rates, but also in the way buildings are designed and constructed. Lighting and mechanical systems have experienced the largest degree of improvement, but all components have seen some improvement. This is in marked contrast to the 1990 sample. In that sample, building design professionals interviewed overwhelmingly indicated that the Energy Code was not enforced, not relevant, or was simply an irritation that could be circumvented with little effort. In the 1995 sample, interviews were conducted with a similar number of design professionals. The general response and attitude toward the Code could best be described as general acceptance; and, when the overall changes in building characteristics are examined, strong evidence exists that most buildings are designed and constructed specifically to comply with the NREC (even in buildings that failed to comply in one particular area).

It should be pointed out that the Implementation Plan was the first of its kind in the country, and intentionally comprehensive in scope. Numerous features were included, such as the development of a Technical Reference Manual, Field Manual, particular training programs aimed at specialty building contractors and designers, and the Special Plans Examiner/Inspector (SPE/I) program. Some of these expenses were one-time investments or experiments which do not need to be repeated. Over its three-year lifespan, the Implementation Plan cost $4.5 million. The energy analysis suggests that the annual impact of the NREC is that 4 MW_a has been purchased for about $.012/kWh. If this were sustained, the initial investment will continue to pay dividends, presumably at a much lower cost.

Using the results calibrated to the NPPC forecast estimates the cost of the savings falls to about $.005/kwh. By any standard, the near term value of the savings from the NREC and the NREC Implementation Plan represented an extremely cost effective resource program.

It is difficult to ascribe causality to the individual components of the Implement Plan or even to the overall Plan itself. However, our interviews indicate that the direct contact and training aimed at builders and designers, and the direct enforcement support through the SPE/I program had substantial impact on the perceptions held by the building community. This is bolstered by the fact that buildings examined by SPE/Is or engineers trained by the SPE/I program experienced significantly higher levels of compliance – 83% for SPE/I-reviewed buildings, and 67% compliance for buildings handled by SPE/I-trained engineers.

It is also observable that this is not a self-sustaining situation. Architects and engineers respond to the inquiries and concerns expressed by building officials. If these inquiries and concerns become less significant or if designers perceive any lack of enforcement, substantial changes in compliance efforts can be expected. If, however, the relatively low cost SPE/I program is fully funded, most of the benefits of the Implementation Plan could be realized for a fraction of its initial implementation cost.

It is my opinion that the Implementation Plan experimented with a number of programs that were unique in the country, attempting to directly address the problems of compliance and energy code support through codified requirements. A precipitous change in building characteristics and an appreciable change in compliance levels were accomplished in approximately two years in an industry where one year lead times are required for virtually any type of construction. This indicates, at least to us, that the Implementation Plan was an unqualified success.

Market Transformation

As a final comment, the level of market transformation that has been accomplished by the NREC is striking. In 1988 and 1989, we reviewed several large buildings constructed under the 1986 WSEC. The 17 office buildings reviewed had LPDs of 1.75 to 1.90 W/ft^2. Three years later, a large-scale sample suggested an average LPD of approximately 1.3 to 1.4 (a decrease of almost 25%). Between 1990 and 1995, the LPD fell to 1.11 W/ft^2 for offices, a reduction of more than 20%. It is likely that some of this reduction is due to federal appliance standards, however more than just federal ballast and lamp standards have affected lighting designs.

Even though a noticeable fraction of the ballasts seen in commercial new construction remain magnetic in violation of the federal standards, the LPDs have continue to decline, largely as a result of the design requirements of the NREC. It is difficult or impossible to determine how much of the LPD reduction can be ascribed to each of the components of the design process. However, the principal reason that lighting designers have been forced or cajoled into increased energy efficiency is clearly the NREC.

The preponderance of evidence suggests that lighting designers have become used to the NREC and have made significant efforts to develop energy efficient designs. These efficiencies are better than achieved in states with similar regulation but lower standards, which suggests that the energy code is the principal reason for these improvements. Furthermore, the use of training, outreach, "brown bags", manuals, documentation and code support, (including the Implementation Plan) has compressed the time required for the code improvements to be accepted in the design community by an appreciable amount. This has meant that the impacts of the Code were significant even shortly after its adoption.

It is apparent that the NREC, as implemented in Washington since 1994, has accomplished its goals of appreciably changing the energy intensity of nonresidential

buildings in this state and of introducing cost-effective energy savings and improvements into the building stock. The money spent in this effort has purchased substantial energy resources, not only for purposes of current planning, but also in terms of improved efficiency and reduced operating costs of this building stock in the future.

Future of Energy Codes

It is straightforward to develop and document cost-effective improvements to an Energy Code. However, the environment in the Washington State Building Code Council is neither particularly supportive nor comprehending of the technical issues associated with these changes. The code changes stemming from the Implementation Plan and associated review were mostly ignored or considered with great suspicion in the Code process, often by individuals without a technical background in building sciences or understanding of the impacts of Energy Codes. In this environment, I suspect that the most that can be accomplished is that the NREC can be made more fair, simple and internally consistent.

The long-term role of utilities to develop and implement the Energy Code is probably over; however, their role in supporting these codes has not been completed. If adequate funding and interest are maintained, utilities can continue to reap the 4 to 5 MW_a available from this program by continuing low levels of enforcement support, and training and marketing to provide information and code support for building officials and design professionals. We believe this would cost only a small fraction of the cost of the Implementation Plan. Whether this is accomplished with incentives, rate structures, or other means is relatively unimportant. The benefits that can be achieved will be a service to the utilities, building owners, and occupants for decades to come.