EVALUATION OF THE MARKET IMPACT OF THE ASHRAE ADVANCED ENERGY DESIGN GUIDES

Final Report

March 2010
Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides

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ENERGY CENTER OF WISCONSIN

455 Science Drive, Suite 200
Madison, WI 53711
608.238.4601
www.ecw.org

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Project Manager

Claire Cowan

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EXECUTIVE SUMMARY

This study assesses the market impact of the ASHRAE Advanced Energy Design Guide series. The guides offer a simple approach for designing small commercial buildings and K-12 schools to achieve 30 percent energy savings compared with buildings constructed to meet the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-1999. This analysis, conducted on behalf of ASHRAE, focuses on the guides for small office buildings, small retail buildings, K-12 schools, and small warehouse/self storage facilities. The research population for this study is ASHRAE members.

The objectives of this evaluation are: (1) to compare awareness and usage of the AEDGs with that of other energy-related design resources for commercial buildings; (2) to assess the energy savings impacts that result from AEDG use; and (3) to assess potential improvements in content, format and delivery method that would maximize the effectiveness of the guides in increasing the energy efficiency of small commercial buildings.

This analysis is based on an online survey of ASHRAE members that elicited 716 responses, in-depth telephone interviews with 54 AEDG users, and secondary market analysis. The majority of participants in both the member survey and the technical interviews are mechanical engineers. Results from the online survey informed the characterization of AEDG awareness and use in comparison with other design resources. Technical interviews provided data that was used in the energy impact analysis as well as detailed information about how the guides are being used and recommendations for improvements in AEDG marketing and content. While the survey and interviews focused on how the guides are currently being used, the secondary market analysis explored other ways in which the guides could be used and promoted.

Key findings are summarized below.

- **Comparative awareness and use of AEDGs**: Among ASHRAE members, AEDG awareness is comparable to that of LEED with around 70 percent of member survey respondents aware of both resources. While 50 percent of survey respondents reported having used LEED, around 30 percent reported having used the AEDGs.

- **AEDG user ratings**: Among member survey respondents who have used the AEDGs, 88 percent agreed the AEDGs are a credible resource, 75 percent agreed that technical content is sufficiently detailed, and 72 percent agreed the AEDGs are effective at reducing energy use. AEDG user ratings were higher than user ratings for LEED, including among individuals who have used both design resources.

- **Estimated energy impacts from AEDG use**: We estimate that on average, sampled buildings achieved a 24 to 28 percent reduction in design energy use compared with the minimum requirements of 90.1-1999. Sampled buildings implemented approximately half of all AEDG recommendations, with higher implementation rates for heating and cooling recommendations and lower implementation rates for lighting and water heating recommendations.

- **Importance of AEDGs in determining energy reductions**: Since prevailing energy codes have become more stringent than the 90.1-1999 standard, we estimate that 54 percent of the overall reduction in energy use achieved by sampled buildings is attributable to code requirements. We estimate that the AEDGs are responsible for 32 percent of the overall reduction in energy use. As
new guides based on more stringent code baselines are released, we expect codes will play a relatively smaller role in determining building energy performance and the AEDGs will play a larger role.

- **The AEDGs are used in a variety of ways:** Some design professionals use the AEDGs as a comprehensive guide for achieving whole building energy performance and others use the guides selectively to inform specific components of the building design. The AEDGs are also being used to support energy efficiency retrofit projects and on building types that are outside the targeted small commercial markets. Maintaining the flexibility of the guides is important to ensuring that they remain viable for a broad spectrum of potential users, particularly as new guides are developed that seek higher levels of energy savings.

- **AEDGs are a valuable communications tool:** Nearly half of the AEDG users we interviewed said they use the guides as a communications tool for influencing clients and other design team members to include energy efficient elements in the building design. This value can be enhanced by giving AEDG users new marketing resources to help them communicate the value of the AEDGs to clients and other members of the design team.

- **Barriers to AEDG use:** Most people who have downloaded the guides have not yet used them in connection with a building design project. Increasing awareness among AEDG users’ typical clients—architects and building owners—would help to promote broader use of the guides. Developing partnerships with utilities that administer commercial new construction programs would bring the AEDGs to new audiences.
CHAPTER 1: INTRODUCTION

ASHRAE has commissioned the Energy Center of Wisconsin to conduct an independent assessment of the market impact of the ASHRAE Advanced Energy Design Guide series. This study addresses AEDGs for small office buildings, small retail buildings, K-12 schools, and small warehouse and self-storage facilities.\(^a\)

RESEARCH OBJECTIVES AND SCOPE

Key objectives of the AEDG evaluation include:

- Comparing AEDG awareness and usage with that of other energy-related design resources for commercial buildings.
- Assessing the market impact of the AEDGs including energy savings impacts on small commercial building design.
- Obtaining insight about potential improvements in the content, format, delivery method, and other aspects of the AEDGs to maximize their effectiveness in increasing the energy efficiency of small commercial buildings.

It is important to note that this study assesses AEDG awareness and usage within the population of ASHRAE members. Given this limited scope, we must exercise caution in using study results to draw broader conclusions about AEDG awareness and usage within the general population of design professionals who work on small commercial buildings.

RESEARCH TASKS

There are three key components of this research effort: (1) a web-based survey of ASHRAE members; (2) technical interviews with AEDG users; and (3) secondary market analysis. Each research task is described in the sections below.

Survey of ASHRAE members

The ASHRAE member survey compared awareness and usage of AEDGs with that of other energy-related design resources for small commercial buildings (LEED® for New Construction, LEED for Schools, ENERGY STAR® Target Finder, Advanced Buildings® Core Performance Guides, BREEAM, and Green Globes). The survey also assessed characteristics of AEDG users and non-users (e.g., areas of design practice, typical role in design projects, extent to which practitioners seek to achieve lower energy use than code requires) and the markets in which they operate (e.g., energy-related codes governing commercial new construction). For individuals who are aware of the AEDGs but have not used them, the survey sought to identify barriers to AEDG usage. For AEDG users, the survey asked participants to describe their typical

\(^a\) As the \textit{ASHRAE Advanced Energy Design Guide for Highway Lodging} was published in June 2009 and the \textit{ASHRAE Advanced Energy Design Guide for Small Hospitals and Healthcare Facilities} was published in November 2009, these guides are not included in the scope of this evaluation.
use of the guides and the quality and usefulness of AEDG components. Lastly, the survey solicited suggestions for AEDG improvement. A copy of the survey instrument is provided in Appendix A. A summary of qualitative responses is provided in Appendix B.

**Technical interviews with AEDG users**

A series of technical interviews with AEDG users focused on obtaining detailed information about how the AEDGs are used in order to understand the impact that they have on small commercial building design. We asked interview participants to provide general information about their typical role in small commercial building design projects as well as detailed information about a representative project where one of the AEDGs was used. Questions addressed building type, square footage, code baseline, AEDG recommendations that were implemented, and challenges that were encountered. We also asked participants to rate the relative importance of the AEDGs in influencing the ultimate energy performance of the building design, as compared with other factors (e.g., personal expertise of the AEDG user, guidance from other design resources, technical assistance and/or incentives from energy efficiency programs, etc.). Information obtained during the interviews was used to estimate energy savings impacts resulting from AEDG usage. A copy of the interview guide is provided in Appendix C. A transcript of interview responses is provided in Appendix E.

**Secondary market analysis**

The secondary market analysis focused on assessing alternative mechanisms for distributing and promoting the AEDGs in order to increase market awareness and use. We assessed opportunities for increased marketing and outreach to architects, building owners, and other clients that AEDG users typically work with. We sought to identify synergies between the AEDGs and existing public/private initiatives targeting energy efficient building design such as AIA’s 2030 Commitment. We also considered opportunities for leveraging energy efficiency programs that target the commercial new construction market.
CHAPTER 2: METHODOLOGY

The following sections describe the research methodology for each component of the AEDG evaluation.

ASHRAE MEMBER SURVEY

In the fall of 2009 the Energy Center conducted a web-based survey of ASHRAE members to test awareness and use of the AEDGs. ASHRAE members represent the largest share (74 percent) of individuals who indicated a membership affiliation when downloading the guides. (Other membership affiliations that can be selected include AIA, IESNA, USGBC, and BOMA). The survey was conducted using the web-based survey software, Vovici.

Survey design

The member survey addressed three key research elements:

- Characterization of the respondent population
- Comparative assessment of awareness and use of the AEDGs and other design resources for the small commercial market
- Quality and usefulness of key components of the AEDGs and barriers to AEDG use

Conducting a web-based survey allowed the Energy Center to program the sequence of questions based on responses to previous questions. For example, respondents who indicated they have used the AEDGs received a series of questions specific to AEDG usage, but respondents who indicated they have not used the guides did not see those questions.

The survey was pre-tested by members of the Energy Center’s commercial building design team who were not involved in drafting the survey instrument. ASHRAE staff and members of the Contract Monitoring Group (part of the AEDG Steering Committee) also reviewed and provided comments on a draft of the survey instrument. A copy of the survey instrument is provided in Appendix A.

Survey data analysis was conducted using Stata 10 software.

Sampling approach

The Energy Center used a stratified random sampling approach to select survey recipients. The samples were pulled from two databases provided by ASHRAE: (1) the general ASHRAE membership list; and (2) ASHRAE members who obtained a free download of one or more of the AEDGs from the ASHRAE web site (not including those individuals who requested no email contact).

The two databases were combined and individuals were classified into the following sample groups:

- **Member group**: ASHRAE members who have not downloaded any of the AEDGs.
- **Targeted job/firm group**: ASHRAE members whose company function is identified as “consulting engineering services” or “design/build,” or whose job function is identified as
“design and application engineer.” Individuals in these job/firm classifications were deemed likely to work on commercial building design projects.

- **Downloader group**: ASHRAE members who have downloaded one or more of the AEDGs.

Table 1 summarizes the number of unique individuals in each group.\(^b\)

**TABLE 1. TOTAL NUMBER OF INDIVIDUALS IN EACH CLASSIFICATION**

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members who have not downloaded AEDGs</td>
<td>36,079</td>
</tr>
<tr>
<td>Targeted job/firm</td>
<td>28,723</td>
</tr>
<tr>
<td>Downloaders</td>
<td>16,355</td>
</tr>
</tbody>
</table>

The survey was distributed in two email rounds. Prior to initiating the survey, we were unsure of the percentage of individuals within the ASHRAE member population who are involved in the design and construction of small commercial buildings. Therefore, the initial survey round was designed to allow us to better understand the composition of the target population. A multi-round approach allowed us to refine our sampling approach in subsequent rounds as needed.

The sample for the Round 1 distribution included a main sample of 1000 individuals from the member group, an oversample of 1000 individuals from the targeted job/firm group, and a second oversample of 250 individuals from the downloader group. In order to be able to test AEDG awareness among the population of ASHRAE members who work on small commercial building design projects, we sampled a larger number of individuals from the member and targeted job/firm lists. The first survey round was sent out via email on September 22, 2009. A reminder email was sent to non-respondents on September 28, 2009.

Responses to Round 1 showed relatively little difference in the percentage of respondents who work on small commercial building design projects across the three sample groups. This information allowed us to simplify the sampling approach for the Round 2 survey distribution, where we sampled 1500 individuals from the targeted job/firm group and 500 individuals from the downloader group. The second survey round was sent out via email on October 8\(^{th}\). A reminder email was sent to non-respondents on October 13\(^{th}\).

Response rates for each round and each sample group are summarized in Table 2.

\(^b\) While there is no overlap between the member and downloader groups, individuals in the targeted job/firm group may also be part of the member group or the downloader group.
TABLE 2. RESPONSE RATES FOR EACH SURVEY ROUND, BY SAMPLE GROUP

<table>
<thead>
<tr>
<th>Round</th>
<th>Sample Group</th>
<th>Surveys Sent</th>
<th>Unable to Contact&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Responses</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Members</td>
<td>1000</td>
<td>144</td>
<td>138</td>
<td>16%</td>
</tr>
<tr>
<td>1</td>
<td>Downloaders</td>
<td>250</td>
<td>27</td>
<td>56</td>
<td>25%</td>
</tr>
<tr>
<td>1</td>
<td>Targeted</td>
<td>1000</td>
<td>106</td>
<td>171</td>
<td>19%</td>
</tr>
<tr>
<td>2</td>
<td>Downloaders</td>
<td>500</td>
<td>48</td>
<td>99</td>
<td>22%</td>
</tr>
<tr>
<td>2</td>
<td>Targeted</td>
<td>1500</td>
<td>109</td>
<td>252</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>4250</td>
<td>434</td>
<td>716</td>
<td>19%</td>
</tr>
</tbody>
</table>

The response rate for this survey was similar to response rates encountered in other web-based survey efforts. Low response rates can be a concern because of the potential for non-response bias—a skewing of survey results that occurs when the population responding to the survey differs from the non-respondent population on key variables of interest. Following Round 1 of the survey effort, the Energy Center conducted a brief follow-up survey of non-respondents to determine whether results would be subject to non-response bias. The non-respondent analysis provided evidence of self-selection as individuals who do not work on small commercial building design projects disproportionally elected not to participate in the Round 1 survey. Since this is not the population targeted by the research effort, however, non-response from this population is not expected to have a detrimental effect on the overall validity of survey results.

TECHNICAL INTERVIEWS

Interview guide

The technical interview process was led by members of the Energy Center’s commercial building design team and addressed the following research elements:

- Estimating the energy savings impacts resulting from AEDG usage, by building type.
- Obtaining a deeper understanding of how the AEDGs are used, including AEDG usage in nontraditional applications such as energy efficiency retrofits.
- Soliciting detailed feedback on ways to promote broader use of the resource as well as suggestions for improving AEDG content.

The interviews were designed to obtain sufficiently detailed information about projects where AEDGs were used to enable us to develop a rough estimate of building-level energy savings attributable to AEDG usage. The interviews focused on AEDG recommendations that are expected to have the greatest energy savings impact—e.g., insulation levels for wall and roof, lighting power density, type and efficiency of heating and cooling equipment, and use of sensors/controls for lighting and HVAC. In addition to

<sup>c</sup> Invalid email addresses as well as emails blocked by spam filters and other bouncebacks.
identifying AEDG recommendations that were implemented, we asked about the relative importance of the AEDG versus other factors that contributed to the resulting energy performance of the building design.

Though an interview guide was developed to define the general scope of the conversation with each AEDG user, it was important to maintain conversational flexibility so that interviewers could tailor questions depending on how each participant has used the AEDGs. ASHRAE staff and members of the Contract Monitoring Group (part of the AEDG Steering Committee) reviewed and provided comments on a draft of the interview guide. A copy of the interview guide is provided in Appendix C. A summary of participant responses is provided in Appendix E.

**Sampling approach**

The Energy Center conducted 54 phone interviews with ASHRAE members who use the AEDGs. Nine of these interviews were with individuals who took the member survey and indicated they would be willing to participate in a follow up interview. The remaining participants were selected using a rolling random sampling approach. The sample frame was comprised of ASHRAE members located in the U.S. or Canada who have downloaded the AEDGs, were not sampled for the member survey, and whose company function or job function indicated they are likely to work on commercial building design projects\(^d\) (n=7,392).

We used a combination of cold-calling and email solicitations to identify interview candidates. In the cold-calling process, sampled individuals received an introductory email one or two days before the initial phone call was made. This email described the purpose of the research and let sampled individuals know to expect a call. We then made two attempts to reach the individual by phone, leaving a voice message if the person was not reached on the first call attempt. The screening call took only a few minutes to complete and allowed us to determine whether the person who downloaded the AEDG(s) had actually used the resource in connection with a design project. If so, they were asked to participate in the longer technical interview which was scheduled for a later date. If not, they were asked about their reasons for downloading the AEDG(s). A copy of the email text and screening call script is provided in Appendix D. In order to schedule a sufficient number of interviews during the available timeframe, we also solicited participants through two email blasts to sampled individuals.

Table 3 presents the sample size and response rate by group.

\(^d\) The following company functions were included in the sample frame: consulting engineering services, design/build firm, architect/architectural and engineering services, and architectural services. The following job functions were included in the sample frame: design and application, architect, and design engineer/designer.
TABLE 3. RESPONSE RATES FOR TECHNICAL INTERVIEWS, BY SAMPLE GROUP

<table>
<thead>
<tr>
<th>Sample Group</th>
<th>Number Sampled</th>
<th>Unable to Contact&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Responses</th>
<th>Response Rate</th>
<th>Interviews Conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member survey volunteers</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>100%</td>
<td>9</td>
</tr>
<tr>
<td>Cold call recipients</td>
<td>405</td>
<td>224</td>
<td>181</td>
<td>45%</td>
<td>14</td>
</tr>
<tr>
<td>Email – Round 1</td>
<td>500</td>
<td>49</td>
<td>10</td>
<td>2%</td>
<td>5</td>
</tr>
<tr>
<td>Email – Round 2</td>
<td>3000</td>
<td>302</td>
<td>42</td>
<td>2%</td>
<td>26</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3915</strong></td>
<td><strong>575</strong></td>
<td><strong>243</strong></td>
<td><strong>7%</strong></td>
<td><strong>54</strong></td>
</tr>
</tbody>
</table>

Most interviews lasted between 15 and 30 minutes. Though we fell slightly short of our original target of conducting at least 60 interviews with AEDG users, we believe the sample size is sufficient to address the key objectives of this analysis.

**Estimation of energy impacts**

We asked interview participants to provide detailed information about a representative project where one of the AEDGs was used. Twenty five of the interviews yielded detailed information about new construction projects that we then used to estimate the energy impacts resulting from AEDG use. Fourteen of the respondents provided detailed information about energy efficiency retrofit projects or new construction projects involving building types outside the targeted markets. While this information was useful in our qualitative assessment, quantifying the energy impacts from these projects was outside the analytical scope. In addition, a number of respondents provided valuable qualitative feedback about the AEDGs and high-level information about how they use the guides in their work, but were not able to provide details about a specific project where one of the AEDGs was used. For each market, Table 4 presents the total number of interviews that provided information that could be used for estimating energy impacts.

<sup>c</sup> For cold calls, invalid telephone numbers and those we were not able to reach after two call attempts. For emails, invalid email addresses as well as emails blocked by spam filters and other bouncebacks.
TABLE 4. NUMBER OF INTERVIEWS THAT PROVIDED PROJECT-LEVEL INFORMATION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>K-12</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Retail</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Warehouse/self-storage</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Other building types</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
<td>14</td>
</tr>
</tbody>
</table>

As comprehensive energy modeling was beyond the scope of this project, we used a simplified approach to estimate the energy impacts resulting from AEDG usage. The first step of this process was determining the typical building energy end use profile for each building type and climate zone using new construction benchmark data files compiled by DOE’s Net-Zero Energy Commercial Building Initiative. This benchmarking study gives the end use energy consumption for a variety of building types in all applicable climate zones. For each building type and climate zone, Appendix F contains tables listing the end use percentages used in this analysis. As DOE developed these building characterizations from models based on calibrated statistical averages of actual buildings in each climate zone, we assumed the end use breakdowns were representative of buildings designed to meet applicable code requirements.

The second step was to modify each end use percentage based on the interviewee’s responses about energy efficiency improvements that were incorporated into the building design. For heating, the following information was used to estimate energy reduction impacts: HVAC heating efficiency (COP, EER, or efficiency), roof R-value, wall R-value, and window U-value. For cooling, the following information was used to estimate energy reduction impacts: HVAC cooling efficiency (SEER, EER, or IPLV), roof R-value, window SHGC, and lighting power density (LPD). For ventilation, energy reduction impacts were estimated if an interviewee implemented demand control ventilation (DCV) or energy recovery ventilation (ERV). LPD was used to estimate lighting energy impacts. Water heating equipment type and efficiency was used to estimate water heating energy impacts. As the interviews did not address information affecting the other end use category, we left the end use percentages in this category unmodified. Appendix F contains the formulas used to adjust end use percentages based on the energy efficiency upgrades that were implemented.

By totaling the end use energy reductions described above, we determined the overall reduction in building energy consumption—as compared with the applicable local energy code—for each project. The final step was to determine the building’s energy consumption relative to the standard on which the AEDGs are based: ANSI/ASHRAE/IESNA Standard 90.1-1999. The code baseline for most of the

\[ \text{Note that these ventilation measures also affected the heating and cooling end uses.} \]
projects described by interviewees was either 90.1-2004 or 90.1-2007, with a smaller number of projects subject to state-specific codes like California’s Title 24. ASHRAE provided information comparing the average energy use intensity (EUI) of buildings designed to meet the 2004 and 2007 versions of the 90.1 standard, as compared with the 1999 version.\(^2\) Based on information provided by Pacific Northwest National Laboratory, we assumed that California’s Title 24 is 12.5 percent more stringent than ASHRAE 90.1-2004.\(^3\) Table 5 summarizes the relative stringencies of these code baselines.\(^g\)

### TABLE 5. RELATIVE STRINGENCY OF CODE BASELINES COMPARED WITH 90.1-1999

<table>
<thead>
<tr>
<th>Code baseline</th>
<th>Stringency increase over 90.1-1999 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.1-1999(^h)</td>
<td>0%</td>
</tr>
<tr>
<td>90.1-2004</td>
<td>11.9%</td>
</tr>
<tr>
<td>90.1-2007</td>
<td>18.1%</td>
</tr>
<tr>
<td>Title 24</td>
<td>22.9%</td>
</tr>
</tbody>
</table>

In reporting results, we identified the relative impact of the AEDGs, more stringent code requirements, and other factors that may have influenced the overall reduction in design energy use. In addition to reporting the percent reduction in energy use as compared with a building constructed to meet the 90.1-1999 standard, we use the stringency factors above to report the share of the overall reduction that is attributable to code requirements. Interviewees were also asked to rate the relative importance of the AEDGs versus other factors in determining the overall energy performance of the building design. This rating used a 1-5 scale where 1 was “not important” and 5 was “very important.” We use this attribution factor to allocate the remaining share of the overall reduction in energy use between the AEDG and other factors. As an example, consider a project that achieved a 30 percent reduction in energy use as compared with a building constructed to meet ASHRAE 90.1-1999. The energy code baseline for this project is ASHRAE 90.1-2004, so an energy use reduction of 11.9 percent is attributable to code requirements. The remaining reduction (18.1 percent) is allocated between the AEDG and other factors. Since the interviewee gave the AEDG a relative importance rating of 4 out of 5, then we attribute 75 percent of the remaining reduction to the AEDG (a 13.6 percent reduction in energy use) and 25 percent to other factors (a 4.5 percent reduction in energy use).

\(^g\) For interview participants who stated that the code baseline was the International Mechanical Code, we used 90.1-2004 as the code default. For interview participants who listed the code baseline as IECC 2003 or 2004, we used 90.1-2004 as the code default.

\(^h\) For two Canadian projects, interviewees reported that the code baseline was similar to 90.1-1989. However, we did not have data comparing the EUI of buildings constructed to meet the 1989 version of 90.1 as compared with buildings constructed to meet the 1999 version. Therefore, we used the 90.1-1999 as the baseline for these two projects.
This analysis is a high-level assessment of the energy impact resulting from AEDG use. It is important to note a few sources of uncertainty as well as key assumptions made in the analysis. The relatively small sample size contributes some uncertainty to our overall results. We report aggregated results for all buildings as well as results for the office and K-12 markets, but the sample was not large enough for retail buildings (three projects) and warehouses (one project) to present market-specific results.

We also used a conservative analytical approach that may understate the actual energy savings impacts resulting from AEDG use, particularly in areas where we had incomplete information. Many interviewees only had partial knowledge about the AEDG recommendations that were implemented or about the characteristics of key components of the building design. In some cases, interviewees were only able to provide informed guesses or partial answers. In other cases, interviewees gave precise answers about complex systems that did not align well with AEDG recommendations, making it difficult to accurately estimate energy savings impacts using the simplified approach described above (e.g., VRF system in combination with gas-fired boiler for radiant floor heating). When an interviewee was not able to provide the requested information about a specific component of the building design or confirm whether an AEDG recommendation was implemented, we made the conservative assumption that the design component was consistent with building code requirements.

Since it was not possible to ask about every AEDG recommendation in the course of an interview, the interviews focused on the AEDG recommendations that were likely to have the greatest energy savings impact. For AEDG recommendations we did not ask about, we left baseline end use energy consumption values unchanged (e.g., equivalent to code). The main recommendations that were not addressed in the interviews were slab insulation, economizers, and ventilation recommendations. Economizers are required by codes based on 90.1-2004 and 90.1-2007, and thus the energy savings resulting from implementing this recommendation are already included in our estimates due to the scaling factors that adjust for more stringent code requirements (see Table 5). For slab insulation, the AEDG recommendations are also fairly close to code requirements that are based on more recent versions of the 90.1 standard. If we had included this recommendation, the impact on our overall energy impact estimates is likely to be less than one percent. The savings impact is larger for ventilation recommendations, however—particularly ERV and DCV.

Although we did not specifically ask about ERV and DCV in the interviews, some participants mentioned that they implemented these efficiency upgrades. In cases where participants specifically mentioned implementing ERV or DCV, our base estimates include the impact of these upgrades. We developed an outer-bound scenario to test the maximum savings that could have been achieved had we specifically asked about ERV and DCV in all interviews. The outer-bound scenario assumed that DCV was used in all office, retail, and warehouse projects, and that ERV was used in all K-12 projects. The estimate is based on the assumption that ERV saves 30 percent of heating and cooling energy and DCV saves 20 percent of ventilation, heating and cooling energy.

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1 This estimate is based on the following assumptions: conduction through the slab accounts for 11 percent of heating load, which is on average around 30 percent of building energy use. Implementing this recommendation would increase slab insulation values slightly, reducing conduction through the slab to around three to four percent. Accounting for AEDG attribution would reduce the savings, resulting in an average impact of less than one percent.
Additional information about modeling assumptions is provided in Appendix F, including a table summarizing the AEDG recommendations and indicating which ones were addressed in the interviews.

SECONDARY MARKET ANALYSIS

The secondary market analysis focused on evaluating new approaches for distributing and promoting the AEDGs to increase market awareness and use of the guides. We focused on three key strategies suggested by technical interview participants: (1) promote the AEDGs more aggressively among architects and building owners/managers; (2) make the AEDGs a more dynamic resource by developing new online tools to support AEDG use; and (3) pursue opportunities for collaboration with utilities and other energy efficiency program administrators.

In connection with this analysis, we reviewed the American Institute of Architects (AIA) sustainability initiatives to assess opportunities for collaboration and cross-promotion with the AEDGs. We reviewed collateral materials that make the business case for using a similar design guide—the New Building Institute’s Advanced Buildings Core Performance—to assess opportunities for developing similar materials to promote the AEDGs. We also conducted a web review of utility-sponsored commercial new construction programs, specifically focusing on programs that have integrated Core Performance into program design and delivery.
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CHAPTER 3: RESULTS

This chapter presents key findings from the member survey, technical interviews, and secondary market analysis. To establish the overall context for the analysis, we begin with a market characterization that discusses who is using the AEDGs, how they are being used, and the degree of influence that the AEDGs have on the resulting energy efficiency of the building design. We then discuss the estimated energy impacts of projects that used the AEDGs. We compare awareness and use of AEDGs with that of other resources that support energy efficient design for commercial buildings, and discuss how AEDG users rate the quality of the resource. Lastly, we discuss barriers to AEDG use and present suggestions for improving the content and promoting broader awareness and use of the guides.

MARKET CHARACTERIZATION

Research scope

Most of the people who participated in both the member survey and the technical interviews are mechanical engineers. Seventy five percent of member survey respondents indicated their primary role is mechanical engineer and only two percent of respondents who indicated their primary role is architectural design.\(^j\) In the technical interviews 48 percent of participants said they have a role in mechanical design, 15 percent said they have a role in HVAC design, and 13 percent said they have a role in plumbing design.\(^k\) No architects participated in the technical interviews.

These results are expected given that this study focuses on ASHRAE members rather than the design community as a whole. Though ASHRAE members represent the largest share (74 percent) of individuals who indicated a membership affiliation when downloading the AEDGs, the research population represents only part of the potential audience for the guides. While the mechanical engineering perspective is well-represented in our research, we have limited information about the extent to which other types of design professionals use the AEDGs and their opinions about the resource.

More AEDG users design for beyond-code energy performance

Not surprisingly, our research indicates that AEDG users are more likely to design for beyond-code energy performance than their peers who do not use the AEDGs. Survey respondents who work on small commercial building design in the targeted markets were asked to specify the typical level of building energy performance they seek to achieve. Figure 1 compares responses to this question across individuals who have used the AEDGs and those who have not. Sixty nine percent of AEDG users indicated that they typically design buildings to achieve better energy performance than code requires, compared with 49 percent in the non-user group.\(^l\)

\(^j\) The sampling margin of error is two percentage points.

\(^k\) Response categories are not mutually exclusive, as some participants indicated a role in multiple areas. These percentages have a sampling margin of error of nine to thirteen percentage points.

\(^l\) These percentages have a sampling margin of error of six to seven percentage points. The difference between the AEDG user and non-user groups is statistically significant at 95 percent confidence (z-score=4.15).
Distinct types of AEDG users

Through the technical interview process, it became clear that there are a few distinct ways in which the AEDGs are being used. Based on interview responses, we classified participants into one of three groups:

- **Comprehensive users**: Individuals who follow AEDG recommendations in a systematic way across all major components of the building design. Some members of this group implement AEDG recommendations as part of a prescriptive path for achieving LEED Energy & Atmosphere credits.

- **Selective users**: Individuals who rely on the AEDGs for specific components of the building design—e.g., envelope design or HVAC equipment efficiency specifications—but do not refer to the resource for other elements of the building design.

- **Reference users**: Individuals who use the AEDG recommendations as a back-check or quality assurance benchmark. For these users, the AEDGs help to verify that the building design meets industry best practices, but have relatively little influence on design decisions.

We classified approximately 40 percent of interviewees as comprehensive users and another 40 percent as selective users. We classified the remaining interviewees as reference users. Within the selective user group, there are two distinct sub-types. Some individuals use the AEDGs selectively because their role is limited to specific components of the building design and they have limited involvement in the design of other building systems. Other selective users indicated they leverage the guides primarily in connection with aspects of the design that are outside their primary area of expertise. For example, a number of mechanical engineers we interviewed said the guides are less influential in informing HVAC design decisions but are primarily used to make envelope recommendations to the architect.
Objectives of AEDG users

In the member survey, we asked AEDG users to select one or more of the following objectives to characterize their typical usage of the guides: (1) designing the whole building to achieve a desired level of energy performance; (2) designing key building systems to achieve a desired level of energy performance; (3) specifying the energy performance of individual pieces of equipment; or (4) other. As shown in Figure 2, 61 percent of AEDG users who took the member survey selected the system performance option while 47 percent selected the whole building performance option.\(^m\)

Figure 2: AEDG user objectives
(n=175)

These results are another indication that different people are using the AEDGs in different ways. It is reasonable to assume that an individual who uses the AEDGs in a comprehensive way would indicate an interest in whole building performance while a selective user would indicate an interest in system or equipment performance. Although more survey respondents use the guides to ensure the energy performance of key building systems, whole building energy performance is an important objective for nearly half of all AEDG users.

AEDG use as a communications tool

Across the three user groups, but particularly among the comprehensive and selective users, many participants cited the value of the AEDGs as communications tool. In this respect, participants use the AEDGs to influence other members of the design team and decision-makers to incorporate energy efficiency upgrades in the building design. Table 6 summarizes the number of individuals who mentioned a communications-related use for the AEDGs within each user group.

\(^m\) These percentages have a sampling margin of error of seven percentage points.
TABLE 6. AEDG USED AS A COMMUNICATIONS TOOL

<table>
<thead>
<tr>
<th>User Group</th>
<th>Number of AEDG Users</th>
<th>Share of group that used AEDG for communications purpose(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>21</td>
<td>48%</td>
</tr>
<tr>
<td>Selective</td>
<td>21</td>
<td>43%</td>
</tr>
<tr>
<td>Reference</td>
<td>12</td>
<td>25%</td>
</tr>
</tbody>
</table>

Many interviewees who mentioned the value of the AEDGs as a communications tool said that they share AEDG recommendations with architects to influence building envelope specifications. A smaller number of interviewees said they share lighting and HVAC recommendations with contractors. Some individuals who work on K-12 and office projects also discussed use of the AEDGs as a communications tool for building owners, school administrators and other decision-makers.

According to interviewees, the AEDGs are a useful communications tool in large part because the recommendations are produced by an independent and credible third party. ASHRAE’s reputation carries significant weight which simplifies the discussion and streamlines the decision-making process. A number of interviewees also mentioned the value of the recommendations list in terms of being application-oriented (prescriptive) and easy to use.

**Most useful sections of the AEDGs**

Member survey respondents and interviewees concurred that the application-oriented information in the AEDGs is a valuable aspect of the resource. In the member survey, we asked AEDG users to rate the key sections of the guides in terms of their usefulness. As shown in Figure 3, 61 percent of survey respondents rated the recommendations by climate zone as useful and 59 percent rated the implementation guidance (how-to tips) as useful. Forty seven percent of respondents found the discussion of the integrated design process and case studies of energy efficient buildings to be useful. The fact that a smaller percentage of respondents found the integrated design process discussion to be useful is a likely indication that a significant number of AEDG users are using the resource selectively rather than as a comprehensive design guide.

\(a\) Percentages have a sampling margin of error of 11 to 13 percentage points.

\(\circ\) These percentages have a sampling margin of error of seven percentage points.
In considering the market impact of the AEDGs, an important factor is the degree of influence that the guides have on the resulting energy efficiency of the building design, as well as on the general practices of design professionals. Our findings suggest that on a project-specific basis, the AEDGs have some influence but other factors are also important. Design professionals who have used the resource more than once or twice rate the guides as more influential. Roughly half of respondents said they implemented an energy efficiency upgrade for the first time after reading information in the guides, with improvements to envelope efficiency the most frequently mentioned improvement.

In the member survey we asked AEDG users to characterize the degree to which their use of the guides influences the resulting energy efficiency of the building design. Fifty eight percent said the AEDGs have some influence, 22 percent said the AEDGs have a great deal of influence and seven percent said the AEDGs have no influence. Figure 4 compares participant responses to the degree of influence question depending on whether the respondent uses the AEDGs often or whether the respondent has used them once or twice.

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Figure 3: Usefulness of AEDG components
(n=175)

**AEDG influence on energy efficiency of building design**

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p These percentages have a sampling margin of error of four to seven percentage points.
Among those who said the AEDGs have a lot of influence on the energy efficiency of the building design, 63 percent reported using the resource often and 37 percent reported using it once or twice. These percentages were reversed in the “some influence” group, with 39 percent reporting that they use the resource often and 61 percent reporting that they have used it once or twice. Among respondents who indicated the AEDGs have a lot of influence, the difference between frequent users and infrequent users is statistically significant at 95 percent confidence (z-score =2.27).

During the technical interviews we addressed the question of AEDG influence with respect to a specific project where one of the guides was used. We asked participants to rate the relative importance of the AEDGs (versus other factors) in determining the overall energy performance of the building design. The ratings ranged from 1-5 where 1 was “not important” and 5 was “very important.” Figure 5 shows the breakdown of AEDG influence responses given by interview participants.

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$q$ These percentages have a sampling margin of error of seven percentage points.

$r$ When respondents gave a range (e.g., “3 or 4”), we used the midpoint of the range as the rating.
Figure 5: Interviewee ratings on degree of AEDG influence (n=39)

While more than 50 percent of respondents gave a rating of four or above, these results indicate there is a good degree of variability in the degree of influence that the AEDGs have on the design professions who use them, and in most cases participants reported that other factors are also influential. In describing other factors that affected the ultimate energy performance of the design, a number of participants cited building codes or energy performance requirements for military facilities, other design resources used, and the interviewee’s own knowledge/expertise.

Through the interview process, we also sought to distinguish between design practices that were influenced by the AEDGs and those that were standard practice before participants began using the guides. We asked interview participants to describe which AEDG recommendations, if any, they implemented for the first time after reading information in the guides. Of the 43 individuals who answered this question, 47 percent reported implementing energy efficiency upgrades for the first time after reading information in the guides. Among those who reported making changes in their practices, 75 percent reported improvements in envelope efficiency, 55 percent reported improvements in HVAC efficiency, and 35 percent reported improvements in lighting efficiency. These respondents discussed making changes to their own practices as well as making suggestions to other members of the design team—particularly among those who mentioned making envelope efficiency improvements for the first time, where the AEDGs were the basis for recommendations submitted to the architect. These responses provide another indication of AEDGs usage as a communications tool.

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These percentages have a sampling margin of error of seven to fifteen percentage points.

These percentages have a sampling margin of error of 18 to 20 percentage points.
ENERGY IMPACT OF AEDG USAGE

Estimated energy savings compared to 90.1-1999

The AEDGs target at least a 30 percent reduction in building energy consumption compared with a building constructed to meet ASHRAE 90.1-1999. Thus, the primary focus of our energy impact analysis was to estimate the achieved reduction in design energy consumption from the 90.1-1999 baseline. According to the AEDG Technical Support Documents, the energy savings potential for each building type is actually greater than 30 percent when averaged across all climate zones, ranging from 42 percent for warehouses to 37 percent for retail buildings. Figure 6 compares the actual energy savings potential by building type with our high-level estimate of the average achieved reduction in energy consumption for the buildings in our sample.

![Energy Savings Chart]

**Figure 6: Estimated reduction in design energy consumption resulting from AEDG use in sampled buildings**

Overall, we estimate that the buildings in our sample achieved a 24 percent reduction in energy consumption below the requirements of 90.1-1999. K-12 schools showed an average reduction of 26 percent and office buildings showed an average reduction of 21 percent, but there is no statistically significant difference between the two markets. On average, we estimate that the sampled buildings captured 61 percent of potential energy savings, with K-12 schools capturing 70 percent of potential savings and offices capturing 55 percent.

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u Sampling margin of error is 14 percentage points at 90 percent confidence.

v Sampling margin of error is 19 to 27 percentage points at 90 percent confidence.
Relative contribution of AEDGs, codes and other factors to total energy savings

We assessed the relative importance of the AEDGs versus code requirements and other factors in determining the energy reductions achieved by sampled buildings. Most of the buildings in our sample are subject to more stringent code requirements than 90.1-1999. For the sampled buildings, more stringent code requirements caused an average energy reduction of 12 percent below the 90.1-1999 standard.\textsuperscript{w} The difference between the overall reduction from 90.1-1999 and the reduction attributable to more stringent code requirements leaves a remainder that is attributable either to AEDG use or to other factors. Other factors that can influence the building design include everything from the personal expertise of the interviewee, to independent determinations made by other members of the design team, to other resources that were used as part of the design process (e.g., LEED, energy models, technical assistance from incentive programs, etc.). The allocation of savings between the AEDGs and other factors was based on each participant’s rating (using a 1-5 scale) of the relative importance of the AEDGs. Figure 7 compares the share of achieved energy savings that is attributable to the AEDGs, code requirements, and other factors.

\textsuperscript{w} These results are in line with expectations given that most sampled projects are subject to codes based on 90.1-2004 or 90.1-2007. DOE estimates that 90.1-2004 is approximately 12 percent more stringent than 90.1-1999, and 90.1-2007 is around 18 percent more stringent.
On average, we found that the AEDGs were responsible for around 32 percent of the overall reduction in energy use, more stringent code requirements were responsible for 54 percent of the overall reduction, and other factors were responsible for 14 percent of the overall reduction. A number of interview participants noted that in order to ensure the continued relevance of the guides, it is important to update them to reflect changes in code requirements. Beginning in 2010, ASHRAE plans to develop new AEDGs that use 90.1-2004 as a baseline. Once the new guides are available, we would expect code requirements to be responsible for a smaller fraction of total energy savings and the AEDGs to be responsible for a larger fraction.

**Percentage of AEDG recommendations that were implemented**

Figure 8 presents our estimates of the percentage of AEDG recommendations adopted by end use and building type.\(^x\) Averaged across all building types, approximately 75 percent of cooling recommendations were implemented, 71 percent of heating recommendations were implemented, 52 percent of envelope recommendations were implemented, 44 percent of lighting recommendations were implemented, and 44 percent of water heating recommendations were implemented. An average of 51 percent of all AEDG recommendations were implemented for the projects in our sample.

\(^x\) Rather than addressing all AEDG recommendations in the interviews, interview questions focused on AEDG recommendations with the greatest potential for energy savings. However, we estimated the share of AEDG recommendations implemented for each end use by factoring in the percentage of recommendations that were implemented of the ones we asked about, as well as the participant’s 1-5 rating of how important the AEDG was in the design of systems affecting each end use.
Given that most interview participants had direct involvement in HVAC design decisions it makes sense that this area shows a higher percentage of AEDG recommendations adopted than in the envelope and lighting areas where fewer participants were involved in design decisions. A number of participants noted that due to the minimal demand for hot water (particularly for office and retail buildings), implementing water heating recommendations was not a priority.

**Outer-bound energy savings estimate**

As previously discussed, we made a number of simplifications and assumptions to deal with incomplete information. Our conservative assumptions regarding missing information may mean our results understate the actual design energy savings achieved by sampled buildings. As a benchmark, we compared our estimates with information that the interviewees provided about the design energy performance of the projects they discussed. In most cases participants claimed that they achieved higher levels of beyond-code energy performance than our calculations indicate. On average, participants said the energy performance of sampled buildings was 24 percent better than code requires. We estimated the energy performance of sampled buildings to be 11 percent better than code requires.

Missing information could be one reason for this discrepancy. Since we could not ask about all AEDG recommendations in the interviews, it was likely that participants did not get credit from some of the energy efficiency measures they implemented. As noted in the methodology discussion, energy recovery ventilation and demand controlled ventilation were two AEDG recommendations which could have produced substantial energy savings but were not addressed in the interviews. To determine the maximum impact that could have been achieved from including these measures, we developed an outer-bound estimate. This scenario assumes that DCV was used in all office, retail, and warehouse projects, and ERV was used in all K-12 projects. Figure 9 compares our conservative and outer-bound estimates with the energy performance information provided by interview participants.

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\[y\] In cases where participants told us that sample projects included ERV and DCV, the conservative estimates include the impact of those upgrades.
Figure 9: Comparison of ECW estimates with participant responses on average building energy performance

Under the outer-bound scenario, the average energy performance of the sampled buildings is 15 percent better than code. Converting this estimate to a comparison to the requirements of 90.1-1999, under the outer-bound scenario the buildings achieve an average reduction of 28 percent beyond the requirements of 90.1-1999. Figure 10 compares the outer-bound estimate with the conservative estimate and potential savings originally shown in Figure 6.

Figure 10: Comparison of conservative and outer-bound estimates with respect to total savings potential

It is likely that some but not all participants implemented ERV and DCV, and that actual savings lie somewhere between the conservative and outer-bound estimates. Despite the limitations inherent in our simplified approach, our results indicate that most AEDG users are not capturing the full energy savings potential associated with comprehensive implementation of all AEDG recommendations. On average
across the sampled projects, AEDG users are implementing around 50 percent of the recommendations in the guides and capturing about 60 percent of the potential energy savings. In addition, our results show that code requirements were responsible for more than half of the overall reduction in design energy consumption as compared with the 90.1-1999 baseline. As code requirements move the market toward a more energy efficient baseline, it is important to update the AEDGs to ensure that they remain a viable resource for helping design professionals achieve beyond-code energy performance.

**Additional savings not included in our estimates**

It is also important to recognize that we were not able to quantify the energy impacts associated with applications of the AEDGs outside of the targeted small commercial building construction markets. A number of technical interview participants discussed AEDG usage in connection with energy efficiency retrofit projects or building types that are not within the targeted small commercial markets. As energy efficiency becomes an increasingly important strategy for controlling costs and taking action to address climate change, there is a growing need for credible, actionable information about opportunities for saving energy in commercial buildings. ASHRAE is a trusted source for this type of information. Though quantifying the energy impacts that result from non-traditional uses of the AEDGs was outside the scope of this study, there is little doubt that such usage is responsible for additional energy savings.
COMPARATIVE AWARENESS AND USE OF AEDGS

We used data from the member survey to compare awareness and usage of the AEDGs with that of other energy efficient/sustainable design resources, namely: LEED for New Construction, LEED for Schools, ENERGY STAR Target Finder, Advanced Buildings Core Performance Guides, Green Globes, and BREEAM. Figure 11 compares awareness and usage results across these resources.

Survey results indicate that LEED NC is the most widely-used design resource, with 50 percent of respondents indicating they have used it at least once. Thirty one percent of respondents indicated they have used the AEDGs. Awareness of LEED and the AEDGs is the same with 72 percent of respondents expressing familiarity with both resources. Familiarity and usage was lowest among the two design resources which are more commonly used in international markets, Green Globes and BREEAM.

There appears to be some variability in AEDG based on the respondent’s typical role in building design projects. Figure 12 compares AEDG usage and awareness among respondents who indicated they had some/a lot of involvement in selecting the overall approach and design details for key building systems: lighting, building envelope, HVAC and water heating. Forty one percent of survey respondents who are involved in lighting and building envelope design indicated that they use the AEDGs, compared with 36

Figure 11: Comparative awareness and usage of design resources
(n=565)

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z These percentages have a sampling margin of error of four percentage points.
percent of those involved in water heating system design and 33 percent of those involved in HVAC design.\textsuperscript{aa}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure12.png}
\caption{Comparative awareness and usage of AEDG by project role}
\end{figure}

- Envelope: n = 119 (overall); 187 (details)
- Lighting: n = 103 (overall); 134 (details)
- HVAC: n = 468 (overall); 482 (details)
- Water heating: n = 350 (overall); 373 (details)

Focusing on the two most widely-used resources—LEED NC and the AEDGs—we conducted a comparative analysis of user ratings of each resource. Each resources was rated on the basis of the following metrics: credibility of the information source, ease of obtaining the resource, level of detail in technical content, effectiveness in reducing building energy use, organization of the information, and allowing for the flexibility to match project needs with energy performance goals. Figure 13 compares responses across all individuals who have used each resource. Figure 14 compares responses across only those individuals who have used both the AEDGs and LEED NC.

\textsuperscript{aa} These percentages have a sampling margin of error of four to eight percentage points. Differences between the lighting group and the HVAC group are statistically significant at 95 percent confidence (z-score=2.03).
The AEDGs received particularly favorable ratings in terms of credibility (88 percent agreement), ease of accessing the resource (82 percent agreement), and level of detail in technical content (75 percent agreement). As we learned during the technical interviews, AEDG users cite the credibility of the

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**Footnote**

These percentages have a sampling margin of error of five to seven percentage points.
resource as particularly important in terms of influencing other members of the design team to implement energy efficiency upgrades.

Across all categories and user groups, AEDGs received more favorable ratings than LEED. Comparing all users of each resource as shown in Figure 13, all differences between AEDG and LEED are statistically significant. Comparing only those individuals who have used both resources as shown in Figure 14, all differences between AEDG and LEED are statistically significant with the exception of the flexibility category. In other words, AEDG received more favorable ratings than LEED on the basis of credibility, level of detail in technical content, effectiveness at reducing energy use, and organization.

These results show high awareness of the AEDGs among the population of ASHRAE members, with awareness equivalent to LEED NC. These results do not tell us what AEDG awareness is among the general population of ASHRAE members. AEDG usage is significantly lower than LEED NC, however, and the challenge will be to motivate individuals who are aware of the AEDGs to take the next step and apply them in their design work.

\[\text{cc}\] Differences between user ratings of AEDGs and LEED NC are statistically significant at 95 percent confidence, with z-scores ranging from 2.59 to 7.42.

\[\text{dd}\] Differences between user ratings of AEDGs and LEED NC are statistically significant at 95 percent confidence, with z-scores ranging from 1.99 to 6.12.
BARRIERS TO AEDG USAGE

Our research indicates that the majority of people who have downloaded the AEDGs have not yet used them in connection with a specific design project. Some AEDG downloaders have accessed the guides for informational purposes despite the fact that they are not directly applicable to the work they do. Our real interest, in terms of identifying and addressing barriers to AEDG use, is in downloaders who work in the targeted markets but have not yet been motivated to use the guides. Our research suggests that some of these individuals have concrete reservations about using the guides, such as cost-effectiveness concerns. But a number of those who work on applicable projects told us they have “not yet had the opportunity” to use the guides, or that “no one has requested that they use them.” This finding suggests that increasing AEDG awareness among mechanical engineers’ typical clients—architects and building owners—could be an effective strategy in driving greater use of the guides.

In recruiting participants for the technical interviews, we conducted a phone screening process that reached 181 people who had downloaded one or more of the AEDGs. Only 22 percent of those individuals reported having used the AEDGs. This percentage is lower than the 30 percent of member survey respondents who reported using the guides, probably due to self-selection on the part of survey respondents (i.e., AEDG users were more likely to participate in the member survey than people who had downloaded the guides but not used them). When we reached non-users during the phone screening process we asked them if they had any reasons for not using the guides. Responses are summarized in Figure 15.

![Figure 15: Reasons for not using AEDGs among downloaders who have not yet used them (n=142)](image)

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**Figure 15: Reasons for not using AEDGs among downloaders who have not yet used them (n=142)**

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œ Sampling margin of error is six percentage points.

if Sampling margins of error range from two to eight percentage points.
Among the individuals who provided a response to this question, the most common reason was that the AEDGs are not applicable to their work. Many of these individuals said they downloaded the guides for informational purposes but they do not work on small commercial building design projects. These results highlight the value of the guides in terms of a general resource for energy efficiency information. But the real potential for expanding use of the guides is in the other categories—the 17 percent of non-users who said they have not had the need or opportunity to use the AEDGs, or the 9 percent who said they have not yet had time to review it.

The member survey provided additional data that can be used to assess potential barriers to AEDG use. The survey asked individuals who are aware of the AEDGs but have not used them to indicate their agreement or disagreement with eight different reasons for not using the guides. Results are presented in Figure 16.

![Figure 16: Reasons for not using AEDGs among those who are aware of the resource (n=235)](image)

The most commonly-cited reason for not using AEDGs was that the individual uses other design resources instead, with 48 percent of respondents indicating agreement with this statement. However, forty three percent of respondents said they have not used AEDGs yet but plan to in the future. Cost-effectiveness concerns were the third most common response, with 27 percent of respondents indicating agreement. Twenty six percent of respondents indicated they do not need design resources in order to design energy efficient buildings. Fewer than 20 percent of respondents indicated agreement with each of the remaining categories.88

88 These percentages have a sampling margin of error of four to seven percentage points.
With increased outreach and marketing there is opportunity for attracting new AEDG users from many of these groups, with the “plan to use” category being the most likely candidates. These results also indicate that AEDG content does not present significant barriers to use. Rather, the challenge is to increase AEDG usage among individuals who work in applicable markets, but who are not motivated to use the AEDGs on their own or have reservations about using them. The following section discusses potential outreach strategies that ASHRAE could pursue to achieve this objective.
STRATEGIES FOR PROMOTING BROADER USE OF THE AEDGS

We asked interview participants to suggest actions ASHRAE could undertake to promote broader use of the AEDGs. In this section we highlight key marketing and outreach recommendations that were suggested by AEDG users:

- Increase AEDG marketing to architects, building owners, and other clients.
- Create an online community for AEDG users to share information.
- Work with utilities and other energy efficiency program administrators to develop a program model that leverages the AEDGs.

Increase AEDG marketing to architects, building owners, and other clients

The most frequently-mentioned suggestion from interview participants was to promote the guides more aggressively to architects. More than twenty percent of interviewees made this recommendation, along with several member survey respondents. In a similar vein, a number of participants suggested that more could be done to increase AEDG awareness among building owners. The intent behind both of these suggestions is to increase AEDG awareness among the typical clients for whom mechanical engineers work on small commercial design projects. By increasing AEDG awareness among these groups, ASHRAE would build broader support for use of the AEDGs, and also potentially stimulate market demand for design professionals who use the AEDGs. Below are a few ideas for increasing outreach to these audiences.

VIRAL MARKETING STRATEGIES

As previously discussed, a number of AEDG users already promote the guides to architects and other clients as well as other members of the design team. Some participants reported that they share links to the free download web page, and others said they review the AEDG recommendations tables during project meetings. ASHRAE could develop marketing materials to support these efforts. One participant who is active in his local AIA chapter said that it would be helpful to have a simple handout or brochure about the AEDGs that he could distribute at chapter events and to clients. The handout would provide basic information about the AEDGs and discuss how architects could benefit from using them. Key benefits for architects include a prescriptive path for earning LEED points and straightforward, practical recommendations for energy efficient building design that align well with AIA sustainability initiatives such as the 2030 Commitment. ASHRAE could contact AIA members who have downloaded the AEDGs to obtain testimonials or case study information that could be used in marketing the guides to architects. In addition to making marketing collateral available on the ASHRAE web site, distributing the handouts via email to AEDG downloaders could produce a viral marketing effect where AEDG users facilitate broader distribution via their clients and other design team members. Ideally, this type of resource would be jointly produced by ASHRAE and AIA.

A similar approach could be used in marketing the AEDGs to building owners. A handout that targets building owners should emphasize the business case for using the AEDGs as a comprehensive design resource. Other marketing efforts that target a similar audience—for example, the ENERGY STAR Commercial Buildings Program and Advanced Buildings Core Performance—emphasize financial value messaging that demonstrates the business case for designing high performance buildings (e.g., increase in
net operating income, a more comfortable work environment, and value-added features that can be used to attract tenants).

CONTINUING EDUCATION CREDITS FOR AEDG TRAINING
AIA’s Continuing Education System is a potential avenue for offering targeted AEDG training opportunities to architects. Each year, AIA requires that its members obtain four hours of continuing education in sustainable design as part of its overall 18-hour annual continuing education requirement. ASHRAE has already developed training courses to support the small office and small retail guides, with plans to develop additional AEDG courses in future. ASHRAE could pursue getting these courses qualified to fulfill AIA’s sustainable design continuing education requirement.6 Trainings can be offered in a distance learning environment to minimize costs and maximize the potential audience.

WHITE PAPERS, JOURNAL ARTICLES AND PRESENTATIONS
A white paper or journal article is inexpensive to develop and can be easily tailored for different publications. The key components would be introducing the AEDGs to the reader, presenting the business case and other benefits, and highlighting a successful project where the AEDGs have been used. For architects and other members of the design team, potential publications include High Performing Buildings, LD+A, Architect Magazine, Building Design and Construction, and Eco-Structure, to name a few. Publications for building owners and property managers include Building Operating Management Magazine and Buildings Magazine.

Similarly, industry conferences and meetings are another avenue for presenting AEDG information to the relevant markets. AIA’s Committee on the Environment (COTE) provides an avenue for regional or local events with a sustainability focus. IFMA, BOMA and other relevant industry associations may also be looking for speakers that can provide technically-oriented information on high performance building design.

Create an online community for AEDG users
One of the limitations of a published resource such as the AEDGs is that frequent updates are generally not practical for cost and other reasons. Many interview and member survey participants expressed interest in seeing the AEDGs updated to reflect increasingly stringent code requirements as well as information on emerging energy efficient technologies that have become more common since the guides were published. One interviewee suggested that an online forum for AEDG users would make the guides more of a dynamic resource. Such a forum could provide a way for ASHRAE members who use the guides frequently to share knowledge with peers who may be less familiar with the AEDGs. For example, AEDG users could post questions regarding the application of specific technologies, and users who have experience with the technology would be able to post responses.

The online forum could also be used to share cost information among AEDG users. Several interviewees noted that information about the relative cost of implementing different recommendations would be helpful in assessing tradeoffs and getting buy-in from clients. However, it is difficult to provide cost information in a published guide. Costs can vary widely depending on project-specific conditions, and this type of information is often quickly out of date. However, AEDG users could use the online forum as an informal way of sharing cost information based on their experiences.
The online forum could serve as repository for a variety of resources to support AEDG use, some of which already exist in different places on the ASHRAE web site. It could be used to highlight success stories about projects where the guides were used. A calendar feature could keep AEDG users informed about upcoming presentations and training opportunities. With the simple addition of an opt-in check box on the AEDG download screen, people could indicate their interest in participating in this online community.

**Collaborate with energy efficiency program administrators**

A growing number of utilities are offering energy efficiency programs that target the commercial new construction market. In addition to incentives, many of these programs offer technical assistance to help design teams and building owners identify energy efficiency opportunities and evaluate alternatives. During the technical interviews we spoke with two people who work for utility energy efficiency programs, one of whom uses the AEDGs extensively as the starting point for making design recommendations to program participants.

Utilities and other energy efficiency program administrators face challenges in serving the small commercial new construction market, however. The size of these projects often means that energy savings are not large enough to justify extensive amounts of technical support. At the same time, in many cases these are the types of projects that would most benefit from the expertise that program staff are able to offer. Smaller projects benefit from a straightforward prescriptive program strategy that minimizes effort on the part of participants and program staff.

The collaboration opportunity is for ASHRAE to work with utilities and other energy efficiency program administrators to develop prescriptive incentive offerings based on implementation of AEDG recommendations. Such an effort would likely require sharing data that utilities can use in conducting cost-effectiveness analysis, a key component for obtaining regulatory approval for new programs. The fact that the AEDGs are based on extensive modeling conducted by national labs on behalf of DOE would likely be beneficial in terms of enhancing credibility with utility regulators. Such collaborations would be particularly timely when ASHRAE releases updated versions of the AEDGs which are based on more stringent code requirements and a more aggressive energy savings target.

Even for utilities that are not able to offer incentives based on AEDG recommendations, there still may be opportunity for fruitful collaborations that promote wider dissemination of the AEDGs. For example, utilities could share AEDG information with design teams they are working with, or distribute copies of the AEDGs to their customers.

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Efficiency Vermont’s new construction program based on Core Performance is one example of a similar type of collaboration: http://www.efficiencyvermont.com/pages/Business/BuildingEfficiently/DesignResources/CorePerformance/.
SUGGESTED CHANGES TO AEDG CONTENT

In both the member survey and technical interviews, AEDG users gave the guides high marks for content and usability. The most frequently-mentioned request was to update the guides based on more stringent code requirements and more aggressive energy savings targets. ASHRAE’s plans to release a new series of guides that are based on 90.1-2004 with an energy savings target of 50 percent will address this issue. Still, other feedback received during the technical interviews is useful for informing the next generation of AEDGs.

Our discussions with AEDG users indicate there is a high degree of variability in how the guides are used. While some users work systematically through the guides in an effort to implement as many recommendations as possible, a good number of users use the guides selectively to inform specific components of the building design. AEDG users also show a good degree of variability in terms of their willingness to push the envelope on energy efficient design. While some already go beyond AEDG recommendations as a standard practice, others are implementing AEDG recommendations in a more limited way. With new guides based on more aggressive targets, it will be important to ensure that the guides remain viable for a broad spectrum of potential users. One option for ensuring the continued flexibility of the guides is to provide information about the relative magnitude of different energy savings opportunities. This would make it easier for AEDG users to evaluate alternatives and tradeoffs. Since the energy savings associated with some recommendations vary widely depending on climate zone and building operation, developing a supplementary calculator tool may be the best approach for facilitating this type of analysis. The New Buildings Institute is currently developing an eQUEST-based software tool that is intended to support this type of analysis for Core Performance.

Overall, AEDG users spoke favorably about the level of detail and the application-oriented information in the AEDGs. However, several interviewees expressed the need for more detailed information about how to implement specific components of energy efficient building design. Participants requested additional detail on proper ventilation, commissioning, duct sealing, addressing thermal breaks, and application of spray foam insulation. One user said that the commissioning process needs to be streamlined and systematized in order to make it truly viable for small buildings. He thought an appendix or supplement with a generic commissioning plan for small buildings would be useful. Another participant provided detailed suggestions for revisions to water heating recommendations in order to properly address the high degree of variability in overall amount of hot water demand, location of demand, and patterns of hot water use among small commercial buildings and schools.

Additional content-related suggestions made by AEDG users include:

- Include links and bookmarks in the PDF version of the guides to make navigation through the document easier.
- Include additional HVAC technologies beyond packaged units.
- Provide more cross-references to other ASHRAE resources that provide detailed information about specific technologies (e.g., resources that address geothermal systems, renewables, etc.)
- Include climate zone information for regions outside the U.S.
- Address the importance of ensuring proper operations and maintenance practices after the building is constructed.
CHAPTER 4: CONCLUSIONS

The goals of this evaluation were to assess awareness and use of the AEDGs in comparison with other design resources, develop a high-level estimate of the energy savings impacts resulting from AEDG use, and assess potential improvements in the content, format, and distribution strategy that could increase AEDG use among design professionals. This analysis is based on 716 responses to an online survey of ASHRAE members who have downloaded the guides, technical interviews with 54 ASHRAE members who have used the guides, and secondary market analysis to explore opportunities for promoting broader use of the guides.

Estimated impact of AEDGs on design energy use
In sampled projects where the AEDGs were used, we estimate that average design energy consumption is between 24 and 28 percent lower than the minimum requirements of 90.1-1999. K-12 schools showed an average reduction of 26 percent and office buildings showed an average reduction of 21 percent. Though more stringent code requirements are currently responsible for around half of the estimated reduction, if the guides are updated to a more stringent baseline in future we would expect the AEDGs to be responsible for a relatively larger share of achieved energy reductions.

AEDG users gave the guides favorable ratings
Most AEDG users who participated in the member survey and technical interviews expressed favorable views about the guides’ usefulness as a design resource. More than 70 percent of AEDG users who responded to the member survey agreed that the guides are a credible source of information on energy efficient building design, that they are easy to obtain, that the technical content is sufficiently detailed, and that they are effective at reducing design energy consumption. A larger percentage of survey respondents found the recommendations by climate zone and how-to tips to be useful (61 percent and 59 percent of AEDG users, respectively) than the discussion on integrated design process (47 percent). The AEDGs received more favorable user ratings than LEED, including among individuals who have used both design resources. When asked whether they were in favor of using the guides on future projects, almost all technical interview participants responded in the affirmative.

Maintaining the AEDGs as a flexible resource for design professionals
The AEDGs are used in a variety of ways, both as a comprehensive design guide for achieving whole building energy performance and selectively to inform the design of key building systems. Technical interview participants were evenly split between comprehensive and selective users, with 40 percent of participants in each category. The remaining 20 percent of participants use the AEDGs primarily as a reference to ensure that the building design meets industry best practices. The guides are also being used in nontraditional ways such as energy efficiency retrofit projects and to design buildings that are outside the targeted small commercial markets. Maintaining the flexibility of the guides is important to ensuring that they remain viable for a broad spectrum of potential users, particularly as new guides are developed that seek higher levels of energy savings. To make the AEDGs a more dynamic resource, ASHRAE could develop an online forum where AEDG users could ask questions of other users, share ideas, and access supplementary resources. For users who are not able to implement the full suite of AEDG recommendations, ASHRAE could provide additional information or develop a supplementary calculator tool to help AEDG users analyze tradeoffs and identify the areas of greatest opportunity.
AEDGs are a valued communications tool
Nearly half of the AEDG users who participated in the technical interviews said they use the guides as a communications tool for influencing clients and other members of the design team to adopt energy efficiency recommendations. According to AEDG users the guides facilitate communications because they are produced by an independent and credible third party, they are easy to use and understand, and they provide practical, application-oriented recommendations for reducing building energy use. By developing viral marketing pieces that communicate the AEDG value proposition to architects and building owners, ASHRAE could support AEDG users’ efforts to introduce the guides to new audiences.

New marketing and outreach strategies could address barriers to AEDG use
Results from this study suggest that with while awareness of the AEDGs is high among ASHRAE members—equivalent to awareness of LEED—new marketing and outreach strategies would likely be beneficial in terms of promoting broader use of the guides. Most people who have downloaded the guides have not yet used them in connection with a specific project. Among member survey respondents who have downloaded the guides but not used them, 43 percent said they plan to use the guides in future. Among AEDG downloaders we spoke to during the phone screening process, 17 percent said they have not yet had a need or opportunity to use the guides. By increasing AEDG awareness among the typical clients for whom mechanical engineers work on small commercial design projects, ASHRAE could stimulate market demand for design professionals who use the guides. Strategies for accomplishing this objective include conducting targeted outreach and training through key industry associations, placing articles in industry publications that have not previously featured AEDG-related content, and developing partnerships with utilities that administer commercial new construction programs. By reaching out to new audiences, ASHRAE could build on the successes already achieved and lay the groundwork for achieving even greater success with the next generation of AEDGs.
END NOTES


2 Personal communication with Bruce Hunn, ASHRAE Director of Strategic Technical Programs (December 11, 2009).

3 Personal communication with Bing Liu, Pacific Northwest National Laboratory (December 21, 2009). PNNL estimates that Title 24 is between 10 and 15 percent more efficient than 90.1-2004.


LIST OF APPENDICES

Appendix A: ASHRAE Member Survey

Appendix B: Qualitative Responses to ASHRAE Member Survey

Appendix C: Technical Interview Guide

Appendix D: Interview Screening Email and Call Script

Appendix E: Technical Interview Responses

Appendix F: Methodology for Energy Impact Estimates
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APPENDIX A: ASHRAE MEMBER SURVEY

Thank you for helping ASHRAE improve energy design resources for small commercial buildings. Please provide responses based on your own perspective, except in the case of specific questions that pertain to the activities of your firm. Survey length will depend on the degree to which you are involved in the small commercial new construction market. At the most, we expect this survey will take 15 minutes to complete. All survey responses will remain anonymous.

1) **Does your work involve the design and/or construction of commercial buildings?**
   - ☐ Yes
   - ☐ No
   *(If “no” is checked, skip to Q23 as respondent does not work on commercial building design projects)*

2) **Which of the following best describes your area of design practice?**
   - ☐ Architectural design
   - ☐ Mechanical design
   - ☐ Electrical design
   - ☐ Project management
   - ☐ Other (please specify): _______________________

3) **To what extent are you typically involved in the following aspects of projects?**

<table>
<thead>
<tr>
<th></th>
<th>choosing the <em>overall</em> approach</th>
<th>developing the design <em>details</em> (equipment specification, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>none / little</td>
<td>some / a lot</td>
</tr>
<tr>
<td>Building envelope design</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>HVAC system design</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lighting design</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Water heating system design</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

4) **How many commercial building design projects do you work on during a typical year?**

*Italicized parentheticals indicate skip patterns programmed into the online survey software.*
5) **Approximately what share of your design work is spent on the categories below?**

<table>
<thead>
<tr>
<th>Building Type</th>
<th>None</th>
<th>1-10%</th>
<th>11-25%</th>
<th>26-50%</th>
<th>&gt;50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small office buildings (up to 20,000 ft²)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small retail buildings (up to 20,000 ft²)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>K-12 school buildings</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small warehouses (up to 50,000 ft²) with unitary HVAC</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Self-storage facilities with unitary HVAC</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

(If “none” is checked in all categories, skip to Q23 as respondent does not work in targeted markets)

6) **What building code(s) govern a significant portion of the buildings you work on?** (Check any that apply).

- ASHRAE 90.1-2007
- ASHRAE 90.1-2004
- State- or country-specific code (please specify): _________________________

7) **In designing small commercial buildings, what is the typical level of energy performance that you seek to achieve?**

<table>
<thead>
<tr>
<th>Energy performance</th>
<th>Consistent with code</th>
<th>1-15% below code</th>
<th>16-30% below code</th>
<th>&gt;30% below code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
8) What share of your small commercial building design projects seek to achieve lower energy usage than required by building energy codes?

<table>
<thead>
<tr>
<th>Building Type</th>
<th>None</th>
<th>Some</th>
<th>Many</th>
<th>Most</th>
<th>All</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small office buildings (up to 20,000 ft²)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Small retail buildings (up to 20,000 ft²)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>K-12 school buildings</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Small warehouses (up to 50,000 ft²) with unitary HVAC</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Self-storage facilities with unitary HVAC</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

9) Please indicate your level of familiarity and usage of the resources listed below that support the design and construction of energy efficient commercial buildings.

<table>
<thead>
<tr>
<th>Design Resource</th>
<th>Not familiar with it</th>
<th>Heard of it</th>
<th>Reviewed it</th>
<th>Used it once or twice</th>
<th>Use it often</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE Advanced Energy Design Guides</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>NBI Advanced Buildings® Core Performance Guides</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>LEED® for New Construction</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>LEED for Schools</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>ENERGY STAR® Target Finder</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>BREEAM</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Green Globes™</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
9a) If you have used other design resources not listed in the table above, please specify: ___________________________

If respondent is aware of the AEDGs but has not used them (“heard of it” or “reviewed it”), skip to Q10.

If respondent checked “used it once or twice” or “use it regularly” for ANY resource, skip to Q12.

If respondent checked “not familiar” with the ASHRAE Guides and “not familiar,” “heard of it” or “reviewed it” for all other resources, skip to Q24.

10) Please identify any reasons you haven’t used the ASHRAE Advanced Energy Design Guides (the Guides) by indicating your agreement/disagreement with the statements below.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I design energy efficient buildings without needing to refer to design guidance resources.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I use design guidance resources other than the Guides.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I have concerns about the technical content in the Guides.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>It is difficult to find relevant information in the Guides.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I would use the Guides but encounter opposition from other members of design team.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I would use the Guides but encounter opposition from my clients.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neither agree nor disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>---------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>I am concerned that using the Guides would result in a project</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>that is not cost-effective.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have not yet used the Guides but may do so in the future.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

11) **If you would like to provide additional information on your reasons for not using the Advanced Energy Design Guides, please submit comments in the space provided.**

(If respondent indicated use of any design resources other than AEDGs in Q9, proceed to Q12. If not, skip to Q24.)

12) **Please rate the quality of the design resources you have used by indicating your agreement/disagreement with the statements below.**

**Design Resource: __________** (Field will list any resource that received a check under “used once or twice” or “use it regularly” in Q9. Table will repeat as needed.)

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The resource is easy to obtain.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The resource is a credible source of information on energy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>efficient building design.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides Appendices

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The technical content of the resource is sufficiently detailed to assist me in my design.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The content is organized in a way that makes it easy to find the information I am looking for.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The resource offers enough flexibility so that I can match individual project needs with specific energy performance goals.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The resource is effective in reducing the energy use of targeted buildings.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

(If respondent checked as “used once or twice” or “use it regularly” for AEDGs in Q9, proceed to Q13. Otherwise, skip to Q24.)

13) **Please indicate the total number of buildings you have worked on that were designed using one of the Advanced Energy Design Guides as a reference.**

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Total Number of Buildings Designed Using Guide as Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small office buildings (Guide published in 2004)</td>
<td></td>
</tr>
<tr>
<td>Small retail buildings (Guide published in 2006)</td>
<td></td>
</tr>
<tr>
<td>K-12 schools (Guide published in 2008)</td>
<td></td>
</tr>
<tr>
<td>Small warehouse/self storage facilities (Guide published in 2008)</td>
<td></td>
</tr>
</tbody>
</table>
14) In general, to what extent does your use of the Advanced Energy Design Guides influence the resulting energy efficiency of the building design?

<table>
<thead>
<tr>
<th>Degree to which Guides influence energy efficiency of building design</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>A great deal</th>
</tr>
</thead>
</table>

15) What categories describe your typical use of the Advanced Energy Design Guides? (Check all categories that apply).
- ○ Designing a building to achieve a desired level of energy performance
- ○ Designing key building systems (HVAC, lighting, etc.) to achieve a desired level of energy performance
- ○ Specifying the energy performance of individual pieces of equipment
- ○ Other (please specify): ____________________________

16) Have you used the Advanced Energy Design Guides to achieve LEED points?
- ○ Yes
- ○ No

17) Please rate the usefulness of individual components of the Advanced Energy Design Guides.

<table>
<thead>
<tr>
<th>Component</th>
<th>Not at all useful</th>
<th>Not very useful</th>
<th>Neutral</th>
<th>Useful</th>
<th>Very useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion of integrated design process</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Recommendations by climate zone</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Guidance on implementing recommendations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Examples of energy efficient buildings in each climate zone</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
18) What percentage of the design professionals who work at your firm use the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>Percentage of design professionals at my firm who use the Guides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t know</td>
</tr>
<tr>
<td>○</td>
</tr>
</tbody>
</table>

19) What suggestions do you have for improving the Advanced Energy Design Guides?

20) Would you like to provide any additional comments regarding the Advanced Energy Design Guides?

21) The second phase of this research project will include 30-minute telephone interviews with design professionals who have used the Advanced Energy Design Guides. Would you be willing to participate in a phone interview regarding your experiences using the guides?

☐ Yes
☐ No

22) Submit screen for participants who were screened out under Q1 and Q5.

Thank you for participating in this survey. While our research targets design professionals who work on specific types of small commercial buildings, it is important that we also identify survey recipients who do not work in the targeted markets.

To make sure your response is counted, please click the “submit” button below.

Thank you again for your willingness to participate!
23) **Submit screen for all other participants.**
Thank you for taking the time to participate in this survey. Your responses will support the development of ASHRAE resources for design professionals serving the small commercial new construction market.

To make sure your responses are counted, please click the “submit” button below.

Thank you again for your willingness to participate!
### APPENDIX B: QUALITATIVE RESPONSES TO MEMBER SURVEY

<table>
<thead>
<tr>
<th>Responses to Q11: If you would like to provide additional information on your reasons for not using the Advanced Energy Design Guides, please submit comments in the space provided.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE has lost its compass as an organization that primarily supports and helps the design professionals, so design professionals have abandoned ASHRAE.</td>
</tr>
<tr>
<td>BREEAM and CIBSE guides are used in UK.</td>
</tr>
<tr>
<td>Cost of getting a print copy of the guide.</td>
</tr>
<tr>
<td>Have not heard about it. Nobody requires it or publicizes it.</td>
</tr>
<tr>
<td>I am currently working in a region where we need to educate the client and sometimes the engineers to adopt new ideas or apply new design approaches.</td>
</tr>
<tr>
<td>I am planning to have the Guides in the near future.</td>
</tr>
<tr>
<td>I don't do much small commercial</td>
</tr>
<tr>
<td>I have not used the Manual as much as intended because I don't have the background to make immediate use of the information. That is not to say that calculations are beyond me, but at our core, we are a PHVAC contractor. I would be more prone to use the Guide if I knew it to be somewhat of a quick(er) reference guide. That said, I intend to delve more deeply into my manual in the near future. (May need to get through '09 first).</td>
</tr>
<tr>
<td>I only perform Test and Balance to projects and refer to engineering designs.</td>
</tr>
<tr>
<td>I plan on using them soon.</td>
</tr>
<tr>
<td>In California, we work under a building code called Title 24. This building requirement is for all types of buildings. Many of the requirements are more restrictive as to the energy savings than the Advanced Energy Design Guides.</td>
</tr>
<tr>
<td>In New Zealand we have other guides and standards to work to. However we could use these Guides if the solutions more than meet the minimum requirement of the NZ standards.</td>
</tr>
<tr>
<td>Local conditions of Brunei, both geographically &amp; socially prevail.</td>
</tr>
<tr>
<td>Most engineers don't have any influence or very little influence on envelope design. The AEDG need to be pushed by AIA in order to inform architects that they control more of the energy conservation efforts than most mechanical engineers.</td>
</tr>
<tr>
<td>Most of the opposition I encounter is due to capital cost issues as well as broken LEED issues, such as a bike rack is worth as much saving 7% building total energy cost. Additionally, how can I compare real-world savings to a model that can't possibly exist in the real world?</td>
</tr>
<tr>
<td>NABERS Guidelines used.</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Not enough concern for humidification in LEED design. Our LEED building is very uncomfortable in the winter because there was no thought of humidification in the design of the project. LEED parameters should have this as a point/high point number. The buildings are not tested either, no infrared testing or blower door tests? Should be a requirement before points are awarded.</td>
</tr>
<tr>
<td>The time involved in getting familiar with the guides is not accounted for in the initial stages of the projects, whereas extra time is allowed for in LEED projects (and hence the use of LEED guides) because the clients seek LEED certification and acknowledge that they will have to allow for greater design fees.</td>
</tr>
</tbody>
</table>
### Responses to Q11: If you would like to provide additional information on your reasons for not using the Advanced Energy Design Guides, please submit comments in the space provided.

<table>
<thead>
<tr>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using ASHRAE 90.1 or CA Title 24 codes performance approach and the available trade off opportunities offered by them, our office rarely uses any prescriptive or similar energy guides.</td>
</tr>
<tr>
<td>We utilize building modeling software, Carrier's HAP.</td>
</tr>
<tr>
<td>ASHRAE needs to spend less time and resources telling consulting engineers what to do, and more time giving them guidance in what they might want to consider doing.</td>
</tr>
<tr>
<td>Haven't used guides typically because I live in Australia.</td>
</tr>
<tr>
<td>I want all the above design guide if possible.</td>
</tr>
<tr>
<td>In the UK the bias is for use of CIBSE Guides &amp; compliance with Building Regs. This said I believe that ASHRAE provides a greater insight which should have more application if the scheme were recognized in the same manner as the aforementioned. I will be using the ASHRAE Guides but this is a personal belief rather than a business decision.</td>
</tr>
<tr>
<td>Many of our design projects are designed around equipment, etc. more than around design guidelines. We would comply to many guidelines by default more than because they formed our design targets. Not super familiar with guidelines.</td>
</tr>
<tr>
<td>Most of our design are done by consulting engineer's office using the latest code and regulation.</td>
</tr>
<tr>
<td>Most of our firm's designs already exceed what we have seen in the Advanced Energy Design Guides and we are waiting for design guides that push the envelope, like net-zero guides.</td>
</tr>
<tr>
<td>Most projects that are in the competitive world have owners that need to be convinced to design per code minimum. Designing to higher energy efficiency, if it means added cost, is out of the question and a reason to find another engineer on the next project.</td>
</tr>
<tr>
<td>No Comments.</td>
</tr>
<tr>
<td>Our clients for commercial buildings ask for specific facilities’ standard. Their standard. There is no much room for innovation.</td>
</tr>
<tr>
<td>Past experience has shown large amounts of time required to understand the guides, only to find the recommendations are not life cycle cost effective.</td>
</tr>
</tbody>
</table>

### Responses to Q19. What suggestions do you have for improving the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Continue publication on a schedule which reflects the increased stringency of the various energy codes;2) Provide more than one level of performance. ie. consider 30% savings over code and 45% savings, or some other increment which would allow LEED points and the opportunity to define specific design elements at various set levels of performance in excess of code.</td>
</tr>
<tr>
<td>Address &quot;specialty spaces&quot; - for instance, gymnasiums in K12 schools.</td>
</tr>
<tr>
<td>Create Large Commercial Office Building AEDG; Create Mid-Rise Dormitory AEDG</td>
</tr>
<tr>
<td>Expand to actual implementation for a more broad use. As is now, good for offices and schools and other major people occupied buildings.</td>
</tr>
<tr>
<td>Extend the scope to larger buildings.</td>
</tr>
</tbody>
</table>
### Responses to Q19. What suggestions do you have for improving the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free seminar online to cover topics.</td>
</tr>
<tr>
<td>Given advances in super windows, the window U values seem low for Northern climates.</td>
</tr>
<tr>
<td>I am not convinced that the energy savings is as great as advertised based on my experience modeling other buildings.</td>
</tr>
<tr>
<td>I'll think about it...</td>
</tr>
<tr>
<td>It would be nice to have an addendum for Australian Regional Climate data.</td>
</tr>
<tr>
<td>Keep it simple and clean. Too much theoretical noise is not helpful. Boil it down for us simple folk.</td>
</tr>
<tr>
<td>Keep them coming. Keep working with USGBC to let us get points by using them instead of modeling. I have trouble getting owners to pay for modeling, but they'll go for us using the guides. Would like to see a guide for healthcare. Also would like to see small office building guide for more than 30%.</td>
</tr>
<tr>
<td>Keep updating with current technology and practices.</td>
</tr>
<tr>
<td>More examples/case studies.</td>
</tr>
<tr>
<td>More research to assist Caribbean countries using 415 V, 3 phase, 50 Hz or 240 V, 1 phase @ 50 Hz equipment e.g. in St. Lucia</td>
</tr>
<tr>
<td>More specific technical guidance to support case studies and the implementation of new technologies.</td>
</tr>
<tr>
<td>More tips</td>
</tr>
<tr>
<td>n</td>
</tr>
<tr>
<td>n/a</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>None at this time.</td>
</tr>
<tr>
<td>Provide more data and specific guidance.</td>
</tr>
<tr>
<td>Since there are a lot more existing buildings that can use energy performance measures, more measures and alternatives for existing buildings will be helpful.</td>
</tr>
<tr>
<td>Some example of buildings with advanced energy design guides.</td>
</tr>
<tr>
<td>Stick to developing simple codes that address human safety. Stay away from using codes and developing standards that push a political agenda. Every project has a life cycle cost. If additional energy is consumed to save maintenance and repair costs, a building can consume more energy and still provide a lower life cycle cost when compared to a low energy high cost maintenance and repair building.</td>
</tr>
<tr>
<td>The guides are a somewhat necessary engineering resource. The real gem is the envelope data by climate zone. We work closely with our architects to tailor the envelope to the climate zone and application. It is invaluable for the prescriptive envelope path. The descriptions of the envelope construction methods are incredibly useful and should be expanded or even spun off as a resource for architects.</td>
</tr>
</tbody>
</table>
### Responses to Q19. What suggestions do you have for improving the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>The savings reference to ASHRAE 90.1-2001 makes the guides somewhat dated. I understand the desire for consistency in the set of Guides.</td>
</tr>
<tr>
<td>The use of SI units to be more user-friendly by engineers with metric system background.</td>
</tr>
<tr>
<td>Update the code they are compared to.</td>
</tr>
<tr>
<td>Update them for the newer versions of ASHRAE 90.1.</td>
</tr>
<tr>
<td>Water Source Heat Pumps - to include hybrid systems, ground source, water source need to be addressed. VRV Systems need to have a recognized category considering their flexibility and efficiencies.</td>
</tr>
<tr>
<td>Would like to see them for a wider variety of building types.</td>
</tr>
</tbody>
</table>

### Responses to Q20. Would you like to provide any additional comments regarding the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good resource.</td>
</tr>
<tr>
<td>Good tool for small buildings. Easy to use. Need some focus on loads and sizing equipment. Please use an updated code, at least for lighting where significant savings occur.</td>
</tr>
<tr>
<td>I like to review them and try to incorporate their suggestions.</td>
</tr>
<tr>
<td>Its a good tool to use, however most manufacturers don't offer the recommended EER/IPLV recommendations and lighting equipment for use at the above electricity supplies.</td>
</tr>
<tr>
<td>More advertising is necessary so every designer would be familiar with this.</td>
</tr>
<tr>
<td>More stress needed to implement dual enthalpy controls on packaged heating and cooling units. Often, the criteria specifying economizers offers a loophole for contractors to install units not requiring this mandate.</td>
</tr>
<tr>
<td>n/a</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Provide resources for users on energy modeling software to replicate the suggested design guide elements in the computer modeling.</td>
</tr>
<tr>
<td>Some of our Architectural Clients view these guides as a way to not have to model the building's energy performance thus saving engineering fees and the engineer's involvement in critical decisions.</td>
</tr>
<tr>
<td>To provide more credibility I would suggest more aggressive requirements.</td>
</tr>
<tr>
<td>Useful so far...</td>
</tr>
<tr>
<td>We use AEDG just as suggestions because any mandatory code exist about energy in Argentina, Paraguay and Uruguay (countries where we work).</td>
</tr>
<tr>
<td>You might consider a separate page that compares the Guide-produced savings to an ASHRAE 90.1-2004 Baseline and an ASHRAE 90.1-2007 Baseline. When ASHRAE 90.1-2010 comes out, they will be the next best thing to irrelevant anyway.</td>
</tr>
</tbody>
</table>
APPENDIX C: TECHNICAL INTERVIEW GUIDE

My name is ___ and I’ll be leading today’s interview about the ASHRAE Advanced Energy Design Guides. Thank you once again for agreeing to participate in the interview process. Your input is greatly appreciated as ASHRAE works to improve resources for design professionals who work on small commercial buildings. All responses given during this interview will remain anonymous.

1. We understand that you work on building design projects in the following markets: [fill in data collected in pre-screening interview]. Approximately how many design projects do you work on in each market during a typical year? [Only ask about markets they work in. Information on what happens under business-as-usual conditions would be helpful, rather than what’s happening as a result of the current economic downturn.]
   a. Number of small office projects: ________
   b. Number of small retail projects: ________
   c. Number of K-12 projects: ________
   d. Number of small warehouse projects: ________

2. What is the typical design team structure for the projects you work on? [Prompt if needed: are all members of the team from the same firm or are multiple firms involved?]

3. What is your typical role in small commercial building design projects?

4. How did you originally learn about the ASHRAE Advanced Energy Design Guides? [Prompt if needed: communication from colleague, communication from another member of design team, ASHRAE communication, web research, conference/industry event, industry publication, other.]

5. Have you ever worked on a project where all of the Guide recommendations were implemented? If so, how many projects have you worked on where all of the Guide recommendations were implemented? [Determine total number for each building type.]

6. If not, are there any recommendations in the Guide that you followed for the first time after reading information in the Guide?
   a. If so, which recommendations did you implement?
   b. Have you implemented these recommendations on more than one project? If not, why not?
   c. If so, is implementing these recommendations currently part of your standard practice?
   d. Approximately how many buildings have you worked on where these recommendations were implemented? [Determine total number for each building type.]
7. Do you know how many buildings your firm has worked on that were informed by the ASHRAE Guides? [Rough approximations are fine.]

8. Please pick a recent representative project that is informed by one of the ASHRAE Guides. [The information below will be used for estimating energy savings impacts resulting from AEDG use.]
   a. What type of building is it? What is the total square footage?
   b. Where is the building located (city, state)?
   c. What energy code was applied to the project?
   d. What was the energy performance of the building design: consistent with code; 1-10% better than code; 11-20% better than code; 21-30% better than code; or more than 30% better than code?
   e. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE Guide (versus other factors) in determining the energy performance of the building design? [1 equals not important and 5 equals very important.]
   f. How was the ASHRAE Guide used in connection with this project?
   g. What fraction of the ASHRAE Guide recommendations was implemented?
   h. Were there any ASHRAE Guide recommendations that you sought to implement but were unsuccessful? If so, why?
   i. Did any other resources inform energy-related components of the building design? If so, what other resources were used? [Prompts if needed: beyond-code standards; other design guides; incentives/technical assistance from energy efficiency programs, etc.]
   j. I'll now ask a series of questions about the design details for key building systems. The purpose of these questions is to identify things that were done differently as a result of using the ASHRAE Guide. [If interviewee was not involved or does not recall details about the design of specific systems, note the response and skip the remaining questions about that system.]
      i. Building envelope
         1. Does building envelope exceed code requirements? If so, what improvements were made to the envelope design?
         2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing upgrades to the building envelope, as compared with other factors? [1 equals not important and 5 equals very important.]
         3. What is the roof construction [Insulation entirely above deck, Attic and other, or Metal Building] and insulation level(s)?
         4. What is the wall construction [Mass, Steel framed, Wood framed and other, Metal building, Below-Grade walls] and insulation level(s)?
5. What is the window-to-wall ratio?
6. What is the thermal transmittance [U-value] of vertical glazing?
7. What is the solar heat gain coefficient of vertical glazing?
8. Is exterior sun control used? If so, what is the projection factor?

### ii. Lighting information

1. Does lighting power density exceed code requirements? If so, what efficiency improvements were made to the lighting design?
2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing lighting efficiency upgrades, as compared with other factors?
3. What is the overall lighting power density (W/ft²)?
4. Are occupancy controls used? If so, where?
5. Is daylighting used? If so, please describe.
6. Is daylight harvesting used? If so, please describe.
7. Are dimming controls for daylight harvesting used?

### iii. HVAC information

1. Does HVAC efficiency exceed code requirements? If so, what efficiency improvements were made to HVAC design?
2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing HVAC efficiency upgrades, as compared with other factors?
3. What type of heating equipment is used?
4. What is the size and efficiency of heating equipment?
5. What type of cooling equipment is used?
6. What is size and efficiency of cooling equipment?
7. Please describe HVAC controls.

### iv. Water heating information

1. Does water heating efficiency exceed code requirements? If so, what efficiency improvements were made to water heating systems?
2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing water heating efficiency upgrades, as compared with other factors?
3. What type of water heating equipment is used [gas or electric, storage or instantaneous]?

4. What is the efficiency of water heating equipment?

k. Did you encounter any challenges in using the ASHRAE Guide during the design process? If so, please describe.

l. After this experience, were you in favor of using the Guide on other projects? Why or why not?

m. Would you be willing to be contacted by DOE for potential inclusion of this building in the DOE High Performance Building Database? [Either way, assure them their responses given in the interview will remain confidential.]

9. Would you suggest any actions ASHRAE could undertake to promote broader use of the Advanced Energy Design Guides?

10. Would you suggest any improvements to make the Guides more useful to design professionals?

11. Would you like to see ASHRAE develop other resources for design professionals? If so, what?
APPENDIX D: INTERVIEW SCREENING EMAIL AND CALL SCRIPT

Introductory email

Subject: ASHRAE Advanced Energy Design Survey

Dear ____:

ASHRAE is working with the U.S. Department of Energy (DOE) to better serve the needs of design professionals who work on small commercial buildings. You have been selected for a brief survey about your experiences with using the ASHRAE Advanced Energy Design Guides, which you downloaded from the ASHRAE Web site. ASHRAE would like to request that you participate in this survey.

I will be contacting you within the next few days to administer the telephone survey which should take no longer than 5 minutes of your time. If there is a convenient time to reach you by phone, please let me know. I look forward to speaking with you.

The Energy Center of Wisconsin is an independent research firm that has been hired by ASHRAE and DOE to evaluate the market impact of ASHRAE resources for design professionals. If you have any questions about this research effort, please contact Bruce Hunn, Director of Strategic Technical Programs, ASHRAE: (678) 539-1103 or BHunn@ashrae.org.

Sincerely

Claire Cowan

Research Manager

ASHRAE Advanced Energy Design Guide Evaluation

Screening call script

My name is ______________, and I'm calling on behalf of ASHRAE. I recently emailed you regarding a survey we're conducting of people who have downloaded one or more of the ASHRAE Advanced Energy Design Guides. Do you have a few minutes to answer some questions about the ASHRAE Guides? These questions should take no more than 5 minutes of your time. If they don't have time to talk now, try to schedule a specific time for a follow up call.

- Does your work involve the design and/or construction of K-12 schools or small commercial buildings? If so, what market segments do you work in? Refer to ASHRAE size limits if necessary to clarify definition of “small:"
  - Small office (up to 20,000 ft²)
  - Small retail (up to 20,000 ft²)
  - K-12 schools
  - Small warehouse/self-storage facilities (up to 50,000 ft²) with unitary HVAC
• If no: What was your reason for downloading the ASHRAE Guide(s)? Thank you for your time.
• If yes: Have you worked on design projects that were informed by one of the ASHRAE Advanced Energy Design Guides?
  o If so, which Guide (or Guides) have you used?
  o Can you tell me how many projects you have worked using (each of) the ASHRAE Guide(s) as a reference?
• If no: Would you mind telling me why you haven’t used the Guide(s)?
• If yes: Would you be willing to participate in a brief telephone interview to discuss details of how you’ve used one of the ASHRAE Guides on a specific project? Your input will be very useful as ASHRAE works to improve resources for design professionals who work on small commercial buildings.
• If no: Thank them for their time.
• If yes: Thank them for their participation. Review upcoming times that members of the commercial building design team are available and schedule interview. (Be sure to check time zones.) Tell them that in the interview we will ask them to provide details on a recent representative design project where the Guide was used.
### APPENDIX E: TECHNICAL INTERVIEW RESPONSES

1. **Approximately how many projects do you work on in each market during a typical year?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Office</th>
<th>Retail</th>
<th>K-12</th>
<th>Warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>2-3/year</td>
<td>3-1/yr</td>
<td>1/yr</td>
<td></td>
</tr>
<tr>
<td>ws8</td>
<td>5/month</td>
<td>10-15/month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws4†</td>
<td>24/year (mostly office at wastewater treatment plans)</td>
<td>2/year</td>
<td>A couple to date, more coming up</td>
<td>Mostly open equipment storage areas</td>
</tr>
<tr>
<td>282</td>
<td></td>
<td></td>
<td>1-2</td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>Few</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>5-6/year (her); 60-72 (firm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>260</td>
<td>52-70 per year across office &amp; retail. More office than retail.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws6</td>
<td>10-20</td>
<td>10-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>332</td>
<td>5 (2 they acted as consultants) govt buildings, healthcare, education)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws1</td>
<td>8-10 per year; different building types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws5</td>
<td>5 small retail/office; 20 projects total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws7</td>
<td>12-24/year</td>
<td>12-24/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws3</td>
<td>Varies - ~100/year across all markets. Primarily water/wastewater treatment projects; some years lots of schools; last year lots of offices.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410</td>
<td></td>
<td></td>
<td>80% of their work - both new (2-3) and retro (4)</td>
<td></td>
</tr>
<tr>
<td>ws2</td>
<td>10, tenant space (office/retail)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>375</td>
<td>3-7</td>
<td>7-15</td>
<td>5-10</td>
<td></td>
</tr>
<tr>
<td>393</td>
<td>1-2/year max (mostly admin offices part of higher ed)</td>
<td></td>
<td>3-4/year</td>
<td></td>
</tr>
<tr>
<td>293</td>
<td>2-3/year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>697</td>
<td>30 projects/year – mix of office, warehouse, mixed use commercial and schools. 3 schools/yr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>610</td>
<td>20-25/year</td>
<td>6/year</td>
<td>75-100/year</td>
<td>6</td>
</tr>
<tr>
<td>3821</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† Responses are for whole mechanical engineering group.
### 2. What is the typical design team structure for the projects you work on?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Most of the people in his firm do site work - civil engineering, environmental and planning work. They have a smaller mechanical engineering dept. On typical projects their firm will work with architects, electrical engineers and HVAC contractors from other firms. The</td>
</tr>
<tr>
<td>Company Name</td>
<td>Services</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ws8</td>
<td>His company supplies chillers and other HVAC equipment.</td>
</tr>
<tr>
<td>ws4</td>
<td>His firm does a wide variety of engineering projects and buildings aren't the main focus. They do a lot of industrial design. Usually his firm does the whole design – mechanical, electrical, structural, civil.</td>
</tr>
<tr>
<td>282</td>
<td>Before he became semi-retired, his firm provided mechanical engineering services. Architects &amp; other members of design team were from other firms.</td>
</tr>
<tr>
<td>119</td>
<td>His firm does mechanical design. They work with other firms for architectural design, structural, etc.</td>
</tr>
<tr>
<td>50</td>
<td>They are an A&amp;E firm with in-house structural engineers. One stop shop for customers.</td>
</tr>
<tr>
<td>260</td>
<td>They are an HVAC design/build firm. Do complete mechanical specs in-house.</td>
</tr>
<tr>
<td>ws6</td>
<td>Design/bid/build. They typically serve as a consultant to the architect on most projects.</td>
</tr>
<tr>
<td>332</td>
<td>Full service in-house</td>
</tr>
<tr>
<td>ws1</td>
<td>Full service A&amp;E – primarily work on military projects</td>
</tr>
<tr>
<td>ws5</td>
<td>MEP consultants – typically hired by architect</td>
</tr>
<tr>
<td>ws7</td>
<td>Team</td>
</tr>
<tr>
<td>ws3</td>
<td>MEP consultant. Sometimes they are the primary contractor and sometimes they are the sub. School projects are mostly engineer-led. Office projects tend to be architect-led.</td>
</tr>
<tr>
<td>410</td>
<td>MEP consultants to architects</td>
</tr>
<tr>
<td>ws2</td>
<td>MEP consultants – sometimes directly to the architect, sometimes directly with owner.</td>
</tr>
<tr>
<td>375</td>
<td>Mechanical, electrical, fire protection, architectural, civil, LEED</td>
</tr>
<tr>
<td>393</td>
<td>Full service in-house (architectural, structural, civil, etc.), no fire protection</td>
</tr>
<tr>
<td>293</td>
<td>In-house architectural, mechanical, structural and electrical engineering. Design only.</td>
</tr>
<tr>
<td>697</td>
<td>Works for a utility – energy efficient commercial new construction program. They typically provide consulting expertise to project architects or engineers – rarely work w/ owners.</td>
</tr>
<tr>
<td>610</td>
<td>MEP consultant. Most projects are architect-led.</td>
</tr>
<tr>
<td>3821</td>
<td>Architect/engineer/MEP – mostly in-house</td>
</tr>
<tr>
<td>2356</td>
<td>They are property owner/manager. Usually use team of consultants.</td>
</tr>
<tr>
<td>3186</td>
<td>Team – usually hired by architect</td>
</tr>
<tr>
<td>2345</td>
<td>In-house full service firm</td>
</tr>
<tr>
<td>3820</td>
<td>Team. A lot of their work is energy efficiency retrofits for existing buildings, and some design work. Do a lot of work on large healthcare facilities.</td>
</tr>
<tr>
<td>3952</td>
<td>Team. His firm provides consulting expertise to design high performance buildings and net zero energy buildings.</td>
</tr>
<tr>
<td>3272</td>
<td>Team. MEP firm typically hired by architect.</td>
</tr>
<tr>
<td>2241</td>
<td>Team. Their firm does commissioning.</td>
</tr>
<tr>
<td>2784</td>
<td>They are full service firm but occasionally work as part of team.</td>
</tr>
<tr>
<td>2878</td>
<td>They are full service firm but also play MEP consultant role</td>
</tr>
<tr>
<td>117</td>
<td>Team. MEP firm.</td>
</tr>
<tr>
<td>4012</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>2564</td>
<td>Full service firm, but they also team w/ architects on some projects.</td>
</tr>
<tr>
<td>3015</td>
<td>Team. They do mechanical and fire protection engineering, usually as a sub to architect.</td>
</tr>
<tr>
<td>2966</td>
<td>Typically a consultant for architect or contractor. Also do some construction management and design/build.</td>
</tr>
</tbody>
</table>
### Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides Appendices

<table>
<thead>
<tr>
<th>ID</th>
<th>Team – MEP</th>
<th>Design Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2101</td>
<td>Team – MEP</td>
<td>Energy Center of Wisconsin</td>
</tr>
<tr>
<td>2138</td>
<td>Team – hired by architect</td>
<td>E-4</td>
</tr>
<tr>
<td>1895</td>
<td>Team. 75% of work is design/bid/build (architect-led); 25% is design/build (contractor led).</td>
<td></td>
</tr>
<tr>
<td>1926</td>
<td>One man shop - energy consulting/analysis. Most work is on existing buildings.</td>
<td></td>
</tr>
<tr>
<td>2327</td>
<td>Team. Primary client is usually architect or contractor.</td>
<td></td>
</tr>
<tr>
<td>2543</td>
<td>Works for large manufacturing company, and they use either full service firms or consultant teams for design projects.</td>
<td></td>
</tr>
<tr>
<td>1112</td>
<td>Full service firm. Work primarily on industrial manufacturing facilities.</td>
<td></td>
</tr>
<tr>
<td>4004</td>
<td>MEP firm. Consult to architects and develop design/build criteria for consultants.</td>
<td></td>
</tr>
<tr>
<td>1532</td>
<td>Full service firm – everything except structural.</td>
<td></td>
</tr>
<tr>
<td>776</td>
<td>Team – mechanical design only (HVAC, plumbing)</td>
<td></td>
</tr>
<tr>
<td>3938</td>
<td>Team – consulting engineering only</td>
<td></td>
</tr>
<tr>
<td>608</td>
<td>Full service A&amp;E</td>
<td></td>
</tr>
<tr>
<td>2132</td>
<td>Team – strictly MEP</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>N/A - works for utility</td>
<td></td>
</tr>
<tr>
<td>2363</td>
<td>Full service A&amp;E firm. Also do some teaming</td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>Team - MEP</td>
<td></td>
</tr>
<tr>
<td>1315</td>
<td>Team – MEP design, commissioning, LEED consulting</td>
<td></td>
</tr>
<tr>
<td>3513</td>
<td>Team – MEP only</td>
<td></td>
</tr>
<tr>
<td>965</td>
<td>Team (architect-led)</td>
<td></td>
</tr>
</tbody>
</table>

### 3. What is your typical role in small commercial building design projects?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>They allocate 10-20% of project budget to developing HVAC alternatives for client review. Start with load calculations, then do full energy analysis of alternatives (eQuest) - estimate costs of heating &amp; cooling, ROI, etc. Show cost savings from energy efficient design approaches.</td>
</tr>
<tr>
<td>ws8</td>
<td>His role is to support the people selling HVAC equipment for his company. The sales people have relationships with the consulting engineers who work on design projects, and he supports the sales force by giving technical advice to the consulting engineers – specifying efficiency and performance levels, scheduling, commissioning, energy management, etc.</td>
</tr>
<tr>
<td>ws4</td>
<td>He is the practice lead in the mechanical engineering group and manages 45 people. Points people toward using the Guides on specific projects, but he’s not directly involved in design projects any more. He tends to get more involved in HVAC and envelope design than other elements of the building design.</td>
</tr>
<tr>
<td>282</td>
<td>He’s mostly retired now but does independent design consulting. Before he retired, most of his firm’s work was on hotels (large and small), some small office buildings, and some schools. 90% of their work was fast track design; did some design/build for small office buildings.</td>
</tr>
<tr>
<td>119</td>
<td>His firm mostly works on large healthcare facilities. Sometimes there is a small office building that is part of a larger campus. He is a mechanical engineer who works on HVAC design. His firm does a lot of sustainable design work and he often gets involved in energy management.</td>
</tr>
<tr>
<td>Employee ID</td>
<td>Role Description</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>50</td>
<td>Lead mechanical engineer. Primarily works on heating and ventilation systems.</td>
</tr>
<tr>
<td>260</td>
<td>HVAC system design.</td>
</tr>
<tr>
<td>ws6</td>
<td>Lead project engineer. Primarily works on mechanical systems and plumbing.</td>
</tr>
<tr>
<td>332</td>
<td>Full spectrum ME</td>
</tr>
<tr>
<td>ws1</td>
<td>LEED coordinator, mechanical design</td>
</tr>
<tr>
<td>ws5</td>
<td>Mechanical design, plumbing design or both</td>
</tr>
<tr>
<td>ws7</td>
<td>Commissioning agent</td>
</tr>
<tr>
<td>ws3</td>
<td>MEP consultant - design of HVAC, lighting and electrical power systems.</td>
</tr>
<tr>
<td>410</td>
<td>HVAC, project management</td>
</tr>
<tr>
<td>ws2</td>
<td>Manager</td>
</tr>
<tr>
<td>375</td>
<td>Reviews, drawings, more involved with front end.</td>
</tr>
<tr>
<td>393</td>
<td>HVAC design, some plumbing design</td>
</tr>
<tr>
<td>293</td>
<td>Mechanical design.</td>
</tr>
<tr>
<td>697</td>
<td>Works for utility -- consultant to design team.</td>
</tr>
<tr>
<td>610</td>
<td>Principal at MEP firm. Oversees design team; provides QA/QC review.</td>
</tr>
<tr>
<td>3821</td>
<td>Mechanical engineer, lighting &amp; electrical</td>
</tr>
<tr>
<td>2356</td>
<td>As energy manager, he acts as filter for design team. Challenges them to do better. Puts forth benchmark energy metrics for consultants to meet.</td>
</tr>
<tr>
<td>3186</td>
<td>HVAC &amp; plumbing design</td>
</tr>
<tr>
<td>2345</td>
<td>Mechanical engineer</td>
</tr>
<tr>
<td>3820</td>
<td>Spec writing, energy analysis, some design</td>
</tr>
<tr>
<td>3952</td>
<td>Energy consultant</td>
</tr>
<tr>
<td>3272</td>
<td>Director of commissioning group.</td>
</tr>
<tr>
<td>2241</td>
<td>Lead commissioning efforts</td>
</tr>
<tr>
<td>2784</td>
<td>Chief mechanical engineer; project manager</td>
</tr>
<tr>
<td>2878</td>
<td>Designer of mechanical, plumbing, and fire protection systems</td>
</tr>
<tr>
<td>117</td>
<td>Mechanical design.</td>
</tr>
<tr>
<td>4012</td>
<td>Not currently working on many design projects; primarily working on green code development for plumbing.</td>
</tr>
<tr>
<td>2564</td>
<td>Manage mechanical design department. Engineer of record.</td>
</tr>
<tr>
<td>3015</td>
<td>Mechanical engineering, LEED consulting</td>
</tr>
<tr>
<td>2966</td>
<td>Mechanical design; project management</td>
</tr>
<tr>
<td>2101</td>
<td>MEP</td>
</tr>
<tr>
<td>2138</td>
<td>Consultant</td>
</tr>
<tr>
<td>1895</td>
<td>Mechanical design consultant</td>
</tr>
<tr>
<td>1926</td>
<td>Energy analysis, modeling, design, commissioning, environmental consulting, indoor air quality.</td>
</tr>
<tr>
<td>2327</td>
<td>President of company. Does not do much work on individual design projects.</td>
</tr>
<tr>
<td>2543</td>
<td>Project manager</td>
</tr>
<tr>
<td>1112</td>
<td>Three roles: project engineering/management; mechanical design; industrial process engineering</td>
</tr>
<tr>
<td>4004</td>
<td>Mechanical engineer; project management</td>
</tr>
<tr>
<td>1532</td>
<td>Senior mechanical engineer</td>
</tr>
</tbody>
</table>
4. **How did you originally learn about the ASHRAE Advanced Energy Design Guides?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>From ASHRAE and from a colleague. Colleague asked him to jump in and absorb all you can from ASHRAE resources when he joined the firm. His previous experience was as a mechanical contractor working in the field. Field work and “behind the desk” work have both been valuable in helping him sell what works.</td>
</tr>
<tr>
<td>ws8</td>
<td>Saw an ad at an ASHRAE committee meeting. He is pretty involved in ASHRAE and serves on a couple of committees.</td>
</tr>
<tr>
<td>ws4</td>
<td>ASHRAE announcement.</td>
</tr>
<tr>
<td>282</td>
<td>From ASHRAE. He is very involved in ASHRAE. Served on a number of program and special project committees.</td>
</tr>
<tr>
<td>119</td>
<td>Not sure but he thinks it was probably an ASHRAE email.</td>
</tr>
<tr>
<td>50</td>
<td>Email from ASHRAE. Her boss is pretty involved in ASHRAE.</td>
</tr>
<tr>
<td>260</td>
<td>Email from ASHRAE.</td>
</tr>
<tr>
<td>ws6</td>
<td>ASHRAE web site.</td>
</tr>
<tr>
<td>332</td>
<td>ASHRAE Journal when the first guide was published</td>
</tr>
<tr>
<td>ws1</td>
<td>Email from ASHRAE</td>
</tr>
<tr>
<td>ws5</td>
<td>ASHRAE announcement</td>
</tr>
<tr>
<td>ws7</td>
<td>Independent research to keep up with what’s happening in the industry.</td>
</tr>
<tr>
<td>ws3</td>
<td>ASHRAE – Journal or website</td>
</tr>
<tr>
<td>410</td>
<td>Research an energy efficient school project.</td>
</tr>
<tr>
<td>ws2</td>
<td>ASHRAE member – he purchased a couple of guides before he realized he could download them for free.</td>
</tr>
<tr>
<td>375</td>
<td>On ASHRAE executive committee that designed the guides.</td>
</tr>
<tr>
<td>393</td>
<td>ASHRAE email. Looked at the Guides in depth after they got their first LEED project. Needed a quick way to get started with LEED compliance.</td>
</tr>
<tr>
<td>293</td>
<td>ASHRAE email</td>
</tr>
<tr>
<td>697</td>
<td>From a colleague. Needed information to support design of energy efficient school.</td>
</tr>
<tr>
<td>610</td>
<td>ASHRAE national meeting. Bought a copy of the school guide.</td>
</tr>
<tr>
<td>3821</td>
<td>ASHRAE – journal or e-newsletter</td>
</tr>
</tbody>
</table>
5. Have you ever worked on a project where all of the Guide recommendations were implemented? If so, how many projects have you worked on where all of the Guide recommendations were implemented?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes – they try to get most recommendations implemented on any project because of interactions between systems. For example, if you don’t do building shell recommendations you won’t get the expected savings from heating and cooling. More</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>ws8</td>
<td>Don’t know. He typically spends only a day or two on any given building design project.</td>
</tr>
<tr>
<td>ws4</td>
<td>Don’t know.</td>
</tr>
<tr>
<td>282</td>
<td>None. He picks and chooses the recommendations that work best for specific projects.</td>
</tr>
<tr>
<td>119</td>
<td>Not sure. Has only worked on two small office projects where he directly used the Guides. Both were LEED projects so he thinks a lot of the recommendations were probably implemented.</td>
</tr>
<tr>
<td>50</td>
<td>Probably not.</td>
</tr>
<tr>
<td>260</td>
<td>No because they work on small commercial buildings. Clients look more at cost control and keeping project on time. Often the client is not the occupant so they are not concerned about operating costs.</td>
</tr>
<tr>
<td>ws6</td>
<td>No</td>
</tr>
<tr>
<td>332</td>
<td>Not quite, but close – all but the lighting</td>
</tr>
<tr>
<td>ws1</td>
<td>No but has come close. They tend to use the Guides in the early part of a project. The Army requires that all building designs get 30% savings over the 90.1-2004 so during the bid process they use the Guide as a quick reference -- general approximation that does not require in depth energy modeling. The Guides are also used as a brainstorming tool/starting point early in the design process. The client usually asks for things (e.g., blast-resistant design) that conflict with certain elements in the design, so they can’t follow it exactly.</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – they implemented all of the mechanical, electrical and plumbing recommendations and she is pretty sure the architect implemented the envelope recommendations.</td>
</tr>
<tr>
<td>ws7</td>
<td>No</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes, on several recent projects. They usually try to exceed the AEDGs.</td>
</tr>
<tr>
<td>410</td>
<td>No – followed as a guideline and they cannot control what the architect is doing.</td>
</tr>
<tr>
<td>ws2</td>
<td>No – small projects, higher upfront costs to their clients.</td>
</tr>
<tr>
<td>375</td>
<td>No – owner stipulates what they want (front end costs).</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>No</td>
</tr>
<tr>
<td>697</td>
<td>Don’t know</td>
</tr>
<tr>
<td>610</td>
<td>No, but have worked on a number of projects where Guide was followed.</td>
</tr>
<tr>
<td>3821</td>
<td>No</td>
</tr>
<tr>
<td>2356</td>
<td>No, some of the recommendations are mutually-exclusive. Currently use the Guides in a few different ways. Starting to use them to develop matrices of energy intensity benchmarks for different building types, climate zones. Share these matrices with design teams. Also useful for existing buildings to see how close you can get to these benchmarks. Biggest challenge is that their portfolio of buildings spans multiple utility service territories and electric rates range from 4-11 cents/kWh. Things that are cost-effective in one area don’t work in others. Also spans 3 climate zones.</td>
</tr>
<tr>
<td>3186</td>
<td>Try to implement all recommendations but have not yet been able to. Hardest thing is building orientation. Electrical is also a challenge, because they always want too much light. Also, first cost is everything.</td>
</tr>
<tr>
<td>2345</td>
<td>No. Number one use of Guides is setting targets for key building systems. They do a lot of federal projects and have to exceed 90.1 by 30%. The recommendations in the Guide are efficient alternatives won’t be cost-effective. They aim to get 18-24 BTUs/sf for heating. Achieving this target means you can’t cheat on other aspects of building design.</td>
</tr>
<tr>
<td>No.</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
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<tr>
<td>3820</td>
<td>No</td>
</tr>
<tr>
<td>3952</td>
<td>Guide is a good first step but it doesn't really give you a high performance building</td>
</tr>
<tr>
<td>3272</td>
<td>Makes recommendations to follow Guide prescriptively</td>
</tr>
<tr>
<td>2241</td>
<td>No, but they usually have the goal of following everything in the Guide.</td>
</tr>
<tr>
<td>2784</td>
<td>They follow Guide prescriptively as much as possible.</td>
</tr>
<tr>
<td>2878</td>
<td>Not sure. Try to follow Guide but can't vouch for what architect does. The Guide is useful because it minimizes the amount of time he has to spend on a project.</td>
</tr>
<tr>
<td>117</td>
<td>No, but have done several LEED projects where many recommendations were implemented. They always try to incorporate as much energy efficiency as they can. Most work is in CA where Title 24 addresses many of the AEDG recommendations.</td>
</tr>
<tr>
<td>4012</td>
<td>Not yet</td>
</tr>
<tr>
<td>2564</td>
<td>No</td>
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<tr>
<td>3015</td>
<td>Yes, one</td>
</tr>
<tr>
<td>2966</td>
<td>No</td>
</tr>
<tr>
<td>2101</td>
<td>No – used as reference only</td>
</tr>
<tr>
<td>2138</td>
<td>No – only consulted on a single project</td>
</tr>
<tr>
<td>1895</td>
<td>Yes – a couple of projects in the last few years. These projects used the AEDG as part of the prescriptive path for the LEED EA1 credit.</td>
</tr>
<tr>
<td>1926</td>
<td>No – AEDGs are used on a piecemeal basis. Most work is on existing buildings, so he uses the guides as a checklist to identify energy efficiency opportunities and see how close they can get to specified efficiency levels in AEDG recommendations.</td>
</tr>
<tr>
<td>2327</td>
<td>Don't know. Most recommendations are things they were doing already.</td>
</tr>
<tr>
<td>2543</td>
<td>Don't know.</td>
</tr>
<tr>
<td>1112</td>
<td>No. They pick and choose specific recommendations to follow based on the project. If clients are interested in conserving energy, using the AEDGs helps them bring additional value to the project.</td>
</tr>
<tr>
<td>4004</td>
<td>No. They follow selected recommendations as applicable.</td>
</tr>
<tr>
<td>1532</td>
<td>Yes, 3 or 4 projects</td>
</tr>
<tr>
<td>776</td>
<td>Yes, 4 or 5 projects</td>
</tr>
<tr>
<td>3938</td>
<td>Yes, 1. AEDG used for LEED compliance</td>
</tr>
<tr>
<td>608</td>
<td>No, follow selected recommendations, mostly on building envelope.</td>
</tr>
<tr>
<td>2132</td>
<td>No, read through AEDG and use as applicable.</td>
</tr>
<tr>
<td>1983</td>
<td>No</td>
</tr>
<tr>
<td>2363</td>
<td>They typically go through the entire list at the beginning of a project and target those applications that fit the project. Commonly-used as a communications tool with the owner. Show them the recommendations list for their climate zone, give them the opportunity to specify which recommendations they're most interested in following.</td>
</tr>
<tr>
<td>111</td>
<td>No - have never gone through the Guide page by page. Typically pull information from the Guide on an as-needed basis.</td>
</tr>
<tr>
<td>1315</td>
<td>Probably. Most LEED projects involve energy modeling and AEDG recommendations are used as a starting point, which simplifies the process.</td>
</tr>
<tr>
<td>3513</td>
<td>No. AEDG is used as a reference to see how their design ideas compare to what's in the Guide. AEDG is usually a back-check and they often go beyond the recommendations</td>
</tr>
<tr>
<td>965</td>
<td>No. AEDG is used as an overall guideline/reference. He has distributed it to a lot of people</td>
</tr>
</tbody>
</table>
6. If not, are there recommendations in the Guide that you followed for the first time after reading information in the Guide?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
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<td>skipped</td>
</tr>
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<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>Yes</td>
</tr>
<tr>
<td>119</td>
<td>No – have only used Guides as a reference</td>
</tr>
<tr>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td>260</td>
<td>Yes</td>
</tr>
<tr>
<td>ws6</td>
<td>Not really, but the Guides are very useful for educating other consultants and architects on energy efficient design approaches.</td>
</tr>
<tr>
<td>332</td>
<td>No – have already been doing them as standard office practices</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes</td>
</tr>
<tr>
<td>ws5</td>
<td>Not sure – have always tried to implement the HVAC recommendations as part of standard design practice.</td>
</tr>
<tr>
<td>ws7</td>
<td>Yes</td>
</tr>
<tr>
<td>ws3</td>
<td>No – usually ahead of AEDGs in standard practice.</td>
</tr>
<tr>
<td>410</td>
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<tr>
<td>ws2</td>
<td>Yes</td>
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<tr>
<td>375</td>
<td>skipped</td>
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<tr>
<td>393</td>
<td>Yes</td>
</tr>
<tr>
<td>293</td>
<td>Yes</td>
</tr>
<tr>
<td>697</td>
<td>No – they tend to use the Guides mostly as an internal resource in developing a list of energy efficiency recommendations for the design team/owner to consider. Buildings are usually partially designed when they get involved. They use the Guides most heavily for envelope recommendations where it is harder to do back of the envelope savings calcs.</td>
</tr>
<tr>
<td>610</td>
<td>Yes</td>
</tr>
<tr>
<td>3821</td>
<td>Yes; skylights</td>
</tr>
<tr>
<td>2356</td>
<td>No. Guides are mainly used as a reference for improving the performance of existing buildings.</td>
</tr>
<tr>
<td>3186</td>
<td>Yes</td>
</tr>
<tr>
<td>2345</td>
<td>Hard to say, but envelope recommendations have been useful in terms of convincing architects to increase U- and R-values.</td>
</tr>
<tr>
<td>3820</td>
<td>No. They use Guides as a reference but what’s recommended is pretty much common practice for them.</td>
</tr>
<tr>
<td>3952</td>
<td>No. Guides are about 5 years too late. Good for design teams that are in the rudimentary stages of energy efficient design.</td>
</tr>
<tr>
<td>3272</td>
<td>Yes</td>
</tr>
<tr>
<td>2241</td>
<td>No – they were mostly doing everything in the Guide already. But the Guide is useful ammunition for convincing other members of the design team.</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
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<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
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<td>skipped</td>
</tr>
<tr>
<td>2878</td>
<td>skipped</td>
</tr>
<tr>
<td>117</td>
<td>No. Guide is used to consider different options and get ideas for where energy savings can be found. Also a useful educational tool for the architect, building owner.</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped – Respondent preferred to focus on shortcomings of AEDGs with respect to water heating recommendations</td>
</tr>
<tr>
<td>2564</td>
<td>Yes</td>
</tr>
<tr>
<td>3015</td>
<td>skipped</td>
</tr>
<tr>
<td>2966</td>
<td>Yes – they make suggestions to the architect based on envelope recommendations but they are not the decision maker.</td>
</tr>
<tr>
<td>2101</td>
<td>No – validated what we were thinking of doing</td>
</tr>
<tr>
<td>2138</td>
<td>No</td>
</tr>
<tr>
<td>1895</td>
<td>Yes</td>
</tr>
<tr>
<td>1926</td>
<td>No. Guides are more of a reference for determining what improvements could be made to existing buildings.</td>
</tr>
<tr>
<td>2327</td>
<td>No</td>
</tr>
<tr>
<td>2543</td>
<td>Don’t know</td>
</tr>
<tr>
<td>1112</td>
<td>No. Guides are a helpful reference for things they’re already doing.</td>
</tr>
<tr>
<td>4004</td>
<td>Probably</td>
</tr>
<tr>
<td>1532</td>
<td>Skipped</td>
</tr>
<tr>
<td>776</td>
<td>No, Guide is a reference for things they are already doing.</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>Yes</td>
</tr>
<tr>
<td>2132</td>
<td>Yes</td>
</tr>
<tr>
<td>1983</td>
<td>skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Their company has aggressively pushed energy savings for a long time so most recommendations are things they were already doing. There may be a few things in the envelope/ventilation area.</td>
</tr>
<tr>
<td>111</td>
<td>No</td>
</tr>
<tr>
<td>1315</td>
<td>They do a lot of LEED projects so most recommendations are things they were already doing. Maybe they boosted some insulation values. Best thing about the Guide is that it is an easy tool for communicating with other members of the design team.</td>
</tr>
<tr>
<td>3513</td>
<td>Yes – followed AEDG recommendations on motor horsepower on one small office project. Most of their projects are outside the scope of the Guides.</td>
</tr>
<tr>
<td>965</td>
<td>Not really. They use it mostly as a reference. He works for the military and a lot of projects are done based on blanket specs. The guides are most useful in terms of seeing where they may need to tailor the design specs based on the climate zone where the project is located.</td>
</tr>
</tbody>
</table>

6.a. If so, which recommendations did you follow for the first time after reading information in the Guides?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
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<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>ws4</td>
<td>Not clear that this is done as a result of Guide but the recommendations they implement most frequently are insulation levels, water heating, and HVAC recommendations. So, no lighting.</td>
</tr>
<tr>
<td>282</td>
<td>The Guides caused them to look at daylighting opportunities more closely. In particular, the K12 Guide puts a lot of emphasis on daylighting.</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>They try to use instantaneous water heaters a lot, and they are now specifying higher SEER ratings on packaged equipment.</td>
</tr>
<tr>
<td>260</td>
<td>They are paying more attention to control systems now – operating schedules, sensors, etc.</td>
</tr>
<tr>
<td>ws6</td>
<td>In terms of influencing other design team members to do things differently, upgrades are primarily to lighting and envelope design.</td>
</tr>
<tr>
<td>332</td>
<td>Skipped</td>
</tr>
<tr>
<td>ws1</td>
<td>Primarily envelope recommendations and lighting. Looked at the envelope how-tos for pre-engineered metal buildings because he was unfamiliar with them. Follow insulation recommendations.</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>Some of the HVAC recommendations but could not name which ones.</td>
</tr>
<tr>
<td>ws3</td>
<td>skipped</td>
</tr>
<tr>
<td>410</td>
<td>Static pressure losses – lower than typical design; efficiencies – match or beat what they recommend</td>
</tr>
<tr>
<td>ws2</td>
<td>Energy recovery for outside air, insulation, no windows facing east, maximize green space.</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Stepped up envelope design – insulation, windows</td>
</tr>
<tr>
<td>293</td>
<td>Increased U values and R values. More attention to proper wall construction for humidity control. Specifying higher-efficiency HVAC equipment. Guide is helpful in providing information to the owner on potential savings as well as educating them about the direction of future standards for high performance buildings.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Daylight harvesting.</td>
</tr>
<tr>
<td>3821</td>
<td>Skylight measures</td>
</tr>
<tr>
<td>2356</td>
<td>skipped</td>
</tr>
<tr>
<td>3186</td>
<td>Water heater efficiency increased to 90% as a result of Guide</td>
</tr>
<tr>
<td>2345</td>
<td>Envelope recommendations</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>Skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Lighting levels for retail stores; humidity control recommendations</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>skipped</td>
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<tr>
<td>2878</td>
<td>skipped</td>
</tr>
<tr>
<td>117</td>
<td>skipped</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Envelope recommendations</td>
</tr>
</tbody>
</table>
The table below summarizes the evaluation of the market impact of the ASHRAE Advanced Energy Design Guides Appendices.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3015</td>
<td>Skipped</td>
</tr>
<tr>
<td>2966</td>
<td>Envelope recommendations, heat recovery, occupancy sensors, CO2 sensors as applicable.</td>
</tr>
<tr>
<td>2101</td>
<td>skipped</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>They made a few requirements more stringent for envelope and lighting. Not many changes made on mechanical systems. Water heating and HVAC recommendations were not too different from their standard practice.</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
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<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Skipped</td>
</tr>
<tr>
<td>4004</td>
<td>Probably some of the HVAC recommendations</td>
</tr>
<tr>
<td>1532</td>
<td>Skipped</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>They explored a few new things as a result of the Guide, like envelope recommendations for metal buildings. Mechanical and electrical recommendations are too specific and not applicable – they do things differently in Alaska. For example, Guide doesn’t cover hydronics but they do a lot of that. They always used pretty high insulation values.</td>
</tr>
<tr>
<td>2132</td>
<td>Envelope information is useful for educating architects. Information on the amount of glazing is useful, as architects usually want to put in too much glazing. HVAC strategies are good food for thought.</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Ventilation &amp; envelope recommendations.</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>May have increased some insulation values.</td>
</tr>
<tr>
<td>3513</td>
<td>Motor horsepower</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
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</tbody>
</table>

### 6.b. Have you implemented these recommendations on more than one project? If not, why not?

<table>
<thead>
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<th>ID</th>
<th>Response</th>
</tr>
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<td>ws4</td>
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<tr>
<td>260</td>
<td>yes</td>
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<tr>
<td>ws6</td>
<td>yes</td>
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<td>yes</td>
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<td>ws5</td>
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<td>ws7</td>
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<td>-----</td>
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<tr>
<td>ws3</td>
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<tr>
<td>410</td>
<td>Yes. Use as a guideling but need to follow the schools design guidelines</td>
</tr>
<tr>
<td>ws2</td>
<td>Yes – several, ductless a/c, daylighting</td>
</tr>
<tr>
<td>375</td>
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</tr>
<tr>
<td>393</td>
<td>Yes</td>
</tr>
<tr>
<td>293</td>
<td>No. They have only used the AEDGs on one small project. Most of their work is on larger buildings.</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes. There have been 3 or 4 projects where they tried to do all recommendations in the Guide, and some other projects where they have done a lot of the recommendations anyway but did not specifically follow the guide.</td>
</tr>
<tr>
<td>3821</td>
<td>No; only used on 1 project</td>
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<td>Yes</td>
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</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes – especially for larger buildings. Humidity control recommendations are harder to do for small buildings.</td>
</tr>
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<tr>
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<td>Yes</td>
</tr>
<tr>
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</tbody>
</table>
6.c. If so, is implementing these recommendations currently part of your standard practice?

<table>
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<th>ID</th>
<th>Response</th>
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<td>ws8</td>
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</tr>
<tr>
<td>ws4</td>
<td>No. About 20% of their work is in CA where Title 24 requirements are pretty close to ASHRAE recommendations in most cases. In other parts of the country they do not follow Guide recommendations as a standard practice but they are interested in doing more. They have increased SEER level specifications across the board (in CA this is code).</td>
</tr>
<tr>
<td>282</td>
<td>He typically follows HVAC and thermal envelope recommendations in the Guides. He has concerns about daylighting, and does not feel the Guide adequately addresses the importance of considering tradeoffs. For example, do lighting savings fully offset thermal losses? What are the savings impacts if buildings get a lot of night-time use? Need to make sure daylighting produces net benefits.</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>They typically design to ASHRAE 90.1-2004. She has looked through the AEDGs once or twice.</td>
</tr>
<tr>
<td>260</td>
<td>Yes – they try to suggest it. Some clients are more open to suggestion than others.</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes</td>
</tr>
<tr>
<td>332</td>
<td>Skipped</td>
</tr>
<tr>
<td>ws1</td>
<td>Use the R values for insulation as a standard practice -- don’t even look at the 90.1 requirements anymore.</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>Yes</td>
</tr>
<tr>
<td>ws3</td>
<td>skipped</td>
</tr>
<tr>
<td>410</td>
<td>yes</td>
</tr>
<tr>
<td>ws2</td>
<td>Yes</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes when cost-effective</td>
</tr>
<tr>
<td>293</td>
<td>Yes, where applicable. With the large projects they typically work on, they usually exceed the R values in the Guide.</td>
</tr>
<tr>
<td>697</td>
<td>Kind of. In working with design teams, they generally focus on energy efficiency in areas where there is some interest. So, if there is no interest in daylighting on a given project, they do not push it.</td>
</tr>
<tr>
<td>610</td>
<td>A lot of the stuff in the Guide was standard practice before they saw the Guide. Now they are doing more school projects, which is where they tend to follow the Guide more frequently.</td>
</tr>
<tr>
<td>3821</td>
<td>Used guide more for reference – mainly as a check for what they are already doing.</td>
</tr>
<tr>
<td>2356</td>
<td>Skipped</td>
</tr>
<tr>
<td>3186</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### 6.d. Approximately how many buildings have you worked on where these recommendations were implemented?

<table>
<thead>
<tr>
<th>ID</th>
<th>Office</th>
<th>Retail</th>
<th>K-12</th>
<th>Warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td></td>
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</tr>
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<td>ws8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>282</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>119</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>50</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>260</td>
<td></td>
<td></td>
<td></td>
<td>48 buildings over</td>
</tr>
<tr>
<td>ws6</td>
<td>4 years – mostly office</td>
<td>50-75% of projects over last 1.5 years [8-23 using numbers from Q1]</td>
<td>50-75% of projects over last 1.5 years [8-23 using numbers from Q1]</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>332</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws5</td>
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</tr>
<tr>
<td>ws7</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws3</td>
<td></td>
<td></td>
<td>3 – in about a year</td>
<td></td>
</tr>
<tr>
<td>ws2</td>
<td>All projects (office/retail)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>375</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>393</td>
<td>4 (mix of office &amp; school)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>293</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>697</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>610</td>
<td></td>
<td>3 or 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3821</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2356</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3186</td>
<td>100 buildings, various types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2345</td>
<td>Less than 10, various types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3820</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>3272</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2241</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2784</td>
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<td>2878</td>
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</tr>
<tr>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2564</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3015</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2966</td>
<td>2 or 3 per year (all markets)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2138</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1895</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1926</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2327</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2543</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1112</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4004</td>
<td>4 (retail/office)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. Do you know how many buildings your firm has worked on that were informed by the ASHRAE Guides?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>1 office; 3-5 retail; 1 school</td>
</tr>
<tr>
<td>ws8</td>
<td>Don’t know</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>30-40</td>
</tr>
<tr>
<td>119</td>
<td>Don’t know. Most of their work is on large healthcare facilities.</td>
</tr>
<tr>
<td>50</td>
<td>Not sure – has not discussed AEDG usage with them.</td>
</tr>
<tr>
<td>260</td>
<td>They always try to follow the recommendations but are only able to implement them about 50% of the time.</td>
</tr>
<tr>
<td>ws6</td>
<td>Tough to say – over 100</td>
</tr>
<tr>
<td>332</td>
<td>Zero because the recommendations are already standard office practices.</td>
</tr>
<tr>
<td>ws1</td>
<td>16 total (8 were a standard design implemented in different locations). Building types do not fall into ASHRAE categories for small commercial.</td>
</tr>
<tr>
<td>ws5</td>
<td>Not sure. One other mechanical engineer uses the Guides occasionally. They have a small firm – only 3 mechanical and 1 electrical engineer.</td>
</tr>
<tr>
<td>ws7</td>
<td>Don’t know</td>
</tr>
<tr>
<td>ws3</td>
<td>3 or 4</td>
</tr>
<tr>
<td>410</td>
<td>Don’t know</td>
</tr>
<tr>
<td>ws2</td>
<td>All projects.</td>
</tr>
<tr>
<td>375</td>
<td>All projects.</td>
</tr>
<tr>
<td>393</td>
<td>4</td>
</tr>
<tr>
<td>293</td>
<td>1</td>
</tr>
<tr>
<td>697</td>
<td>They always try to recommend best practices on all the projects they work on (30/year). The Guides directly influence around 1 or 2 projects/year.</td>
</tr>
<tr>
<td>610</td>
<td>20</td>
</tr>
<tr>
<td>3821</td>
<td>1</td>
</tr>
<tr>
<td>2356</td>
<td>Have used Guides as a reference on 20-40 projects, mostly existing buildings</td>
</tr>
<tr>
<td>3186</td>
<td></td>
</tr>
<tr>
<td>2345</td>
<td>Less than 10</td>
</tr>
</tbody>
</table>
3820 | 5-10
---|---
3952 | None. Guides are too basic for the high performance design work they do. Sometimes they encourage clients to review the Guides if they're not sure whether they want to do a green building.
3272 | 25-50 projects used the Guides in some way
2241 | Don't know – work for a large company
2784 | No response given
2878 | 12
117 | Don't know
4012 | skipped
2564 | 25
3015 | 4
2966 | Don't know
2101 | None - used as a potential reference
2138 | Don't think used
1895 | 2 recent projects. Looked at the Guides for another project but went with an energy analysis/modeling approach instead.
1926 | 1 school retrofit; 8-10 large office retrofits.
2327 | Don't know
2543 | Don't know
1112 | 4-5
4004 | Don't know. He has referred colleagues to the Guides but is not sure what they've done.
1532 | 15-24 projects (5-6 per year for 3 or 4 years)
776 | 4-5 buildings
3938 | Others in the firm use the Guides, primarily as a reference for energy modeling.
608 | Dozens of projects, mainly in the preliminary design stage
2132 | 6 projects have systematically used the Guides. Most projects they do probably are affected by information in the Guides.
1983 | Skipped
2363 | 18-23
111 | Less than 10 office buildings
1315 | Don't know
3513 | 1 office
965 | Don’t know – Guide is used as a reference for many projects

8.a. Please pick a recent representative project that is informed by one of the ASHRAE Guides. What type of building is it?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>K-12</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>K-12. This was a retrofit of 1949-vintage school building to eliminate coal-fired heating equipment as part of the air quality measures taken prior to Beijing Olympics.</td>
</tr>
<tr>
<td></td>
<td>Category</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>119</td>
<td>Small office</td>
</tr>
<tr>
<td>50</td>
<td>Reserve center (military facility) – mostly office with some training rooms.</td>
</tr>
<tr>
<td>260</td>
<td>Retail w/ two suites (one physician suite and one pharmacy/retail suite)</td>
</tr>
<tr>
<td>ws6</td>
<td>K12</td>
</tr>
<tr>
<td>332</td>
<td>admin complex for the Forest Service</td>
</tr>
<tr>
<td>ws1</td>
<td>Technical equipment maintenance facility. Heated garage (high bay and low bay) with office &amp; other space types. Military buildings tend to be multi-use facilities that don’t fall into typical classifications for commercial buildings. This year they have done a lot of child development centers which have 8-10 classrooms, administrative spaces, gathering areas like gymnasiums.</td>
</tr>
<tr>
<td>ws5</td>
<td>Designed prototype retail banking center for national bank chain. They were not sure whether to use the retail or office guide but ended up using the office guide.</td>
</tr>
<tr>
<td>ws7</td>
<td>K-12</td>
</tr>
<tr>
<td>ws3</td>
<td>Office</td>
</tr>
<tr>
<td>410</td>
<td>K-12 school</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Administrative building for higher education – office with some classrooms. Used mix of recommendations from office and K12 Guide. Project was 50% retrofit and 50% new addition.</td>
</tr>
<tr>
<td>293</td>
<td>Office</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Middle school</td>
</tr>
<tr>
<td>3821</td>
<td>Office/retail – retrofit of an existing building</td>
</tr>
<tr>
<td>2356</td>
<td>Big box retail</td>
</tr>
<tr>
<td>3186</td>
<td>Clubhouse in apartment complex</td>
</tr>
<tr>
<td>2345</td>
<td>Office</td>
</tr>
<tr>
<td>3820</td>
<td>Medical office – existing building</td>
</tr>
<tr>
<td>3952</td>
<td>Skipped</td>
</tr>
<tr>
<td>3272</td>
<td>office</td>
</tr>
<tr>
<td>2241</td>
<td>Skipped – not comfortable discussing any project in detail</td>
</tr>
<tr>
<td>2784</td>
<td>K-12 school – 6 1-floor buildings on a single campus as part of a comprehensive renovation/rehab</td>
</tr>
<tr>
<td>2878</td>
<td>office</td>
</tr>
<tr>
<td>117</td>
<td>K12. Energy technology learning center that is part of a high school campus.</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>K12 – elementary school</td>
</tr>
<tr>
<td>3015</td>
<td>Office – extensive retrofit of historical building for local rural electric cooperative, plus addition with data center</td>
</tr>
<tr>
<td>2966</td>
<td>Office - administrative building on a college campus</td>
</tr>
<tr>
<td>2101</td>
<td>k-12</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Office</td>
</tr>
<tr>
<td>1926</td>
<td>Large office retrofit</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Office</td>
</tr>
<tr>
<td>4004</td>
<td>Office</td>
</tr>
<tr>
<td>1532</td>
<td>K12</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Office</td>
</tr>
<tr>
<td>608</td>
<td>Office</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>K12</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Office/warehouse</td>
</tr>
<tr>
<td>3513</td>
<td>Office</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
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</table>

8.a.1. What is the approximate square footage?

<table>
<thead>
<tr>
<th>ID</th>
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<th>Description</th>
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<tbody>
<tr>
<td>ws9</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>ws8</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>ws4</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>282</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>260</td>
<td>Did not ask</td>
<td></td>
</tr>
<tr>
<td>ws6</td>
<td>175,000 sf</td>
<td></td>
</tr>
<tr>
<td>332</td>
<td>9075 sf</td>
<td></td>
</tr>
<tr>
<td>ws1</td>
<td>1st floor: 18,000 sf – garage with radiant floor heating, some ancillary storage &amp; equipment check-out areas. 2nd floor: 6-8,000 sf fully conditioned office space.</td>
<td></td>
</tr>
<tr>
<td>ws5</td>
<td>4500 sf</td>
<td></td>
</tr>
<tr>
<td>ws7</td>
<td>100,000 sf</td>
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</tr>
<tr>
<td>ws3</td>
<td>6,000 sf</td>
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</tr>
<tr>
<td>410</td>
<td>112,000 sf</td>
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<tr>
<td>ws2</td>
<td>skipped</td>
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</tr>
<tr>
<td>375</td>
<td>skipped</td>
<td></td>
</tr>
<tr>
<td>393</td>
<td>14,000 sf retrofit; 14,000 sf addition</td>
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</tr>
<tr>
<td>293</td>
<td>10,000 sf</td>
<td></td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
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<tr>
<td>610</td>
<td>140,000 sf</td>
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<tr>
<td>3821</td>
<td>22,000 sf</td>
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<tr>
<td>2356</td>
<td>80,000-100,000 sf</td>
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### Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides Appendices

**Energy Center of Wisconsin**

<table>
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<td>3186</td>
<td>3000 sf</td>
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<tr>
<td>2345</td>
<td>80,000 sf</td>
</tr>
<tr>
<td>3820</td>
<td>50,000 sf</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>9,500 sf</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>150,000 sf (25,000 sf per building x 6 buildings)</td>
</tr>
<tr>
<td>2878</td>
<td>Under 2000 sf</td>
</tr>
<tr>
<td>117</td>
<td>8,000 sf</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
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<tr>
<td>2564</td>
<td>62,000 sf</td>
</tr>
<tr>
<td>3015</td>
<td>13,500 sf</td>
</tr>
<tr>
<td>2966</td>
<td>20,000 sf</td>
</tr>
<tr>
<td>2101</td>
<td>18,000 sf</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>15000 sf (50% administrative offices; 50% client support/services – job training/placement for handicapped individuals)</td>
</tr>
<tr>
<td>1926</td>
<td>876,000 sf</td>
</tr>
<tr>
<td>2327</td>
<td>skipped</td>
</tr>
<tr>
<td>2543</td>
<td>skipped</td>
</tr>
<tr>
<td>1112</td>
<td>6,000 sf</td>
</tr>
<tr>
<td>4004</td>
<td>20,000 sf</td>
</tr>
<tr>
<td>1532</td>
<td>118,000 sf</td>
</tr>
<tr>
<td>776</td>
<td>skipped</td>
</tr>
<tr>
<td>3938</td>
<td>9,000 sf</td>
</tr>
<tr>
<td>608</td>
<td>70,000 sf</td>
</tr>
<tr>
<td>2132</td>
<td>skipped</td>
</tr>
<tr>
<td>1983</td>
<td>skipped</td>
</tr>
<tr>
<td>2363</td>
<td>86,000 sf</td>
</tr>
<tr>
<td>111</td>
<td>skipped</td>
</tr>
<tr>
<td>1315</td>
<td>20,000 sf office and 90,000 sf warehouse</td>
</tr>
<tr>
<td>3513</td>
<td>1000 sf</td>
</tr>
<tr>
<td>965</td>
<td>skipped</td>
</tr>
</tbody>
</table>

8.b. Where is the building located (city, state)?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Lenox, MA</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>Outside Beijing, China</td>
</tr>
<tr>
<td>119</td>
<td>Seattle, WA</td>
</tr>
<tr>
<td>50</td>
<td>Maine</td>
</tr>
<tr>
<td>260</td>
<td>Orlando, FL</td>
</tr>
<tr>
<td>ws6</td>
<td>Central OH</td>
</tr>
<tr>
<td>------</td>
<td>---------------------</td>
</tr>
<tr>
<td>332</td>
<td>Zone 7 - Michigan</td>
</tr>
<tr>
<td>ws1</td>
<td>Ft Lee, VA (Petersburg)</td>
</tr>
<tr>
<td>ws5</td>
<td>Prototype design used at locations across the country – design specs cover all climate zones. Not sure how many have been/will be built. Building activity has slowed a lot recently.</td>
</tr>
<tr>
<td>ws7</td>
<td>Virginia</td>
</tr>
<tr>
<td>ws3</td>
<td>Dracut, MA</td>
</tr>
<tr>
<td>410</td>
<td>Spring, TX</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Salem, VA</td>
</tr>
<tr>
<td>293</td>
<td>Nashville, TN</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Ft Worth, TX</td>
</tr>
<tr>
<td>3821</td>
<td>Kansas City, MO</td>
</tr>
<tr>
<td>2356</td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td>3186</td>
<td>Wichita, KS</td>
</tr>
<tr>
<td>2345</td>
<td>Bethesda, MD</td>
</tr>
<tr>
<td>3820</td>
<td>Boston, MA</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Woodlands, TX</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Canoga Park, CA</td>
</tr>
<tr>
<td>2878</td>
<td>Wawa, PA</td>
</tr>
<tr>
<td>117</td>
<td>Clovis, CA</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Somerset, KY</td>
</tr>
<tr>
<td>3015</td>
<td>Fairbanks, AK</td>
</tr>
<tr>
<td>2966</td>
<td>Toronto, Ontario</td>
</tr>
<tr>
<td>2101</td>
<td>Watertown MA</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Richland, WA</td>
</tr>
<tr>
<td>1926</td>
<td>Tampa, FL</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Portland, OR</td>
</tr>
<tr>
<td>4004</td>
<td>Cupertino, CA</td>
</tr>
<tr>
<td>1532</td>
<td>Dalton, MA</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Casper, WY</td>
</tr>
<tr>
<td>608</td>
<td>Fairbanks, AK</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
### 8.c. What energy code was applied to the project?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>ASHRAE 90.1-2007</td>
</tr>
<tr>
<td>Ws8</td>
<td>Involved in projects all over the country. Codes range widely.</td>
</tr>
<tr>
<td>Ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>Did not see references to code on this project. However, there was a government mandate to get rid of the school’s coal-fired equipment.</td>
</tr>
<tr>
<td>119</td>
<td>WA state energy code, which he thinks is stricter than 90.1-2004 when it comes to envelope and HVAC requirements.</td>
</tr>
<tr>
<td>50</td>
<td>90.1-2007 (required by military)</td>
</tr>
<tr>
<td>260</td>
<td>Florida building code Chapter 13 for equipment sizing and SEER rating</td>
</tr>
<tr>
<td>ws6</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>332</td>
<td>ASHRAE 90.1 2004</td>
</tr>
<tr>
<td>ws1</td>
<td>International Mechanical Code</td>
</tr>
<tr>
<td>ws5</td>
<td>International Mechanical Code. Prototype includes notes to designer on modifying design to meet local code requirements &amp; climate zone.</td>
</tr>
<tr>
<td>ws7</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>ws3</td>
<td>IECC, but tend not to worry much about code because they usually exceed it.</td>
</tr>
<tr>
<td>410</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>IECC 2006/90.1-2004</td>
</tr>
<tr>
<td>293</td>
<td>IECC 2006, IMC, IPC</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>IECC 2003</td>
</tr>
<tr>
<td>3821</td>
<td>90.1-2007 to meet LEED requirements</td>
</tr>
<tr>
<td>2356</td>
<td>Ontario building code – based on archaic ASHRAE standard (90.1-89).</td>
</tr>
<tr>
<td>3186</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>2345</td>
<td>90.1-2007</td>
</tr>
<tr>
<td>3820</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Title 24</td>
</tr>
<tr>
<td>2878</td>
<td>90.1-2004</td>
</tr>
<tr>
<td>117</td>
<td>Title 24</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
2564  IECC-2004
3015  None. Alaska has no state energy code and Fairbanks has no local code.
2966  Ontario Building Code – based on ASHRAE 52 and 90.1
2101  90.1 2004
2138  skipped
1895  Washington state nonresidential building code
1926  Florida state energy code, based on 90.1
2327  Skipped
2543  Skipped
1112  90.1-2004
4004  Title 24
1532  90.1-2007
776  Skipped
3938  IMC
608  No code in Fairbanks
2132  Skipped
1983  Skipped
2363  NY state energy code references 90.1-2004
111  Skipped
1315  90.1-2004
3513  Montreal code
965  Skipped

8.d. What was the energy performance of the building design: consistent with code; 1-10% better than code; 11-20% better than code; 21-30% better than code; or more than 30% better than code?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>15% better than code</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>11-20% better than code</td>
</tr>
<tr>
<td>50</td>
<td>Consistent with 90.1-2007.</td>
</tr>
<tr>
<td>260</td>
<td>Not sure</td>
</tr>
<tr>
<td>ws6</td>
<td>21-30% better than code</td>
</tr>
<tr>
<td>332</td>
<td>21-30% better than code</td>
</tr>
<tr>
<td>ws1</td>
<td>40% better than code</td>
</tr>
<tr>
<td>ws5</td>
<td>Not sure.</td>
</tr>
<tr>
<td>ws7</td>
<td>Consistent with code.</td>
</tr>
<tr>
<td>ws3</td>
<td>21-30% better than code</td>
</tr>
<tr>
<td>410</td>
<td>Around 10% better</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>Number</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>393</td>
<td>20% better than code</td>
</tr>
<tr>
<td>293</td>
<td>11-20% better than code</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Haven’t done estimate yet, but probably 30% better than IECC</td>
</tr>
<tr>
<td>3821</td>
<td>Probably not better than code, but 35-45% better compared to existing building</td>
</tr>
<tr>
<td>2356</td>
<td>30-40% better than code</td>
</tr>
<tr>
<td>3186</td>
<td>20% better than code</td>
</tr>
<tr>
<td>610</td>
<td>Haven’t done estimate yet, but probably 30% better than IECC</td>
</tr>
<tr>
<td>3820</td>
<td>N/A (existing building)</td>
</tr>
<tr>
<td>3952</td>
<td>Skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2241</td>
<td>Skipped</td>
</tr>
<tr>
<td>2784</td>
<td>20% better than code</td>
</tr>
<tr>
<td>2878</td>
<td>Don’t know</td>
</tr>
<tr>
<td>117</td>
<td>22% better than Title 24</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>30% better than code. Original goal was to do net zero building, but the renewable energy components were dropped due to cost.</td>
</tr>
<tr>
<td>3015</td>
<td>N/A (no local code)</td>
</tr>
<tr>
<td>2966</td>
<td>50% savings based on energy simulation results. Building includes renewable energy generation. Original goal was energy neutral building.</td>
</tr>
<tr>
<td>2101</td>
<td>20% better than code</td>
</tr>
<tr>
<td>2138</td>
<td>Skipped</td>
</tr>
<tr>
<td>1895</td>
<td>20% better than 90.1-2004 (required to get 4 LEED points)</td>
</tr>
<tr>
<td>1926</td>
<td>Don’t know – better than code</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Hard to say because the office is part of a larger building that does energy intensive manufacturing (metal plating). Office energy use is only 6% of total facility energy use.</td>
</tr>
<tr>
<td>4004</td>
<td>Don’t know</td>
</tr>
<tr>
<td>1532</td>
<td>30% better than code (school board mandate)</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>30% better than code</td>
</tr>
<tr>
<td>608</td>
<td>Skipped (not applicable)</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>20-30% better</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>30% better</td>
</tr>
<tr>
<td>3513</td>
<td>45% below 90.1-1999</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.e. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE Guide (versus other factors) in determining the energy performance of the building design?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>4 of 5. The Guides make it easy to put efficient options on paper and ask everyone to follow them. However, it's harder to implement.</td>
</tr>
<tr>
<td>ws8</td>
<td>In general, what he recommends is consistent with the Guides but Guides are not all that important in his day-to-day work. A lot of times he gets involved in projects after the design strategy has already been determined.</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>4 or 5. The credulity of the Guide was very useful in this project. It allowed him to make recommendations without seeming like he was selling something. He could show what to do and why based expertise from an independent third party. This helped with fast-tracking implementation of his recommendations.</td>
</tr>
<tr>
<td>119</td>
<td>1. WA code is in many cases consistent with Guide recommendations for HVAC and envelope efficiency. Also, this was a LEED Gold project.</td>
</tr>
<tr>
<td>50</td>
<td>2. Guide had lower importance because they were required to follow the 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>5. She likes using the Guides – very easy.</td>
</tr>
<tr>
<td>ws6</td>
<td>3</td>
</tr>
<tr>
<td>332</td>
<td>2 – gave table to architect for pre-design</td>
</tr>
<tr>
<td>ws1</td>
<td>3 or 4. Guides are important early in the design process but then trail off.</td>
</tr>
<tr>
<td>ws5</td>
<td>4</td>
</tr>
<tr>
<td>ws7</td>
<td>4</td>
</tr>
<tr>
<td>ws3</td>
<td>4</td>
</tr>
<tr>
<td>410</td>
<td>3.5 - 4</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>skipped</td>
</tr>
<tr>
<td>293</td>
<td>3</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>3</td>
</tr>
<tr>
<td>3821</td>
<td>3</td>
</tr>
<tr>
<td>2356</td>
<td>4</td>
</tr>
<tr>
<td>3186</td>
<td>5</td>
</tr>
<tr>
<td>2345</td>
<td>3 or 4.</td>
</tr>
<tr>
<td>3820</td>
<td>4</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No response</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>5</td>
</tr>
<tr>
<td>2878</td>
<td>5</td>
</tr>
<tr>
<td>117</td>
<td>4</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>3</td>
</tr>
<tr>
<td>3015</td>
<td>5 – very easy to use, saved time</td>
</tr>
</tbody>
</table>
8.f. **How was the ASHRAE Guide used in connection with this project?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Sought to implement all recommendations in the Guide. They aimed to show client and other members of design team that choosing not to implement some recommendations would impact expected savings and costs.</td>
</tr>
<tr>
<td>Ws8</td>
<td>He often refers people to the Guides. Every consulting engineer knows the 90.1 standard but only around 30-40% are familiar with the Guides. In general younger engineers are more receptive to using the Guides and the price is right. Older design engineers think they already know how to design for efficiency.</td>
</tr>
<tr>
<td>Ws4</td>
<td>Generally speaking for small projects they will implement specific recommendations from the Guide based on what makes sense for the project.</td>
</tr>
<tr>
<td>282</td>
<td>He recommended installation of geothermal system based on information in the Guide and this recommendation was adopted.</td>
</tr>
<tr>
<td>119</td>
<td>The project was fully designed when he inherited it from a colleague who was leaving. He used the Guides as a reference, backchecking to make sure that the design specifications met or exceeded ASHRAE recommendations.</td>
</tr>
<tr>
<td>50</td>
<td>Because they hadn't done a lot of work in Climate Zone 6, they looked through the Guide to see what the recommendations were for that climate zone, and compared those recommendations with the requirements of the 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>Tried to get the best system they could without making it too expensive. She looked at recommendations for outside air ventilation, ducts, HVAC controls.</td>
</tr>
<tr>
<td>Ws6</td>
<td>Envelope recommendations reviewed with architect. Lighting/daylighting recs reviewed.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>332</td>
<td>Compliance path for LEED 2.2</td>
</tr>
<tr>
<td>ws1</td>
<td>Basically a jumping-off point for meeting energy requirements of design. Used in bid process and early brainstorming as discussed above. He picks and chooses pieces of the Guide to use in the design.</td>
</tr>
<tr>
<td>Ws5</td>
<td>Compliance path for LEED. The prototype was designed, then they went through each recommendation in the Guide to make sure it was met. If it wasn’t, they modified the design.</td>
</tr>
<tr>
<td>Ws7</td>
<td>Comprehensive guide.</td>
</tr>
<tr>
<td>Ws3</td>
<td>Comprehensive guide, particularly useful for persuading architects to do high performance design. He can send around a comprehensive list of recommendations and cite ASHRAE, which carries a lot of weight.</td>
</tr>
<tr>
<td>410</td>
<td>They used it as a general guideline for HVAC &amp; lighting recommendations. Variable duct system, dedicated outdoor air, lighting,</td>
</tr>
<tr>
<td>Ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Compliance path for LEED</td>
</tr>
<tr>
<td>293</td>
<td>AEDG was used as reference tool to convince owner to accept efficiency recommendations. Mostly used for R-values and equipment efficiency specifications.</td>
</tr>
<tr>
<td>697</td>
<td>Owner was interested in building energy efficient school. Discussed LEED, AEDG, and California High Performance Schools (ChiPS). Decided to go with ChiPS, but there is a lot of overlap with AEDG recommendations (around 90% of ChiPS recommendations are also in AEDGs.)</td>
</tr>
<tr>
<td>3821</td>
<td>Skylight measures</td>
</tr>
<tr>
<td>2356</td>
<td>Useful as a resource for ideas, and then as something to refer to in pitching the ideas to the owner. Ideas then have to be vetted with other members of design team.</td>
</tr>
<tr>
<td>3186</td>
<td>Following the Guide as a standard practice.</td>
</tr>
<tr>
<td>2345</td>
<td>Resource for meeting required target for military facilities. Useful as a reference to point to in discussions w/ architect and building owner, as a way to go beyond minimum requirements.</td>
</tr>
<tr>
<td>3820</td>
<td>Reference to identify energy efficiency opportunities. Compare performance levels in the Guide with existing system operations.</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Architect followed envelope recommendations prescriptively. Guide was also followed for mechanical design. Because the Guides are a consensus-based document, it’s easier to get architects to buy in.</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Followed recommendations prescriptively. Because it was a retrofit, there were some things they could not implement (exterior structure).</td>
</tr>
<tr>
<td>2878</td>
<td>Sent recommended R-values to architect; went beyond Guide on efficiency of mechanical systems.</td>
</tr>
<tr>
<td>117</td>
<td>Reviewed the Guide early in the design process to get an idea about different system options. Also shared with architect.</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2564</td>
<td>Followed recommendations prescriptively.</td>
</tr>
<tr>
<td>3015</td>
<td>Comprehensive design guide. Convinced architect to adopt thermal envelope recommendations.</td>
</tr>
<tr>
<td>2966</td>
<td>Suggestions made to architect and electrical consultant based on Guide.</td>
</tr>
<tr>
<td>2101</td>
<td>Used as reference</td>
</tr>
<tr>
<td>2138</td>
<td>Skipped</td>
</tr>
<tr>
<td>1895</td>
<td>They are really trying to make the prescriptive approach work for LEED compliance. Following Guide is easiest 4 pts in LEED.</td>
</tr>
<tr>
<td>1926</td>
<td>Identify energy savings opportunities for existing building. Guide values used as benchmark.</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>AEDG used to set energy performance targets for office component of building. Where possible, carried envelope and lighting recommendations over to the metal plating shop.</td>
</tr>
<tr>
<td>4004</td>
<td>Reference for specifying minimum efficiency requirements for mechanical equipment. Guidance on how to do demand controlled ventilation.</td>
</tr>
<tr>
<td>1532</td>
<td>Worked with architect on envelope design to ensure AEDG recommendations were met. Used HAP/Trace to determine design for other systems</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>LEED compliance. Made changes in a lot of areas as a result of the Guide – daylight harvesting (dimming within 12 feet of wall), insulation on basement walls. Looked at attic insulation recommendations but did not need to increase.</td>
</tr>
<tr>
<td>608</td>
<td>Evaluating envelope tradeoffs. HVAC recommendations were irrelevant (did not cover hydronics).</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Used as a benchmark – LEED project</td>
</tr>
<tr>
<td>3513</td>
<td>Sent envelope recommendations to architect; referenced AEDG values for motor horsepower (ventilation system)</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

8.g. What fraction of the ASHRAE Guide recommendations was implemented?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>At least 75%</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>Main recommendation was installing geothermal system.</td>
</tr>
<tr>
<td>119</td>
<td>Not sure, but he thinks most recommendations were probably met.</td>
</tr>
<tr>
<td>50</td>
<td>70-80% (met what was required by 2007 standard)</td>
</tr>
<tr>
<td>260</td>
<td>65%</td>
</tr>
<tr>
<td>Project</td>
<td>Result</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>ws6</td>
<td>75%</td>
</tr>
<tr>
<td>332</td>
<td>98% all but the lighting power density</td>
</tr>
<tr>
<td>ws1</td>
<td>33% - went beyond Guide in most areas.</td>
</tr>
<tr>
<td>ws5</td>
<td>100%</td>
</tr>
<tr>
<td>ws7</td>
<td>Don't know</td>
</tr>
<tr>
<td>ws3</td>
<td>100% of those that applied (insulation, windows, lighting, etc.)</td>
</tr>
<tr>
<td>410</td>
<td>70%</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>skipped</td>
</tr>
<tr>
<td>293</td>
<td>10-20%</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>90%</td>
</tr>
<tr>
<td>3821</td>
<td>&lt;5%; only skylight</td>
</tr>
<tr>
<td>2356</td>
<td>40%. Used intensity-based approach for lighting, influenced layouts and use of reflectors and colors.</td>
</tr>
<tr>
<td>3186</td>
<td>75-100% of the easy ones. Some will get value engineered out.</td>
</tr>
<tr>
<td>2345</td>
<td>All those needed to meet energy target.</td>
</tr>
<tr>
<td>3820</td>
<td>Not sure - 25-30%.</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>100%</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>60-70%</td>
</tr>
<tr>
<td>2878</td>
<td>Don't know – made recommendations to the architect but not sure what they implemented</td>
</tr>
<tr>
<td>117</td>
<td>50%</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Don't know</td>
</tr>
<tr>
<td>3015</td>
<td>85% - roof, wall, floor, door, glazing recommendations were followed. Did not quite meet Guide recommendations for lighting.</td>
</tr>
<tr>
<td>2966</td>
<td>30%.</td>
</tr>
<tr>
<td>2101</td>
<td>Not sure – only worked on MEP</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>90%</td>
</tr>
<tr>
<td>1926</td>
<td>50%</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>20%</td>
</tr>
<tr>
<td>4004</td>
<td>Don't know</td>
</tr>
<tr>
<td>1532</td>
<td>20% likely (still in feasibility study phase)</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>100%</td>
</tr>
<tr>
<td>608</td>
<td>60%</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.h. Were there any ASHRAE Guide recommendations that you sought to implement but were unsuccessful? If so, why?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>No</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>No. He does not typically recommend things that don’t have a good chance of acceptance.</td>
</tr>
<tr>
<td>50</td>
<td>Nothing comes to mind.</td>
</tr>
<tr>
<td>260</td>
<td>Using motorized dampers on exhaust fans</td>
</tr>
<tr>
<td>ws6</td>
<td>Daylight harvesting</td>
</tr>
<tr>
<td>332</td>
<td>Lighting power density – due to small size of some rooms (bathrooms, storage rooms), corridors, etc. that require a fixture. They got close with a 0.98 but could not get to the recommendation of 0.9.</td>
</tr>
<tr>
<td>ws1</td>
<td>Sun control measures are challenging for a military design work because of requirements for blast-resistance. They cannot typically meet U-value and SHGC recommendations.</td>
</tr>
<tr>
<td>ws5</td>
<td>Everything was pretty straightforward. However, it was difficult to find RTUs that met both the AEDG efficiency specifications while still complying with</td>
</tr>
<tr>
<td></td>
<td>Was designing in Climate Zone 1 – have to design to worst case scenario. As result impossible to meet AEDG efficiency requirements for RTUs and meet the LEED refrigeration management strategy for LEED – met the LEED pre-req, but could not get point.</td>
</tr>
<tr>
<td>ws7</td>
<td>No</td>
</tr>
<tr>
<td>ws3</td>
<td>No</td>
</tr>
<tr>
<td>410</td>
<td>They sent the guide to the architect but they did not choose to follow the window recommendations.</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes - daylighting</td>
</tr>
<tr>
<td>293</td>
<td>Roof and wall R values were reduced in compromise with other design team members.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Project has not been priced yet, so right now nothing has been ruled out. Project does not include onsite renewables.</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Guide recommendations are taken as suggestions. A vetting process is used to make</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>3186</td>
<td>Have challenges reducing the amount of glass. This project also has too much lighting.</td>
</tr>
<tr>
<td>3820</td>
<td>No</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Since it was an existing building, there were some limits on what could be done for insulation levels. Also, they wanted to specify the highest-possible efficiency for HVAC equipment but went with lower efficiency level due to cost (still consistent with Guide recommendations, though)</td>
</tr>
<tr>
<td>2878</td>
<td>Don’t know – there is a lack of communication with other members of the design team on what was implemented.</td>
</tr>
<tr>
<td>117</td>
<td>Looked at doing geothermal but payback was too long for small building</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>No</td>
</tr>
<tr>
<td>3015</td>
<td>Client was reluctant to reduce lighting power density, however building was designed with two-level lighting so that some of it could be shut off during daily use.</td>
</tr>
<tr>
<td>2966</td>
<td>Building is in Climate Zone 6 and it was not possible to implement many of the HVAC recommendations. Also payback was too long for gray water and snow melting systems.</td>
</tr>
<tr>
<td>2101</td>
<td>No – used as reference</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>They ran into some floor slab issues. Also were not able to meet lighting power density recommendations.</td>
</tr>
<tr>
<td>1926</td>
<td>Outside air economizers are not possible in hot/humid climate. Also not possible to do CO2 sensors for ventilation control because of building structure.</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Water heating recommendations not relevant due to minimal water demand. HVAC recommendations are good for the office part of the building but totally insufficient to meet the ventilation requirements on the shop floor.</td>
</tr>
<tr>
<td>4004</td>
<td>Don’t know. They did design and delivered to another consultant for implementation.</td>
</tr>
<tr>
<td>1532</td>
<td>AEDG is useful starting point, but code (90.1-2007) is basically equivalent to AEDG values.</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>No, but frustrated with WWR recommendations that don’t take site into account. This building was shaded by neighboring building on the south side, so going above the AEDG U-values would be better because you’d actually get some heating savings. Daylight harvesting is very expensive for savings achieved. Foundation insulation recommendations were tough to meet since it was a retrofit of an existing building.</td>
</tr>
<tr>
<td>608</td>
<td>Did not go after lighting recommendations. Owner decided not to do demand controlled ventilation because of cost. Went with standard thermostats.</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Looked at improving DHW efficiency but first cost eliminated this recommendation.</td>
</tr>
</tbody>
</table>
Because it was a retrofit, some envelope measures were cost-prohibitive.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Overlooked water heating</td>
</tr>
<tr>
<td>3513</td>
<td>No</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

8.i. Did any other resources inform energy-related components of the building design? If so, what other resources were used?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>The client was interested in LEED, though they did not go for certification. Guide was primary resource.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>They do some LEED projects, CA Title 24</td>
</tr>
<tr>
<td>282</td>
<td>He uses the 90.1 standard and other technical resources for evaluating cold storage, PV, and other energy saving opportunities.</td>
</tr>
<tr>
<td>119</td>
<td>LEED Gold. Core Performance Guide.</td>
</tr>
<tr>
<td>50</td>
<td>90.1-2007; LEED.</td>
</tr>
<tr>
<td>260</td>
<td>90.1-2007</td>
</tr>
<tr>
<td>ws6</td>
<td>90.1-2004 and LEED</td>
</tr>
<tr>
<td>332</td>
<td>90.1, LEED guidelines, standard office practices</td>
</tr>
<tr>
<td>ws1</td>
<td>LEED</td>
</tr>
<tr>
<td>ws5</td>
<td>IMC, LEED, ASHRAE 90.1, other ASHRAE resources on thermal comfort, ventilation</td>
</tr>
<tr>
<td>ws7</td>
<td>LEED</td>
</tr>
<tr>
<td>ws3</td>
<td>None</td>
</tr>
<tr>
<td>410</td>
<td>90.1, LEED</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>90.1, LEED</td>
</tr>
<tr>
<td>293</td>
<td>90.1, other ASHRAE standards for ventilation, Air Diffusion Performance Index, etc.</td>
</tr>
<tr>
<td>697</td>
<td>Energy modeling is used to develop recommendations for program participants.</td>
</tr>
<tr>
<td>610</td>
<td>CHIPS, LEED (discussed)</td>
</tr>
<tr>
<td>3821</td>
<td>90.1-2007, LEED; High Performing Building Magazine</td>
</tr>
<tr>
<td>2356</td>
<td>Always look at the industry literature, other guidance documents. But the format of the AEDGs sets it apart from other resources.</td>
</tr>
<tr>
<td>3186</td>
<td>90.1-2004. He is LEED AP but have not done LEED project yet.</td>
</tr>
<tr>
<td>2345</td>
<td>LEED</td>
</tr>
<tr>
<td>3820</td>
<td>In-house expertise</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>90.1. They considered LEED but decided not to go for it.</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Title 24, Energy Pro for cooling load calc</td>
</tr>
<tr>
<td>2878</td>
<td>None</td>
</tr>
<tr>
<td>117</td>
<td>Title 24, LEED</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ws9</td>
<td>Yes. They recommended residential insulation levels and other efficiency specifications for building shell.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Not sure. In Seattle the climate is mild, so exceeding code does not have much energy savings impact. Glazing is one exception.</td>
</tr>
<tr>
<td>50</td>
<td>Envelope is consistent with 2007 standard for insulation.</td>
</tr>
<tr>
<td>260</td>
<td>No, they are given envelope guidelines by the architect and don’t have a lot of influence. If a building has a lot of windows they may make some suggestions.</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes – increased the R value of insulation.</td>
</tr>
<tr>
<td>332</td>
<td>Yes – R-11value, low e argon filled windows</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes</td>
</tr>
</tbody>
</table>

8.j.i.1. Does building envelope exceed code requirements? If so, what improvements were made to the envelope design?
<table>
<thead>
<tr>
<th>ws5</th>
<th>Not sure – did not work on envelope</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws7</td>
<td>Don’t know</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes. Tracked down thermal breaks, continuous insulation.</td>
</tr>
<tr>
<td>410</td>
<td>Met or exceeded</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes – insulation R values increased, windows upgrades</td>
</tr>
<tr>
<td>293</td>
<td>Yes – insulation R values increased</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – increased insulation and changed insulation type from batts to rigid continuous</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Yes</td>
</tr>
<tr>
<td>3186</td>
<td>Yes</td>
</tr>
<tr>
<td>2345</td>
<td>Yes</td>
</tr>
<tr>
<td>3820</td>
<td>skipped (existing building)</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes - insulation</td>
</tr>
<tr>
<td>2878</td>
<td>Yes, if recommendations were followed by architect</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Yes</td>
</tr>
<tr>
<td>3015</td>
<td>Yes – increased insulation values plus continuous insulation, all single pane glazing replaced with triple pane</td>
</tr>
<tr>
<td>2966</td>
<td>Yes, roof and wall insulation values, glazing recommendations</td>
</tr>
<tr>
<td>2101</td>
<td>Yes, R values increased</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes – continuous insulation</td>
</tr>
<tr>
<td>1926</td>
<td>Yes – retrofit included air sealing for exterior glazing, increased insulation</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes – increased R value of insulation. Did not pay attention to infiltration recommendations because of high ventilation requirements for shop floor.</td>
</tr>
<tr>
<td>4004</td>
<td>Yes – increased insulation</td>
</tr>
<tr>
<td>1532</td>
<td>Yes – increased R values for roof and walls; replaced windows</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Yes</td>
</tr>
<tr>
<td>608</td>
<td>Yes</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Their retrofit project did not involve envelope upgrades, but under a separate project last year a cool roof was done, all windows were upgraded, and roof insulation was increased.</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1315</td>
<td>Yes – insulation values for wall and roof were increased; glazing upgrade; cool roof</td>
</tr>
<tr>
<td>3513</td>
<td>Yes – shared envelope recommendations with architect but not sure what they implemented</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

8.j.i.2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing upgrades to the building envelope, as compared with other factors?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>5</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>1 because they were following the 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>2. Not her decision.</td>
</tr>
<tr>
<td>ws6</td>
<td>3</td>
</tr>
<tr>
<td>332</td>
<td>4 – to be sure they were compliant</td>
</tr>
<tr>
<td>ws1</td>
<td>4</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>Skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>4 – used to inform architects</td>
</tr>
<tr>
<td>410</td>
<td>3</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>4 or 5 – guide was most influential for building envelope design</td>
</tr>
<tr>
<td>293</td>
<td>3</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>3</td>
</tr>
<tr>
<td>3821</td>
<td>3</td>
</tr>
<tr>
<td>2356</td>
<td>3</td>
</tr>
<tr>
<td>3186</td>
<td>4</td>
</tr>
<tr>
<td>2345</td>
<td>4 or 5</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>5</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>3</td>
</tr>
<tr>
<td>2878</td>
<td>5</td>
</tr>
<tr>
<td>117</td>
<td>3. Lots of modeling was also done based on interest in exceeding Title 24.</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>4</td>
</tr>
<tr>
<td>3015</td>
<td>skipped</td>
</tr>
<tr>
<td>2966</td>
<td>4</td>
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</table>
### 8.j.i.3. What is the roof construction and insulation levels?

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<tbody>
<tr>
<td>ws9</td>
<td>R-38</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>Metal standing seam building; insulation above deck at R38.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Insulation entirely above deck. Not sure about the R value but think it was above 90.1-2004 requirements.</td>
</tr>
<tr>
<td>332</td>
<td>Attic – R-60 blown in insulation</td>
</tr>
<tr>
<td>ws1</td>
<td>Pre-engineered metal roof; insulation above-deck. R values consistent with Guide.</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>Skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>Light gauge steel trusses with rigid insulation above deck (4 inches polyiso)</td>
</tr>
<tr>
<td>410</td>
<td>R19 – roof, R13 walls -</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>2x6 rafters, insulation batts @ R39</td>
</tr>
<tr>
<td>293</td>
<td>Partial sloped wood construction and partial exposed roof, so partly attic and partly insulation entirely above deck. R-15</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Insulation entirely above deck, more than R20</td>
</tr>
<tr>
<td>3186</td>
<td>Attic, R38</td>
</tr>
<tr>
<td>2345</td>
<td>Insulation entirely above deck, R20 continuous</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Insulation entirely above deck; R30</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Insulation entirely above deck, R30</td>
</tr>
<tr>
<td>2878</td>
<td>Insulation under metal seam roof, R value unknown</td>
</tr>
<tr>
<td>117</td>
<td>Part of roof was insulation entirely above deck, part was green roof. SIP, but R value was not mentioned.</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Insulation entirely above deck, R40</td>
</tr>
<tr>
<td>2966</td>
<td>Insulation entirely above deck, R values consistent with Guide recommendations for Zone 6</td>
</tr>
<tr>
<td>2101</td>
<td>Insulation entirely above deck. Not sure about the R value but think it was above 90.1-2004 requirements.</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Metal deck with insulation on top. R38.</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Insulation entirely above deck. High SRI membrane (cool roof). Don’t recall R value.</td>
</tr>
<tr>
<td>4004</td>
<td>Don’t know roof construction, R19 (code requirement)</td>
</tr>
<tr>
<td>1532</td>
<td>Insulation entirely above deck, R30</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>Insulation entirely above deck, R40. No roof replacement.</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Metal pan with 4 inches isocyanate on top. White membrane for cool roof.</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Metal deck with R-30. White roof.</td>
</tr>
<tr>
<td>3513</td>
<td>Insulation entirely above deck. R value unknown.</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

**8.j.i.4. What is the wall construction and insulation levels?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Wood-framed 2&quot; x 6&quot;; R-19 + C.i.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>Masonry walls with stud backup. Insulation consistent with 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Mass walls - not sure about the R value but think it was above 90.1-2004 requirements.</td>
</tr>
<tr>
<td>332</td>
<td>Foam product on 2x6 – R-24</td>
</tr>
<tr>
<td>ws1</td>
<td>CMU (concrete masonry unit) up to 8 feet, then pre-engineered metal building above. Insulation between masonry – but no R value given</td>
</tr>
<tr>
<td>ws5</td>
<td>Steel framed walls</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>Steel posts with light gauge infill, insulation outside. 2 inches polyiso.</td>
</tr>
<tr>
<td>410</td>
<td>R15</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Steel framed, R-13 + R-7.5 ci</td>
</tr>
<tr>
<td>293</td>
<td>Wood construction, R15</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Large volume areas (gym, auditorium) have mass walls – heavy masonry w/ continuous insulation. Rest of the building has brick façade with studs and insulation batts. R value in the range of 21-24.</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Steel framed, R 15-18</td>
</tr>
<tr>
<td>3186</td>
<td>2x6 with R19</td>
</tr>
<tr>
<td>2345</td>
<td>Combo mass walls and steel framed, R13 continuous</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Steel-framed; R13</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Wood-framed, R19 with R30 in some multi-purpose areas</td>
</tr>
<tr>
<td>2878</td>
<td>Don’t know</td>
</tr>
<tr>
<td>117</td>
<td>SIP (R value not specified)</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Mass wall with interior framed to hold insulation. Existing wall was uninsulated concrete block. Built frame &amp; did insulation on the inside. R24 plus R10 c.i.</td>
</tr>
<tr>
<td>2966</td>
<td>No response given on wall construction or R value</td>
</tr>
<tr>
<td>2101</td>
<td>CMU</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Structural metal studs, framed wall. R21 batts plus 5 inches of rigid foam continuous insulation (R7)</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
1112 | Steel frame above grade (prefab sandwich system); high performance below grade walls to keep chemicals from leaching
4004 | Don’t know wall construction, R11
1532 | Brick and storefront curtain wall. R14 to R19 added to brick.
776 | Skipped
3938 | Skipped
608 | Steel framed, effective R30 (includes 3 inches of continuous insulation)
2132 | Skipped
1983 | Skipped
111 | Skipped
1315 | Steel framed, R19.
3513 | Steel framed w/ concrete siding, R value unknown.
965 | Skipped

8.j.i.5. What is the window-to-wall ratio?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>15-25% (net not gross)</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>In the 40% range</td>
</tr>
<tr>
<td>50</td>
<td>25-30%</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Less than 20% (upper teens)</td>
</tr>
<tr>
<td>332</td>
<td>21.8%</td>
</tr>
<tr>
<td>ws1</td>
<td>Not sure. Because it’s a garage, the door ratio is higher than the window ratio. Used translucent wall assemblies instead of windows.</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>10-15%</td>
</tr>
<tr>
<td>410</td>
<td>Unsure – there are not many windows.</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>15%</td>
</tr>
<tr>
<td>293</td>
<td>50%. This was one area where our recommendations failed.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Don’t know</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Don’t know – very few windows except up front w/ vestibule (big box)</td>
</tr>
<tr>
<td>3186</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2345</td>
<td>Don’t know</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
</tbody>
</table>
3952 skipped
3272 Not sure – less than 40%
2241 skipped
2784 50% - lots of windows in classrooms for daylighting
2878 Don’t know
117 15%
4012 skipped
2564 Participant indicated more detailed information would be sent via email
3015 Don’t know
2966 Less than 30%
2101 Estimate 20-30%
2138 skipped
1895 10%
1926 Skipped
2327 Skipped
2543 Skipped
1112 Skipped
4004 20-30%
1532 30%
776 Skipped
3938 Skipped
608 20%
2132 Skipped
1983 Skipped
2363 10%
111 Skipped
1315 Office @ 30%; warehouse @ 10%
3513 Don’t know
965 Skipped

8.j.i.6. What is the thermal transmittance [U-value] of vertical glazing?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
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<tbody>
<tr>
<td>ws9</td>
<td>U-0.32</td>
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</tr>
<tr>
<td>ws4</td>
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</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>0.45</td>
</tr>
<tr>
<td>50</td>
<td>Consistent with 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Don’t know</td>
</tr>
<tr>
<td>332</td>
<td>0.37</td>
</tr>
<tr>
<td>ws1</td>
<td></td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>ws3</td>
<td>At least R3; low e argon w/ film.</td>
</tr>
<tr>
<td>410</td>
<td>skipped</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>0.42</td>
</tr>
<tr>
<td>293</td>
<td>0.3</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>0.33 – low e windows</td>
</tr>
<tr>
<td>3821</td>
<td>0.5 (skylights, used vertical north facing)</td>
</tr>
<tr>
<td>2356</td>
<td>Don't know</td>
</tr>
<tr>
<td>3186</td>
<td>Don't know, but windows are double paned w/ argon</td>
</tr>
<tr>
<td>2345</td>
<td>0.42</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>0.45</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Not sure – windows are low e double glazed</td>
</tr>
<tr>
<td>2878</td>
<td>Not sure – windows are high efficiency double glazed</td>
</tr>
<tr>
<td>117</td>
<td>0.28</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>0.33</td>
</tr>
<tr>
<td>2966</td>
<td>0.2</td>
</tr>
<tr>
<td>2101</td>
<td>0.33 – low e</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>0.29</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
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</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Skipped</td>
</tr>
<tr>
<td>4004</td>
<td>Don't know</td>
</tr>
<tr>
<td>1532</td>
<td>R value is 3.45</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>R value of window assembly is 5.88; U=0.17</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>0.1-0.08</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>0.6-0.5, double paned glass</td>
</tr>
<tr>
<td>3513</td>
<td>Don't know</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.j.i.7. **What is the solar heat gain coefficient of vertical glazing?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Not sure w/out looking it up on manufacturers specifications but they usually use the industry standard of 0.4.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don’t know</td>
</tr>
<tr>
<td>50</td>
<td>Consistent with 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Don’t know</td>
</tr>
<tr>
<td>332</td>
<td>0.44 (shading coefficient)</td>
</tr>
<tr>
<td>ws1</td>
<td>Not applicable</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>0.4 (probably)</td>
</tr>
<tr>
<td>410</td>
<td>skipped</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>0.29</td>
</tr>
<tr>
<td>293</td>
<td>0.4</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>0.3</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>0.55</td>
</tr>
<tr>
<td>3186</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2345</td>
<td>0.39</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>0.31</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2878</td>
<td>Don’t know</td>
</tr>
<tr>
<td>117</td>
<td>0.27</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2966</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2101</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>0.38</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Skipped</td>
</tr>
<tr>
<td>4004</td>
<td>Don't know</td>
</tr>
<tr>
<td>1532</td>
<td>Don't know</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>0.4</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Don't know</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>0.24</td>
</tr>
<tr>
<td>3513</td>
<td>Don't know</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

8.j.i.8. **Is exterior sun control used? If so, what is the projection factor?**

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes but not sure about projection factor. Shading was over 2 ft in some spots. Shading was important because building is used as a daycare facility in the summer.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don't know</td>
</tr>
<tr>
<td>50</td>
<td>Not on outside because of concerns about snow load. All sun control was interior.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>No – part of the original design but was value engineered out in the construction process</td>
</tr>
<tr>
<td>332</td>
<td>2ft external overhangs on all sides</td>
</tr>
<tr>
<td>ws1</td>
<td>No</td>
</tr>
<tr>
<td>ws5</td>
<td>skipped</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>No</td>
</tr>
<tr>
<td>410</td>
<td>skipped</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>Yes, large overhangs. Don't know projection factor.</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – Considered building and window orientation, light shells shade lower ½ of windows, maybe some fins. Don't recall significant exterior shading, though.</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>No</td>
</tr>
<tr>
<td>3186</td>
<td>Overhangs</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
</tr>
</tbody>
</table>
8.j.ii.1. Does lighting power density exceed code requirements? If so, what efficiency improvements were made to the lighting design?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes. LPD meets Guide recommendations; good building orientation; daylighting; controls</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don't know</td>
</tr>
<tr>
<td>50</td>
<td>Yes – high efficiency fixtures, lighting distribution (some direct/indirect fixtures; some lay-in fixtures).</td>
</tr>
<tr>
<td>260</td>
<td>No – they don’t have a lot of say over lighting design.</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>332</td>
<td>No – they could not reach the 0.9 recommendation</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes</td>
</tr>
<tr>
<td>ws7</td>
<td>No</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes. High efficiency T8s, super efficient ballasts. Ballast factors adjusted to meet rooms. Some exterior LEDs. Indirect lighting with high reflectivity ceilings and high scotopic lamps. Also asked the architect to use higher reflectivity paint (0.65 =/-) on the walls.</td>
</tr>
<tr>
<td>410</td>
<td>Yes - super T8’s, fewer fixtures, and occupancy sensors.</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes</td>
</tr>
<tr>
<td>293</td>
<td>Not sure – not involved</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – daylighting, indirect lighting</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Yes (but code is not very stringent)</td>
</tr>
<tr>
<td>3186</td>
<td>No</td>
</tr>
<tr>
<td>2345</td>
<td>Maybe slightly</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Not sure – probably close to code</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes – full lighting retrofit was done</td>
</tr>
<tr>
<td>2878</td>
<td>Yes</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Yes – upgraded fixtures</td>
</tr>
<tr>
<td>2966</td>
<td>Yes – daylighting, occupancy sensors</td>
</tr>
<tr>
<td>2101</td>
<td>Yes – tried to consider daylighting</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes – exceeded code but did not meet Guide recommendations</td>
</tr>
<tr>
<td>1926</td>
<td>Retrofit included lighting upgrades: T12 magnetic to T8 electronic.</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes – Looked at T8s, daylighting modeling, transparent wall on S side, daylight sensors, skylights. Not sure how many of these were implemented.</td>
</tr>
<tr>
<td>4004</td>
<td>No - consistent with code.</td>
</tr>
<tr>
<td>1532</td>
<td>Yes – upgraded fixtures, daylighting, daylight harvesting</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Yes – fixtures, occupancy controls, dimming controls</td>
</tr>
<tr>
<td>608</td>
<td>Did not upgrade interior fixtures – not enough money. Exterior lighting was upgraded with controls, some LED signage</td>
</tr>
</tbody>
</table>
8.j.ii.2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing lighting efficiency upgrades, as compared with other factors?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>5</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>1. Not sure if lighting designer had a copy of the Guide. His main reference was the 2007 standard.</td>
</tr>
<tr>
<td>260</td>
<td>3 – it doesn’t happen often but when it does, Guide is influential.</td>
</tr>
<tr>
<td>ws6</td>
<td>4</td>
</tr>
<tr>
<td>332</td>
<td>4 – but more to meet 90.1</td>
</tr>
<tr>
<td>ws1</td>
<td>1 or 2</td>
</tr>
<tr>
<td>ws5</td>
<td>3</td>
</tr>
<tr>
<td>ws7</td>
<td>3</td>
</tr>
<tr>
<td>ws3</td>
<td>1 – did not look at it.</td>
</tr>
<tr>
<td>410</td>
<td>0-1</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>4, although electrical engineer already designs to less than 1 w/ft² as standard practice</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>4-5. Guide greatly influenced how architect designed the size and placement of windows.</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>3</td>
</tr>
<tr>
<td>3186</td>
<td>Important, but can’t convince electrical engineers to follow</td>
</tr>
<tr>
<td>2345</td>
<td>1 or 2</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>4 to 5</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>5</td>
</tr>
</tbody>
</table>
### 8.j.ii.3. What is the overall lighting power density (W/ft²)?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>0.9 w/sf</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Not sure, but code requires 1.0. They usually target 0.8 for LEED projects.</td>
</tr>
<tr>
<td>50</td>
<td>0.78 w/sf</td>
</tr>
<tr>
<td>260</td>
<td>Don’t know. The load calculation software uses LPD defaults by room type and the only way to change them is to change the room type.</td>
</tr>
<tr>
<td>ws6</td>
<td>Under 1 w/sf</td>
</tr>
<tr>
<td>332</td>
<td>1.1</td>
</tr>
<tr>
<td>ws1</td>
<td>0.8-0.9 w/sf</td>
</tr>
<tr>
<td>ws5</td>
<td>0.9 w/sf</td>
</tr>
<tr>
<td>ws7</td>
<td>1-something</td>
</tr>
<tr>
<td>ws3</td>
<td>Not sure – haven’t calculated yet. Probably code or better.</td>
</tr>
<tr>
<td>410</td>
<td>0.65 w/sf for classrooms</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>0.9 w/sf</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Don't know</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Between 1.3 and 1.5 w/sf</td>
</tr>
<tr>
<td>3186</td>
<td>1.3 w/sf</td>
</tr>
<tr>
<td>2345</td>
<td>Don't know</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>0.9-1.0 w/sf</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>2.0 w/sf</td>
</tr>
<tr>
<td>2878</td>
<td>Used 1.5 w/sf in calcs but actual value was lower</td>
</tr>
<tr>
<td>117</td>
<td>0.47 w/sf</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Don't know</td>
</tr>
<tr>
<td>2966</td>
<td>1.1 w/sf in corridor; 1.5 w/sf in offices</td>
</tr>
<tr>
<td>2101</td>
<td>Think around 1.0</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>1.1 w/sf</td>
</tr>
<tr>
<td>1926</td>
<td>1.5 w/sf</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Don't know</td>
</tr>
<tr>
<td>4004</td>
<td>1.2 to 1.3 w/sf (code)</td>
</tr>
<tr>
<td>1532</td>
<td>Don't know, but lighting retrofit cut LPD by half.</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Not sure, slightly less than the Guide value</td>
</tr>
<tr>
<td>608</td>
<td>Skipped</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>LPD reduced from 3 w/sf to 0.9 w/sf</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Office LPD =0.87 w/sf. Not sure about warehouse (120 w/fixture).</td>
</tr>
<tr>
<td>3513</td>
<td>0.9 w/ sf</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.j.ii.4. Are occupancy controls used? If so, where?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes – always. In classrooms, bathrooms, halls. Also implemented CO2 and humidity sensors.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Yes – required by code for buildings of a certain occupant density</td>
</tr>
<tr>
<td>50</td>
<td>Yes</td>
</tr>
<tr>
<td>260</td>
<td>No</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes – in classrooms</td>
</tr>
<tr>
<td>332</td>
<td>Yes – in all spaces</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes – standard on everything they do</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – all areas except main teller lobby</td>
</tr>
<tr>
<td>ws7</td>
<td>Yes – in classrooms</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes – in all spaces</td>
</tr>
<tr>
<td>410</td>
<td>Yes, sensors in classrooms, supply rooms, etc.</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>skipped</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – throughout building</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>No</td>
</tr>
<tr>
<td>3186</td>
<td>No</td>
</tr>
<tr>
<td>2345</td>
<td>Yes – throughout building</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes – throughout building</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes</td>
</tr>
<tr>
<td>2878</td>
<td>Don’t know</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Yes</td>
</tr>
<tr>
<td>2966</td>
<td>Yes</td>
</tr>
<tr>
<td>2101</td>
<td>Yes – classrooms and bathrooms</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes</td>
</tr>
<tr>
<td>1926</td>
<td>Yes – all common areas, management conference rooms, some offices. All future tenant build-outs will include occupancy sensor installation</td>
</tr>
</tbody>
</table>

Energy Center of Wisconsin
8.j.ii.5. Is daylighting used? If so, please describe.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes. Building orientation, classroom daylighting.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Yes – perimeter daylighting required by code.</td>
</tr>
<tr>
<td>50</td>
<td>Yes – daylighting on N side and SE side. High windows, clerestory in one area.</td>
</tr>
<tr>
<td>260</td>
<td>No</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes – sensors in classrooms. However WWR wasn’t very high so there was not a lot of savings benefit associated with this upgrade.</td>
</tr>
<tr>
<td>332</td>
<td>Yes – 2 continuous dimming in open office spaces (~4200 sq ft)  Adam:</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes – translucent paneling in garage; solar tubes in offices</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – lot of glass in front of lobby; windows in conference rooms.  Michelle:</td>
</tr>
<tr>
<td>ws7</td>
<td>Yes</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes – tubular skylights to match pattern of main lighting  Michelle:</td>
</tr>
<tr>
<td>410</td>
<td>No</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – daylighting considered in size and placement of windows. Lots of light wells and light shells.</td>
</tr>
<tr>
<td>3821</td>
<td>Yes, skylights</td>
</tr>
<tr>
<td>2356</td>
<td>No. Considered skylights but ruled out because of timing and cost.  Michelle:</td>
</tr>
<tr>
<td>3186</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2345</td>
<td>No</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes – lots of windows in classrooms</td>
</tr>
<tr>
<td>2878</td>
<td>No</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Yes – would have met daylighting requirements for LEED</td>
</tr>
<tr>
<td>2966</td>
<td>Yes – in corridors</td>
</tr>
<tr>
<td>2101</td>
<td>Tried to consider daylighting in classrooms</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1926</td>
<td>No</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes – in office</td>
</tr>
<tr>
<td>4004</td>
<td>No</td>
</tr>
<tr>
<td>1532</td>
<td>Building already had nice window wells before the retrofit</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Yes</td>
</tr>
<tr>
<td>608</td>
<td>Skipped</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Yes – existing building has skylights</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Yes</td>
</tr>
<tr>
<td>3513</td>
<td>Yes</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
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8.j.ii.6. Is daylight harvesting used? If so, please describe.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
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</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes</td>
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<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>Yes – daylight controls used</td>
</tr>
<tr>
<td>260</td>
<td>No</td>
</tr>
<tr>
<td>ws6</td>
<td>skipped</td>
</tr>
<tr>
<td>332</td>
<td>Yes</td>
</tr>
<tr>
<td>ws1</td>
<td>No</td>
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<tr>
<td>-----</td>
<td>----</td>
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<tr>
<td>ws5</td>
<td>Yes</td>
</tr>
<tr>
<td>ws7</td>
<td>No</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes</td>
</tr>
<tr>
<td>410</td>
<td>No</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – daylight sensors w/ light shells.</td>
</tr>
<tr>
<td>3821</td>
<td>No</td>
</tr>
<tr>
<td>2356</td>
<td>No</td>
</tr>
<tr>
<td>3186</td>
<td>No</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
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<td>3952</td>
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<tr>
<td>3272</td>
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<td>No</td>
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<td>117</td>
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</tr>
<tr>
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<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>No</td>
</tr>
<tr>
<td>2966</td>
<td>No</td>
</tr>
<tr>
<td>2101</td>
<td>Don’t think so</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes</td>
</tr>
<tr>
<td>1926</td>
<td>No</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes</td>
</tr>
<tr>
<td>4004</td>
<td>No</td>
</tr>
<tr>
<td>1532</td>
<td>Yes</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Yes</td>
</tr>
<tr>
<td>608</td>
<td>Skipped</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>No</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>No</td>
</tr>
<tr>
<td>3513</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### 8.j.ii.7. Are dimming controls for daylight harvesting used?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes – dimmable ballasts</td>
</tr>
<tr>
<td>332</td>
<td>Yes – 2 continuous dimming in open office spaces (~4200 sq ft)</td>
</tr>
<tr>
<td>ws1</td>
<td>skipped</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – stepped dimming controls</td>
</tr>
<tr>
<td>ws7</td>
<td>Not sure, probably</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes - stepped controls w/ photosensor control 50% of system</td>
</tr>
<tr>
<td>410</td>
<td>No</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>skipped</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – throughout building. Not sure if stepped or dimmed</td>
</tr>
<tr>
<td>3821</td>
<td>No</td>
</tr>
<tr>
<td>2356</td>
<td>No</td>
</tr>
<tr>
<td>3186</td>
<td>No</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
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<tr>
<td>2784</td>
<td>No</td>
</tr>
<tr>
<td>2878</td>
<td>No</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>No</td>
</tr>
<tr>
<td>2966</td>
<td>No</td>
</tr>
<tr>
<td>2101</td>
<td>Don’t think so</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes</td>
</tr>
<tr>
<td>1926</td>
<td>No</td>
</tr>
</tbody>
</table>
### 8.j.iii.1. Does HVAC efficiency exceed code requirements? If so, what efficiency improvements were made to HVAC design?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>In CA they follow code. Outside CA SEER levels exceed code.</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Doesn’t remember but probably wasn’t much better than code. Project used packaged units.</td>
</tr>
<tr>
<td>50</td>
<td>Yes, probably. Geothermal system used.</td>
</tr>
<tr>
<td>260</td>
<td>Yes – sometimes. [I think this answer was in general and not specifically about the retail project we were discussing.] SEER ratings are several points ahead of the code requirement.</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes – geothermal system (WSHP) with variable speed pumping.</td>
</tr>
<tr>
<td>332</td>
<td>Yes – energy recovery ventilation</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – RTU efficiency was increased as a result of AEDG recommendation. Prototype design met the most stringent Guide requirements for Zone 1 while allowing for use of different equipment in other climate zones.</td>
</tr>
<tr>
<td>ws7</td>
<td>Consistent with code</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes</td>
</tr>
<tr>
<td>410</td>
<td>Yes – one large chiller &amp; one small chiller instead of two identical size chillers. Designed for part load conditions, dedicated outdoor air system</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes - efficiency of heating and cooling equipment</td>
</tr>
<tr>
<td>No.</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
</tr>
<tr>
<td>293</td>
<td>Yes – HVAC equipment efficiency</td>
</tr>
<tr>
<td>697</td>
<td>skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
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<tr>
<td>2356</td>
<td>Yes</td>
</tr>
<tr>
<td>3186</td>
<td>Yes</td>
</tr>
<tr>
<td>2345</td>
<td>Probably</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes</td>
</tr>
<tr>
<td>2878</td>
<td>Yes</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Yes - upgrades to heating &amp; cooling equipment, ventilation</td>
</tr>
<tr>
<td>2966</td>
<td>Yes – geothermal system installed</td>
</tr>
<tr>
<td>2101</td>
<td>Yes - increased performance specs for HVAC equipment</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes – increased efficiency specs for HVAC equipment</td>
</tr>
<tr>
<td>1926</td>
<td>Yes. Installed VFDs on air supply vans and return fans (Supply = 6 fans per air handler, 45 hp each; return = 7 fans @ 40 hp each).</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes for office area but there is currently debate about whether the design meets code for the process area.</td>
</tr>
<tr>
<td>4004</td>
<td>Yes – increased efficiency specs for HVAC equipment</td>
</tr>
<tr>
<td>1532</td>
<td>They are currently considering different options for heating system upgrade. Looking at geothermal, water loop, heat recovery.</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Yes</td>
</tr>
<tr>
<td>608</td>
<td>Not applicable</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Yes – took out 80% efficient boiler and replaced with condensing boiler @ 96% max efficiency (91% overall efficiency). Brought ventilation up to code with heat recovery enthalpy wheels. Took out 25-hp fan coil units in walls and put in radiant system in ceiling.</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Yes. Used higher-SEER equipment than Guide recommends, heat recovery.</td>
</tr>
<tr>
<td>3513</td>
<td>Yes – geothermal system, efficient ventilation system with dedicated outside air and heat recovery. Fan coils on all floors for AC distribution. Radiant floor heating.</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.j.iii.2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing HVAC efficiency upgrades, as compared with other factors?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Did not answer.</td>
</tr>
<tr>
<td>ws8</td>
<td>Guide is general, not very influential</td>
</tr>
<tr>
<td>ws4</td>
<td>Not important especially for California projects</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>1. Guides discuss packaged system, but they were unable to use a packaged system for this building so they went with the geothermal system.</td>
</tr>
<tr>
<td>260</td>
<td>5</td>
</tr>
<tr>
<td>ws6</td>
<td>4</td>
</tr>
<tr>
<td>332</td>
<td>1 – standard office practice</td>
</tr>
<tr>
<td>ws1</td>
<td>0 to 1</td>
</tr>
<tr>
<td>ws5</td>
<td>5</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>4 – pushed us a little</td>
</tr>
<tr>
<td>410</td>
<td>4</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>2 or 3 – Guide reinforced what they are already doing</td>
</tr>
<tr>
<td>293</td>
<td>4</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>3.5 to 4. Already doing certain efficiency measures before Guide. Guide pushed them from using conventional energy-efficient equipment to more unconventional systems like GSHP.</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>3</td>
</tr>
<tr>
<td>3186</td>
<td>No response</td>
</tr>
<tr>
<td>2345</td>
<td>1</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>5</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>4</td>
</tr>
<tr>
<td>2878</td>
<td>5</td>
</tr>
<tr>
<td>117</td>
<td>4 or 5</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>skipped</td>
</tr>
<tr>
<td>2966</td>
<td>5</td>
</tr>
<tr>
<td>2101</td>
<td>4 – used as a reference</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>5</td>
</tr>
</tbody>
</table>
8.j.iii.3. What type of heating equipment is used?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Hybrid system – ground coupled water source heat pump w/ condensing boiler. Radiant slab w/ hydronic coils. Reheat coils sized to act as dehumidifier coil in summer. Passive ventilation.</td>
</tr>
<tr>
<td>ws8</td>
<td>Heat pumps and air handlers</td>
</tr>
<tr>
<td>ws4</td>
<td>RTU w/ constant volume multi-zone system; not VAV</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Gas furnace with electric reheat.</td>
</tr>
<tr>
<td>50</td>
<td>WSHP. Some miscellaneous storage areas had hydronic heating from a residential-scale condensing boiler with low water temp (120º-140º).</td>
</tr>
<tr>
<td>260</td>
<td>A few small heaters were used – only about 5 heating days per year.</td>
</tr>
<tr>
<td>ws6</td>
<td>Geothermal system (WSHP) plus some small electric heaters in entryways.</td>
</tr>
<tr>
<td>332</td>
<td>Hot water boilers, radiant floor heating in all exterior spaces</td>
</tr>
<tr>
<td>ws1</td>
<td>Went far beyond packaged units discussed in Guides. Used VRF system for conditioned space; gas-fired boiler serving radiant floor heating; demand-controlled ventilation; large variable frequency makeup air unit</td>
</tr>
<tr>
<td>ws5</td>
<td>Prototype included three options: RTU with gas heat; RTU with electrical heat; heat pump</td>
</tr>
<tr>
<td>ws7</td>
<td>80-100 WSHP</td>
</tr>
<tr>
<td>ws3</td>
<td>8 heat pumps. EER 11.74 - 12.73</td>
</tr>
<tr>
<td>410</td>
<td>Hybrid – condensing boiler &amp; non-condensing boiler for lower return temp – took this from AEDG</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Gas-fired condensing boiler</td>
</tr>
<tr>
<td>293</td>
<td>GSHP</td>
</tr>
</tbody>
</table>
8.j.iii.4. What is the size and efficiency of heating equipment?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Design was 6 3.5 ton heat pumps or 2 5-ton; COP above 3.5156 -200 kBTUh (probably five 5 ton units) , COP 3.5</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
</tbody>
</table>
### Evaluation of the Market Impact of the ASHRAE Advanced Energy Design Guides Appendices

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws4</td>
<td>3-10 tons, SEERs in line with guide</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don't know</td>
</tr>
<tr>
<td>50</td>
<td>19 WSHPs</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>3-ton units for most classrooms, ECM motors</td>
</tr>
<tr>
<td>332</td>
<td>2 – 135KBTU/h boilers, 95% efficient</td>
</tr>
<tr>
<td>ws1</td>
<td>2 VRF loops – 25 tons and 15 tons</td>
</tr>
<tr>
<td>ws5</td>
<td>Prototype specified 5 RTUs that can be selected based on building needs. Sizes range from 2 tons to 6 tons. 4 of the options are 13 SEER units. The 6-ton unit specifies 11.3 EER in Climate Zones 1 and 2; 11 EER in other zones.</td>
</tr>
<tr>
<td>ws7</td>
<td>75-80% efficient</td>
</tr>
<tr>
<td>ws3</td>
<td>Sizes of heat pumps range from ¾ ton to 1.5 ton. EER ranges from 11.74 to 12.73.</td>
</tr>
<tr>
<td>410</td>
<td>2,000,000 btu/h each, condensing 99% efficient, non-condensing 87% efficient</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>&lt; 1 million Btu/h; 90% efficient</td>
</tr>
<tr>
<td>293</td>
<td>2 10-ton systems. COP = 3.3</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>340 tons</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Size unknown, 80% efficient</td>
</tr>
<tr>
<td>3186</td>
<td>100,000 btuh, 90% efficient</td>
</tr>
<tr>
<td>2345</td>
<td>N/A (plant)</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Don't know, but efficiency was consistent with Guide</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>90% efficient</td>
</tr>
<tr>
<td>2878</td>
<td>Most units under 5 tons</td>
</tr>
<tr>
<td>117</td>
<td>20 ton chiller; IPLV = 13.9</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Don't know</td>
</tr>
<tr>
<td>2966</td>
<td>Size unknown; COP = 2.5-3.0</td>
</tr>
<tr>
<td>2101</td>
<td>90 % efficient</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>RPUs: 3 5-ton, 1 8.5-ton, 1 15-ton, SEER 14/11-12 EER</td>
</tr>
<tr>
<td>1926</td>
<td>Electric</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>No response given</td>
</tr>
<tr>
<td>4004</td>
<td>Don't know size, efficiency is 85%</td>
</tr>
<tr>
<td>1532</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.j.iii.5. What type of cooling equipment is used?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>See 8.j.iii.3</td>
</tr>
<tr>
<td>ws8</td>
<td>He mainly works on chillers – a lot of air cooled and some water cooled.</td>
</tr>
<tr>
<td>ws4</td>
<td>Typical system is rooftop packaged unit. Efficiency level is in line with Guides.</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Packaged rooftop unit</td>
</tr>
<tr>
<td>50</td>
<td>19 WSHPs</td>
</tr>
<tr>
<td>260</td>
<td>Split system</td>
</tr>
<tr>
<td>ws6</td>
<td>Geothermal system (WSHP)</td>
</tr>
<tr>
<td>332</td>
<td>Direct expansion, split system</td>
</tr>
<tr>
<td>ws1</td>
<td>VRF</td>
</tr>
<tr>
<td>ws5</td>
<td>RTU</td>
</tr>
<tr>
<td>ws7</td>
<td>80-100 WSHP</td>
</tr>
<tr>
<td>ws3</td>
<td>Heat pumps and evaporative fluid cooler. – didn’t want to drill wells or would have done geothermal</td>
</tr>
<tr>
<td>410</td>
<td>2 – a variable system and a screw water chiller and centrifugal</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Chiller plant serving 4 buildings</td>
</tr>
<tr>
<td>293</td>
<td>GSHP</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>GSHP</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Packaged RTU</td>
</tr>
<tr>
<td>3186</td>
<td>Packaged RTU</td>
</tr>
<tr>
<td>2345</td>
<td>N/A (plant)</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>DX RTU</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>ID</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>2784</td>
<td>RTU</td>
</tr>
<tr>
<td>2878</td>
<td>Packaged system</td>
</tr>
<tr>
<td>117</td>
<td>Mini chiller</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Economizer cooling – cools with outside air for most of the year. Data center has chilled glycol loop that runs outside. Glycol chiller can run w/out the compressor, which only turns on when outside air temperature is hot enough.</td>
</tr>
<tr>
<td>2966</td>
<td>Geothermal heat pump</td>
</tr>
<tr>
<td>2101</td>
<td>Chiller plant</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Rooftop packaged unit</td>
</tr>
<tr>
<td>1926</td>
<td>There were 4 chillers originally and now only 3 are needed. One has been replaced already and the other two are scheduled for replacement w/in the next few years. 0.78 kW/ton Carrier was replaced with new Trane chiller @ 0.68 kW/ton.</td>
</tr>
<tr>
<td>2327</td>
<td>skipped</td>
</tr>
<tr>
<td>2543</td>
<td>skipped</td>
</tr>
<tr>
<td>1112</td>
<td>skipped</td>
</tr>
<tr>
<td>4004</td>
<td>Packaged air-cooled RTU</td>
</tr>
<tr>
<td>1532</td>
<td>skipped</td>
</tr>
<tr>
<td>776</td>
<td>skipped</td>
</tr>
<tr>
<td>3938</td>
<td>skipped</td>
</tr>
<tr>
<td>608</td>
<td></td>
</tr>
<tr>
<td>2132</td>
<td>skipped</td>
</tr>
<tr>
<td>1983</td>
<td>skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Central water chiller replaced RTUs.</td>
</tr>
<tr>
<td>111</td>
<td>skipped</td>
</tr>
<tr>
<td>1315</td>
<td>RTUs and split systems</td>
</tr>
<tr>
<td>3513</td>
<td>Geothermal</td>
</tr>
<tr>
<td>965</td>
<td>skipped</td>
</tr>
</tbody>
</table>

8.j.iii.6. What is size and efficiency of cooling equipment?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>EER 16</td>
</tr>
<tr>
<td>ws8</td>
<td>Size ranges between 20 and 500 tons. Typical is 200 tons. Efficiency target is 10 EER, 14 IPLV.</td>
</tr>
<tr>
<td>Ws4</td>
<td>Size range is 3-10 tons; SEERS in line with guide</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don’t know</td>
</tr>
<tr>
<td>50</td>
<td>11 EER</td>
</tr>
<tr>
<td>260</td>
<td>14 SEER. Unit for each tenant space: 1 5-ton, 2 4-ton, and 6 3.5 ton units.</td>
</tr>
<tr>
<td>ws6</td>
<td>3 ton units for most classrooms</td>
</tr>
<tr>
<td>332</td>
<td>Two 7.5 ton 13 EER, one 2 ton 11.6 EER</td>
</tr>
<tr>
<td>ws1</td>
<td>See above</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>ws5</td>
<td>See above</td>
</tr>
<tr>
<td>ws7</td>
<td>No response given.</td>
</tr>
<tr>
<td>ws3</td>
<td>Cooling equipment doesn’t have an efficiency rating.</td>
</tr>
<tr>
<td>410</td>
<td>Variable – centrifugal 315 ton, efficiency .573 &amp; MPLV .543; screw – 115 ton, efficiency .707 &amp; MPLV .539</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>~100 tons for the referenced building; efficiency is 0.66 kW/ton = 18 EER</td>
</tr>
<tr>
<td>293</td>
<td>SEER 13</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>No response given</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Less than 100 tons; EER 11</td>
</tr>
<tr>
<td>3186</td>
<td>4 to 5 tons; SEER 13</td>
</tr>
<tr>
<td>2345</td>
<td>N/A (plant)</td>
</tr>
<tr>
<td>3820</td>
<td>Skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Don’t know, but efficiency was consistent with Guide</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>SEER 14</td>
</tr>
<tr>
<td>2878</td>
<td>EER 16</td>
</tr>
<tr>
<td>117</td>
<td>IPLV = 13.9</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Don’t know</td>
</tr>
<tr>
<td>2966</td>
<td>Don’t know – pretty high</td>
</tr>
<tr>
<td>2101</td>
<td>About 16 EER</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>RPUs: 3 5-ton, 1 8.5-ton, 1 115-ton, SEER 14/11-12 EER</td>
</tr>
<tr>
<td>1926</td>
<td>New chiller at 0.68 kW/ton</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>No response given</td>
</tr>
<tr>
<td>4004</td>
<td>Don’t know</td>
</tr>
<tr>
<td>1532</td>
<td>Skipped</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>Skipped</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>50 ton nominal, chiller is highest-possible efficiency w/ variable speed compressor</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>2 split systems @ 5 ton each, 19 SEER. 4 RTUs at 15 ton each, 13-14 SEER</td>
</tr>
</tbody>
</table>
## 8.j.iii.7. Please describe HVAC controls.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>CO₂, occ., and H₂O sensors used. (Did not provide information about other controls used.)</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>Don’t know</td>
</tr>
<tr>
<td>50</td>
<td>DDC</td>
</tr>
<tr>
<td>260</td>
<td>7 suites were undedicated (no tenants yet). These units just had standard thermostats. In the 2 dedicated units, they put in room temperature sensors, CO₂ sensor, and programmable thermostat.</td>
</tr>
<tr>
<td>ws6</td>
<td>Full DDC. Demand control ventilation in gym &amp; cafeteria. Airflow monitoring at intakes. Night time setbacks.</td>
</tr>
<tr>
<td>332</td>
<td>digital</td>
</tr>
<tr>
<td>ws1</td>
<td>Extensive controls on all systems (Army requirement)</td>
</tr>
<tr>
<td>ws5</td>
<td>Current design has night-time setback. Bank is developing the capacity for centralized energy monitoring/management of all locations.</td>
</tr>
<tr>
<td>ws7</td>
<td>DDC</td>
</tr>
<tr>
<td>ws3</td>
<td>Evaporative cooler controls fan on VFD. Programmable thermostat controls heat pumps. Packaged reset control on boiler.</td>
</tr>
<tr>
<td>410</td>
<td>Demand control ventilation; variable primary only system</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>skipped</td>
</tr>
<tr>
<td>293</td>
<td>Unitary logic controllers</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>No centralized controls; stand-alone on RTUs. Demand controlled ventilation.</td>
</tr>
<tr>
<td>3186</td>
<td>Programmable thermostats</td>
</tr>
<tr>
<td>2345</td>
<td>DDC</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Programmable thermostat</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>DDC</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2878</td>
<td>Single zone with single programmable thermostat</td>
</tr>
<tr>
<td>117</td>
<td>Demand control ventilation; CO2 sensors in classrooms. Economizer mix box on each air handler.</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>DDC</td>
</tr>
<tr>
<td>2966</td>
<td>Geothermal loop controlled based on demand. HRV unit for fresh air. VFD pumps. Occupancy sensors to control VAV box.</td>
</tr>
<tr>
<td>2101</td>
<td>Skipped</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Variable sub zoning control. Not DDC but Carrier's 3-V control system (poor man's VAV)</td>
</tr>
<tr>
<td>1926</td>
<td>Energy management system</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>No response given</td>
</tr>
<tr>
<td>4004</td>
<td>Part of package system</td>
</tr>
<tr>
<td>1532</td>
<td>DDC</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>Skipped</td>
</tr>
<tr>
<td>608</td>
<td>Replaced first generation DDC with current DDC</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>DDC for HVAC and lighting. Lighting shutoff @ 10PM.</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Trane tracker system</td>
</tr>
<tr>
<td>3513</td>
<td>DDC</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>

8.j.iv.1. Does water heating efficiency exceed code requirements? If so, what efficiency improvements were made to water heating systems?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes. Generation of DHW off compressor coils in summer.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>No</td>
</tr>
<tr>
<td>50</td>
<td>skipped</td>
</tr>
<tr>
<td>260</td>
<td>No involvement in water heating system design.</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes</td>
</tr>
<tr>
<td>332</td>
<td>Indirect water heater – comes off the boilers</td>
</tr>
<tr>
<td>ws1</td>
<td>yes</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – used to use instantaneous water heaters in kitchen, lavatory, and janitor closet. Now use 1 small tank water heater that serves all hot water needs.</td>
</tr>
<tr>
<td>Code</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>ws7</td>
<td>Consistent with code</td>
</tr>
<tr>
<td>ws3</td>
<td>Probably – not sure</td>
</tr>
<tr>
<td>410</td>
<td>Yes – high efficiency 2-way valve boiler</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes</td>
</tr>
<tr>
<td>293</td>
<td>Yes but below Guide recommendations. Insulation on pipes.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>No, not a lot of water use so cost of efficiency upgrade not justified</td>
</tr>
<tr>
<td>3186</td>
<td>Yes</td>
</tr>
<tr>
<td>2345</td>
<td>Yes – solar hot water</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Consistent with Title 24</td>
</tr>
<tr>
<td>2878</td>
<td>Yes</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Yes</td>
</tr>
<tr>
<td>2966</td>
<td>Yes</td>
</tr>
<tr>
<td>2101</td>
<td>Yes</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>No – consistent with code. Building has small water heating requirements.</td>
</tr>
<tr>
<td>1926</td>
<td>All electric system recently replaced. Insulation on pipes. Tied into building energy management system so heaters turn off when not in use.</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>No – consistent with code</td>
</tr>
<tr>
<td>4004</td>
<td>No – consistent with code</td>
</tr>
<tr>
<td>1532</td>
<td>Yes – considering options including biomass and combined space/water heating system</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>No water heating upgrades made</td>
</tr>
<tr>
<td>608</td>
<td>Not applicable</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>No – water heating upgrade was not done b/c of cost.</td>
</tr>
<tr>
<td>111</td>
<td>skipped</td>
</tr>
<tr>
<td>1315</td>
<td>No – consistent with code</td>
</tr>
<tr>
<td>3513</td>
<td>No</td>
</tr>
<tr>
<td>965</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.j.iv.2. On a scale of 1 to 5, how would you rate the relative importance of the ASHRAE guide in influencing water heating efficiency upgrades, as compared with other factors?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
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</thead>
<tbody>
<tr>
<td>ws9</td>
<td>No answer</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>3. The water heating system was selected because they have had favorable experiences with similar systems in the past.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>3</td>
</tr>
<tr>
<td>332</td>
<td>1 – standard office practice</td>
</tr>
<tr>
<td>ws1</td>
<td>2</td>
</tr>
<tr>
<td>ws5</td>
<td>2 or 3</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>1 – did not review AEDG recommendations</td>
</tr>
<tr>
<td>410</td>
<td>4 – recommendation of boilers-high delta T</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>3 or 4. They usually implement recommendations as standard practice.</td>
</tr>
<tr>
<td>293</td>
<td>4</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>2 – had little impact</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Skipped</td>
</tr>
<tr>
<td>3186</td>
<td>Not much</td>
</tr>
<tr>
<td>2345</td>
<td>1</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No response</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Skipped</td>
</tr>
<tr>
<td>2878</td>
<td>5, but did not use Guide</td>
</tr>
<tr>
<td>117</td>
<td>3</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>skipped</td>
</tr>
<tr>
<td>2966</td>
<td>2-3. Guides do not get into much detail on solar hot water.</td>
</tr>
<tr>
<td>2101</td>
<td>3 – used as a reference</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>3</td>
</tr>
</tbody>
</table>
### 8.j.iv.3 What type of water heating equipment is used?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Fossil fuel in winter, pull heat off GSHP compressors in winter</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>Instantaneous gas-fired.</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Gas fired condensing water heaters</td>
</tr>
<tr>
<td>332</td>
<td>gas</td>
</tr>
<tr>
<td>ws1</td>
<td>Gas fired condensing water heater</td>
</tr>
<tr>
<td>ws5</td>
<td>Electric</td>
</tr>
<tr>
<td>ws7</td>
<td>Gas-fired water heater</td>
</tr>
<tr>
<td>ws3</td>
<td>High efficiency condensing gas boiler; indirect w.h.</td>
</tr>
<tr>
<td>410</td>
<td>Boiler</td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>20-gallon point of use gas-fired water heaters.</td>
</tr>
<tr>
<td>293</td>
<td>Electric storage. Did not follow volume storage calcs in Guide.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Maybe condensing gas water heater, but can’t remember for sure</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>Gas storage</td>
</tr>
<tr>
<td>3186</td>
<td>Instantaneous electric</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2345</td>
<td>Solar hot water</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Point of use (3 to 5 gallon) electric storage</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Gas storage</td>
</tr>
<tr>
<td>2878</td>
<td>Instantaneous, electric</td>
</tr>
<tr>
<td>117</td>
<td>High efficiency water heater (mini boiler with storage tank) coupled with solar thermal system</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>BoilerMate indirect water heater</td>
</tr>
<tr>
<td>2966</td>
<td>Solar hot water meets 100% of building demand</td>
</tr>
<tr>
<td>2101</td>
<td>Gas fired condensing</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Electric storage</td>
</tr>
<tr>
<td>1926</td>
<td>skipped</td>
</tr>
<tr>
<td>2327</td>
<td>skipped</td>
</tr>
<tr>
<td>2543</td>
<td>skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Don’t know</td>
</tr>
<tr>
<td>4004</td>
<td>Gas storage, 20-30 gallon</td>
</tr>
<tr>
<td>1532</td>
<td>skipped – still evaluating options</td>
</tr>
<tr>
<td>776</td>
<td>skipped</td>
</tr>
<tr>
<td>3938</td>
<td>skipped</td>
</tr>
<tr>
<td>608</td>
<td>Steam heat exchanger provides hot water</td>
</tr>
<tr>
<td>2132</td>
<td>skipped</td>
</tr>
<tr>
<td>1983</td>
<td>skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Natural gas boiler</td>
</tr>
<tr>
<td>111</td>
<td>skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Tankless gas water heater</td>
</tr>
<tr>
<td>3513</td>
<td>Electric storage water heater; free hot water with geothermal system when available</td>
</tr>
<tr>
<td>965</td>
<td>skipped</td>
</tr>
</tbody>
</table>

8.j.iv.4 What is the efficiency of water heating equipment?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Didn’t answer</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>skipped</td>
</tr>
<tr>
<td>119</td>
<td>skipped</td>
</tr>
<tr>
<td>50</td>
<td>Not sure, but she thinks it was consistent with the Guide – maybe 81%</td>
</tr>
<tr>
<td>260</td>
<td>skipped</td>
</tr>
<tr>
<td>ws6</td>
<td>Don't know</td>
</tr>
<tr>
<td>------</td>
<td>------------------------</td>
</tr>
<tr>
<td>332</td>
<td>Not applicable</td>
</tr>
<tr>
<td>ws1</td>
<td>Low 90s</td>
</tr>
<tr>
<td>ws5</td>
<td>Don't know</td>
</tr>
<tr>
<td>ws7</td>
<td>80%</td>
</tr>
<tr>
<td>ws3</td>
<td>Can exceed 93% if return temperature is low enough</td>
</tr>
<tr>
<td>410</td>
<td></td>
</tr>
<tr>
<td>ws2</td>
<td>skipped</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>No response given</td>
</tr>
<tr>
<td>293</td>
<td>100% - electric</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>At least code and maybe better – not sure</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>80%</td>
</tr>
<tr>
<td>3186</td>
<td>Electric</td>
</tr>
<tr>
<td>2345</td>
<td>Solar</td>
</tr>
<tr>
<td>3820</td>
<td>skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Don't know</td>
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<tr>
<td>2241</td>
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</tr>
<tr>
<td>2784</td>
<td>85%</td>
</tr>
<tr>
<td>2878</td>
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</tr>
<tr>
<td>117</td>
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</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Participant indicated more detailed information would be sent via email</td>
</tr>
<tr>
<td>3015</td>
<td>Don't know</td>
</tr>
<tr>
<td>2966</td>
<td>N/A (solar hot water)</td>
</tr>
<tr>
<td>2101</td>
<td>Not sure</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
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<tr>
<td>1895</td>
<td>N/A (electric)</td>
</tr>
<tr>
<td>1926</td>
<td>Skipped</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Don't know</td>
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<tr>
<td>4004</td>
<td>80%</td>
</tr>
<tr>
<td>1532</td>
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</tr>
<tr>
<td>776</td>
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<tr>
<td>3938</td>
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</tr>
<tr>
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</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Don't know</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
8.k Did you encounter any challenges in using the ASHRAE Guide during the design process? If so, please describe.

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Not really. The design team was all in support of making the building design as energy efficient as possible.</td>
</tr>
<tr>
<td>ws8</td>
<td>Skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>Skipped</td>
</tr>
<tr>
<td>282</td>
<td>Yes. It was time-consuming to convince his Chinese clients that the climate zone they were in was analogous to one of the U.S. zones. Guides should present climate zones in global terms.</td>
</tr>
<tr>
<td>119</td>
<td>No. Just referenced the Guide quickly.</td>
</tr>
<tr>
<td>50</td>
<td>HVAC equipment discussed in the Guide (packaged rooftop) was not possible for this project. Guide does not address heat pumps.</td>
</tr>
<tr>
<td>260</td>
<td>None, other than that she’d like to be able to implement more recommendations.</td>
</tr>
<tr>
<td>ws6</td>
<td>No. Guide was very easy to work through, especially compared with the complexity of code books. Good graphics/visuals.</td>
</tr>
<tr>
<td>332</td>
<td>Confusion with how-to sections – client read a how-to section and took it as a recommendation where they did not. In this case it was the operable windows section.</td>
</tr>
<tr>
<td>ws1</td>
<td>System types are too limited – doesn’t line up with 90.1-2004. Guides are not much more aggressive than the latest 90.1 standard. They are required to do lifecycle cost analysis of each energy measure. He assumes Guide recommendations are based on lifecycle analysis but hard to guarantee they meet this requirement based on the information provided.</td>
</tr>
<tr>
<td>ws5</td>
<td>Biggest challenge was the confusion about whether to use the small retail or small office guide. The other challenge was the difficulty in finding RTU equipment that could meet both the ASHRAE efficiency specifications and the LEED requirements for refrigeration.</td>
</tr>
<tr>
<td>ws7</td>
<td>Guides are a pain in the butt, but necessary. Have blocked out specifics on challenges.</td>
</tr>
<tr>
<td>ws3</td>
<td>No</td>
</tr>
<tr>
<td>410</td>
<td>None other than trying to get others (i.e. school district) on the same page.</td>
</tr>
<tr>
<td>ws2</td>
<td>No – pretty much common sense &amp; straightforward.</td>
</tr>
<tr>
<td>375</td>
<td>Always front end cost challenges – more success with schools/municipalities/owners who are in it for the long term.</td>
</tr>
<tr>
<td>393</td>
<td>They encountered some structural/architectural challenges around getting the desired level of insulation on the roof, given the pitch &amp; 2x6 rafters.</td>
</tr>
<tr>
<td>293</td>
<td>No. Guides are very well laid out. Impossible to get confused. Likes how recommendations are broken out by climate zone in a delineated table.</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Not really. Straightforward, good information.</td>
</tr>
<tr>
<td>No.</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
</tr>
<tr>
<td>3821</td>
<td>No – the guides are straightforward.</td>
</tr>
<tr>
<td>2356</td>
<td>Not really – good reference.</td>
</tr>
<tr>
<td>3186</td>
<td>No, but most of the envelope decisions were already made. Chart is useful, but there is usually not enough time to implement pre-design process. All contractors tend to work in series rather than together.</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
</tr>
<tr>
<td>3820</td>
<td>No</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Not really, just the usual challenges since it was a design/build process and the contractors wanted to substitute cheaper equipment.</td>
</tr>
<tr>
<td>2241</td>
<td>Architects are not aware of Guide recommendations and how it relates to what they do</td>
</tr>
<tr>
<td>2784</td>
<td>No</td>
</tr>
<tr>
<td>2878</td>
<td>There is still an issue with vendors not supplying equipment that meets efficiency criteria specified in the Guide recommendations</td>
</tr>
<tr>
<td>117</td>
<td>No. They use the Guide for up-front evaluation of different system options and it works well for this purpose.</td>
</tr>
<tr>
<td>4012</td>
<td>skipped</td>
</tr>
<tr>
<td>2564</td>
<td>The copyright requirements are cumbersome and restrict their ability to distribute the Guide as needed. For example, they can’t store it on a network drive, and it is prohibited to make copies of certain pages and distribute. This makes it hard to share information in the Guide with owners/architects, who are not motivated to download their own copies of the Guides.</td>
</tr>
<tr>
<td>3015</td>
<td>Guide recommends that ductwork for VAV system be low pressure. They could not do this because of space constraints, so ductwork is medium pressure.</td>
</tr>
<tr>
<td>2966</td>
<td>More detailed information is needed on specific technologies. More details and case studies needed. More detailed information on successful application of specific technologies.</td>
</tr>
<tr>
<td>2101</td>
<td>Not sure if architects using</td>
</tr>
<tr>
<td>2138</td>
<td>Hard to get whole team to use</td>
</tr>
<tr>
<td>1895</td>
<td>Could not meet a couple of recommendations, like lighting power density. Difficulty interpreting which AEDG to use for building type that did not fall neatly into one of the defined categories.</td>
</tr>
<tr>
<td>1926</td>
<td>No - good, credible resource for making recommendations to client.</td>
</tr>
<tr>
<td>2327</td>
<td>No – they do 80-90% of the recommendations anyway. They encounter resistance to some things due to cost concerns.</td>
</tr>
<tr>
<td>2543</td>
<td>Not really, as long as the use the Guides from the beginning of the design process.</td>
</tr>
<tr>
<td>1112</td>
<td>Unfamiliarity with AEDGs on the part of other design team members, especially architects.</td>
</tr>
<tr>
<td>4004</td>
<td>No, they dipped into the Guides here and there and followed applicable recommendations.</td>
</tr>
<tr>
<td>1532</td>
<td>Issues with the baseline, since AEDGs are equivalent to code.</td>
</tr>
<tr>
<td>776</td>
<td>No</td>
</tr>
<tr>
<td>3938</td>
<td>There are set values in the Guide rather than ranges that allow you to take tradeoffs into account. No forgiveness for site conditions. Because building was shaded on south side, there would have been energy savings from letting more light in through windows rather than going with Guide’s U-value and SHGC recommendations,</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>608</td>
<td>Guide needs to talk about the window assembly, not just the glass. The assembly R value is what matters not the U-value and SHGC.</td>
</tr>
<tr>
<td>2132</td>
<td>No, for the most part information and strategies are good.</td>
</tr>
<tr>
<td>1983</td>
<td>Project was cancelled so no challenges encountered</td>
</tr>
<tr>
<td>2363</td>
<td>Not really. Project is simple and Guide covers all issues.</td>
</tr>
<tr>
<td>111</td>
<td>No</td>
</tr>
<tr>
<td>1315</td>
<td>Guide recommendations for glazing have a U-value that assumes there is shading. The default assumption should be that there is no shading, so recommended U-values should be lower. Architects latch onto the Guide value and then they have to argue it out.</td>
</tr>
<tr>
<td>3513</td>
<td>No, they used it as a reference for a few values.</td>
</tr>
<tr>
<td>965</td>
<td>No</td>
</tr>
</tbody>
</table>

8.1 After this experience, were you in favor of using the Guide on other projects? Why or why not?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes – when new projects come in I always try to use the Guide</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>Yes – frequently use the Guides for HVAC and thermal envelope recommendations.</td>
</tr>
<tr>
<td>119</td>
<td>Yes – if designing an office building would start with the Guide to see if recommendations meet or exceed what they would normally aim to do. If Guide exceeded their typical design practice, they would consider doing what’s in the Guide.</td>
</tr>
<tr>
<td>50</td>
<td>It depends. If it’s a LEED project, the Guides are behind because they’re based on the 1999 standard. LEED 2.2 references the 2004 standard.</td>
</tr>
<tr>
<td>260</td>
<td>Yes</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes</td>
</tr>
<tr>
<td>332</td>
<td>Yes because it is a good scoping tool for pre-design.</td>
</tr>
<tr>
<td>ws1</td>
<td>Yes – most useful in terms of starting a dialog w/ architects, other parties</td>
</tr>
<tr>
<td>ws5</td>
<td>Yes – easy to use.</td>
</tr>
<tr>
<td>ws7</td>
<td>Yes</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes. It’s a great tool to use with architects.</td>
</tr>
<tr>
<td>410</td>
<td>Yes</td>
</tr>
<tr>
<td>ws2</td>
<td>Yes</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Yes. Good quick reference.</td>
</tr>
<tr>
<td>293</td>
<td>Yes</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes – good guidance and information. If a person isn’t already doing certain things, the Guides are a good source of ideas.</td>
</tr>
<tr>
<td>3821</td>
<td>Yes – they are good for backup research even though they are fairly basic for their work. They are good for conversations with clients.</td>
</tr>
<tr>
<td>2356</td>
<td>Yes. The Guides take a lot of technical information and make it more practical and useful.</td>
</tr>
<tr>
<td>3186</td>
<td>Yes – great resource, but requirements are getting more stringent.</td>
</tr>
<tr>
<td>ID</td>
<td>Response</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2345</td>
<td>Yes</td>
</tr>
<tr>
<td>3820</td>
<td>Yes – would look at it as a reference.</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>Yes – he preaches the Guide as a resource for small building design projects.</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>Yes</td>
</tr>
<tr>
<td>2878</td>
<td>Yes</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Yes</td>
</tr>
<tr>
<td>3015</td>
<td>Yes</td>
</tr>
<tr>
<td>2966</td>
<td>Yes</td>
</tr>
<tr>
<td>2101</td>
<td>Yes – better is all use however</td>
</tr>
<tr>
<td>2138</td>
<td>Yes – but need to use from beginning</td>
</tr>
<tr>
<td>1895</td>
<td>Yes. Prescriptive approach is great for small buildings that go LEED. Avoiding energy modeling simplifies the process.</td>
</tr>
<tr>
<td>1926</td>
<td>Yes</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>Yes – very much in favor. Great resource.</td>
</tr>
<tr>
<td>4004</td>
<td>Yes</td>
</tr>
<tr>
<td>1532</td>
<td>Yes, when the Guides are updated to reflect new standard</td>
</tr>
<tr>
<td>776</td>
<td>Yes</td>
</tr>
<tr>
<td>3938</td>
<td>Yes for new construction, but never again for an existing building</td>
</tr>
<tr>
<td>608</td>
<td>Yes – they use it all the time as a scoping tool</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Yes</td>
</tr>
<tr>
<td>2363</td>
<td>Yes</td>
</tr>
<tr>
<td>111</td>
<td>Skipped</td>
</tr>
<tr>
<td>1315</td>
<td>Yes</td>
</tr>
<tr>
<td>3513</td>
<td>skipped</td>
</tr>
<tr>
<td>965</td>
<td>Yes – it is a useful resource</td>
</tr>
</tbody>
</table>

8.m Would you be willing to be contacted by DOE for potential inclusion of this building in the DOE High Performance Building Database?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Yes – would love to.</td>
</tr>
<tr>
<td>ws8</td>
<td>skipped</td>
</tr>
<tr>
<td>ws4</td>
<td>skipped</td>
</tr>
<tr>
<td>282</td>
<td>No</td>
</tr>
<tr>
<td>119</td>
<td>Not sure, but will pass the idea on to decision-maker.</td>
</tr>
<tr>
<td>50</td>
<td>Not sure. Would want to wait until building gets LEED certification.</td>
</tr>
<tr>
<td>260</td>
<td>Yes</td>
</tr>
<tr>
<td>Project</td>
<td>Status</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>ws6</td>
<td>Yes</td>
</tr>
<tr>
<td>332</td>
<td>Yes</td>
</tr>
<tr>
<td>ws1</td>
<td>No</td>
</tr>
<tr>
<td>ws5</td>
<td>No – prototype design so could not provide details on specific buildings</td>
</tr>
<tr>
<td>ws7</td>
<td>skipped</td>
</tr>
<tr>
<td>ws3</td>
<td>Yes</td>
</tr>
<tr>
<td>410</td>
<td>Yes</td>
</tr>
<tr>
<td>ws2</td>
<td>Yes</td>
</tr>
<tr>
<td>375</td>
<td>skipped</td>
</tr>
<tr>
<td>393</td>
<td>Not sure – not his call.</td>
</tr>
<tr>
<td>293</td>
<td>Yes</td>
</tr>
<tr>
<td>697</td>
<td>Skipped</td>
</tr>
<tr>
<td>610</td>
<td>Yes</td>
</tr>
<tr>
<td>3821</td>
<td>skipped</td>
</tr>
<tr>
<td>2356</td>
<td>skipped</td>
</tr>
<tr>
<td>3186</td>
<td>Sure but while this building is above-average, would not consider it high performance.</td>
</tr>
<tr>
<td>2345</td>
<td>Yes – thinks this is required for military facilities</td>
</tr>
<tr>
<td>3820</td>
<td>Skipped</td>
</tr>
<tr>
<td>3952</td>
<td>skipped</td>
</tr>
<tr>
<td>3272</td>
<td>No, but only because there was a serious falling out with the builder on this project and it is still a sensitive issue.</td>
</tr>
<tr>
<td>2241</td>
<td>skipped</td>
</tr>
<tr>
<td>2784</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>2878</td>
<td>skipped</td>
</tr>
<tr>
<td>117</td>
<td>Yes</td>
</tr>
<tr>
<td>4012</td>
<td>Skipped</td>
</tr>
<tr>
<td>2564</td>
<td>Yes</td>
</tr>
<tr>
<td>3015</td>
<td>Skipped</td>
</tr>
<tr>
<td>2966</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>2101</td>
<td>Skipped</td>
</tr>
<tr>
<td>2138</td>
<td>skipped</td>
</tr>
<tr>
<td>1895</td>
<td>Yes, intending to get LEED certification for this project.</td>
</tr>
<tr>
<td>1926</td>
<td>Not sure</td>
</tr>
<tr>
<td>2327</td>
<td>Skipped</td>
</tr>
<tr>
<td>2543</td>
<td>Skipped</td>
</tr>
<tr>
<td>1112</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>4004</td>
<td>Skipped</td>
</tr>
<tr>
<td>1532</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>776</td>
<td>Skipped</td>
</tr>
<tr>
<td>3938</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>608</td>
<td>No – not eligible</td>
</tr>
<tr>
<td>2132</td>
<td>Skipped</td>
</tr>
<tr>
<td>1983</td>
<td>Skipped</td>
</tr>
<tr>
<td>2363</td>
<td>Skipped</td>
</tr>
</tbody>
</table>
9. Would you suggest any actions ASHRAE could undertake to promote broader use of the Advanced Energy Design Guides?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>Keep up advertising and lobbying. A lot of engineers don't belong to ASHRAE and more should. The more people that know about ASHRAE the better.</td>
</tr>
<tr>
<td>ws8</td>
<td>Conduct outreach at YEA events (younger engineers more receptive to using Guides). Feature AEDGs at local chapter events. Conduct more outreach beyond ASHRAE membership – e.g., attend trade shows for school administrators to access audiences that would be receptive to Guides. In publicizing Guides to ASHRAE members, do stand-alone communications that are only about the Guides rather than having Guides buried in a list of other publications.</td>
</tr>
<tr>
<td>ws4</td>
<td>Feature AEDG tips on ASHRAE web site and in ASHRAE journal. Teaser info to encourage people to dig into the Guides. Thinks everyone knows about the guides.</td>
</tr>
<tr>
<td>282</td>
<td>Skipped</td>
</tr>
<tr>
<td>119</td>
<td>Guides are probably pretty well known by mechanical engineers. Might suggest increasing publicity/outreach beyond ASHRAE membership. Partner with AIA.</td>
</tr>
<tr>
<td>50</td>
<td>Not sure</td>
</tr>
<tr>
<td>260</td>
<td>Not sure – haven't thought about it.</td>
</tr>
<tr>
<td>ws6</td>
<td>Any way to make it a more fluid document in terms of updating the AEDGs more often to incorporate new systems/technologies. For example, updating more frequently via new appendices or addendums. Would be nice to get regular updates on successful applications of new technologies.</td>
</tr>
<tr>
<td>332</td>
<td>ASHRAE is doing everything it can, but maybe more promotion to architects.</td>
</tr>
<tr>
<td>ws1</td>
<td>skipped</td>
</tr>
<tr>
<td>ws5</td>
<td>ASHRAE is doing a good job by making the guides free and available by download. ASHRAE does a good job of email communications.</td>
</tr>
<tr>
<td>ws7</td>
<td>Guarantee payback for efficiency recommendations.</td>
</tr>
<tr>
<td>ws3</td>
<td>Advertise in different mediums such as architecture publications. More articles in non-ASHRAE publications, feature successful examples of AEDG usage.</td>
</tr>
<tr>
<td>410</td>
<td>No</td>
</tr>
<tr>
<td>ws2</td>
<td>A lot of the people who are using the guides, etc. are not engineers so they do not understand everything they can and cannot do. So more promotion and clarification of this fact.</td>
</tr>
<tr>
<td>375</td>
<td>How jurisdictions and 189.1 will impact the guides. Guides will become prescriptive tools when code is stricter.</td>
</tr>
<tr>
<td>393</td>
<td>Emails worked well for him. Maybe more outreach to architects through AIA, etc.</td>
</tr>
<tr>
<td>293</td>
<td>Owners need to see benefits of energy efficiency. Hard to persuade them to do capital expenditures on beyond-code measures. They need to see payback and other benefits.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>697</td>
<td>Engineers are on board already.</td>
</tr>
<tr>
<td>610</td>
<td>No</td>
</tr>
<tr>
<td>610</td>
<td>Emphasize performance more than savings level. 30% savings is pretty meaningless because what's the baseline? He is more focused on what you need to do to have a high performance design.</td>
</tr>
<tr>
<td>3821</td>
<td>Getting the guides to school boards/building owners, etc.</td>
</tr>
<tr>
<td>2356</td>
<td>Not sure</td>
</tr>
<tr>
<td>3186</td>
<td>ASHRAE’s DC lobbyists should work to make it a requirement that municipalities that take ARRA money devote part of the funding to enforcement of local building codes. A lot of places don’t enforce 90.1 and it should be required.</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
</tr>
<tr>
<td>3820</td>
<td>AEDGs not well known. Maybe more Journal articles, newsletter publications.</td>
</tr>
<tr>
<td>3952</td>
<td>ASHRAE should play a role in the code enforcement arena (DC lobbying, etc.) States are in really different places and there needs to be a consistent national approach to code enforcement.</td>
</tr>
<tr>
<td>3272</td>
<td>There should be more marketing to developers and building owners so they understand the value of the Guides as a straightforward way to save energy and avoid modeling. They need to be sold on using Guides.</td>
</tr>
<tr>
<td>2241</td>
<td>Not sure. Guides made a big splash in the engineering community when they came out but seem to have a low profile now.</td>
</tr>
<tr>
<td>2784</td>
<td>More presentations about the AEDGs at ASHRAE national meetings, chapters. More interface/coordination with USGBC.</td>
</tr>
<tr>
<td>2878</td>
<td>Promote more to architects and electrical engineers.</td>
</tr>
<tr>
<td>117</td>
<td>No, ASHRAE does a pretty good job of distributing the Guides. Free downloads are good for wide circulation.</td>
</tr>
<tr>
<td>4012</td>
<td>Engineers are only one side of the equation. Guides need to be shared with building owners, property managers, school districts, and architects, as these are the entities ASHRAE is trying to influence. They need to be “sold” on why the Guides should be used. ASHRAE needs a better understanding of the priorities of these entities, and they should be offered an opportunity to provide input on how to improve the Guides. Also recommend developing an online forum for AEDG users. Answer questions, share information about how specific technologies have worked in different applications. Guides are static so this type of forum would be useful. It would allow ASHRAE members to help other members do better.</td>
</tr>
<tr>
<td>2564</td>
<td>Change copyright restrictions so that it is easier to share the Guides with colleagues and other members of the design team. Guides are well known among HVAC engineers but not among architects. Suggest more outreach to architects, builders, etc. Look to USGBC as a model for outreach strategies.</td>
</tr>
<tr>
<td>3015</td>
<td>Free downloads are good. More outreach to AIA to get more architects to use AEDGs.</td>
</tr>
<tr>
<td>2966</td>
<td>Do something for Canada climate zones….limited use beyond the US border, although would like to use more</td>
</tr>
<tr>
<td>2101</td>
<td>Try to get architects to use</td>
</tr>
<tr>
<td>2138</td>
<td>Need stuff for existing buildings</td>
</tr>
<tr>
<td>1895</td>
<td>Biggest motivator to using AEDG was LEED compliance opportunity. ASHRAE should</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Encourage other green design guidance resources to reference the AEDGs.</td>
<td></td>
</tr>
<tr>
<td>1926</td>
<td>Emphasize that AEDGs are good resource for existing buildings as well.</td>
</tr>
<tr>
<td>2327</td>
<td>No, good reference for rule of thumb and to identify energy efficiency opportunities.</td>
</tr>
<tr>
<td>2543</td>
<td>Not many building owners and code agencies are familiar with AEDGs. They don't know how to read/enforce ASHRAE standard. More training/awareness building needed for code agencies.</td>
</tr>
<tr>
<td>1112</td>
<td>More outreach/interaction with AIA and IEEE. Architects are not aware of AEDGs.</td>
</tr>
<tr>
<td>4004</td>
<td>Free downloads are good. Would like more outreach to architects through AIA.</td>
</tr>
<tr>
<td>1532</td>
<td>Free downloads are good. ASHRAE should do more cross-pollination with AIA, American Society for Plumbing Engineers, Construction Specifications Institute so that these organizations will cite the AEDGs in their master specs. These specs are what is used for bidding purposes.</td>
</tr>
<tr>
<td>776</td>
<td>No, like the free downloads.</td>
</tr>
<tr>
<td>3938</td>
<td>No</td>
</tr>
<tr>
<td>608</td>
<td>There is a conflict with LEED and EPAct 2005, which reference 30% dollar savings rather than BTU savings. It is unclear whether AEDGs save dollars or BTUs. AEDGs are very useful for LEED points but you need 10% more BTU savings to meet the 30% dollar savings requirement.</td>
</tr>
<tr>
<td>2132</td>
<td>More outreach to architects. Partner with AIA and encourage them to use. Most architects aren't even familiar with 90.1.</td>
</tr>
<tr>
<td>1983</td>
<td>More education is needed on proper ventilation of buildings. LEED is pushing for over-ventilation. Operationally, system components are often shut down (sometimes in the name of energy) and then buildings are under-ventilated.</td>
</tr>
<tr>
<td>2363</td>
<td>ASHRAE has done a good job of advertising the Guides. The biggest thing is to get engineers who aren't using the Guides to wake up, overcome their apathy. But there is not much ASHRAE can do about that.</td>
</tr>
<tr>
<td>111</td>
<td>Free downloads are good. No suggestions.</td>
</tr>
<tr>
<td>1315</td>
<td>ASHRAE should provide more tools to support regional outreach. For example, he’s part of Gulf Coast Green, an AIA regional group. Would be nice to have a basic card or one-page handout about the Guides, or a standard email he could circulate. Recent ½ page AEDG ad in High Performing Building magazine was good – lots of architects read the magazine and view it favorably. It is helpful that USGBC allows Guides to be used for LEED points but would like to see LEED move further away from requiring energy modeling for small buildings. For example, increase minimum square footage requirements so that more small buildings can use the Guides for LEED, allow Guides to be used for schools.</td>
</tr>
<tr>
<td>3513</td>
<td>Free downloads are very nice. Sponsor “distinguished lecturers” to talk about the Guides at chapter conferences or in webcasts.</td>
</tr>
<tr>
<td>965</td>
<td>ASHRAE should do research to find out what’s actually being implemented in the field. Meet with design teams in each climate zone, determine how many recommendations they are incorporating into building designs. For the recommendations not incorporated, find out why not. Are there cost reasons, performance-related reasons for specific technologies, etc. Also, would be good to study buildings after they have been constructed to determine how they are operating. Are the savings as expected?</td>
</tr>
</tbody>
</table>
10. Would you suggest any improvements to make the Guides more useful to design professionals?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>No – Guides are well thought out and planned. Good examples.</td>
</tr>
<tr>
<td>ws8</td>
<td>K-12 guide is well laid out. Doesn’t prescribe what should be done. Designers can choose from a number of options. When Guides are updated, they should also update the example buildings and include technologies/system configurations that are becoming more commonly used.</td>
</tr>
<tr>
<td>ws4</td>
<td>No answer</td>
</tr>
<tr>
<td>282</td>
<td>The details in the Guide are excellent. They have sufficient detail to be useful, but are written in a way that anyone can understand. Some other ASHRAE resources are too theoretical and overly technical, and Guides avoid this issue. Climate zones are excellent but they should be global. Make sure to emphasize the importance of ensuring that daylighting should only be done if it produces net energy savings. None of the Guides put enough emphasis on considering renewables. At a minimum, the Guides should reference other ASHRAE resources that deal with renewable systems like geothermal. The Guides should discuss the system-wide efficiency losses associated with fuel-switching from gas to electric. Avoid politics but discuss the facts.</td>
</tr>
<tr>
<td>119</td>
<td>Put more links and bookmarks in the PDF so that navigation through the document is easier.</td>
</tr>
<tr>
<td>50</td>
<td>Update the Guides to beyond the 1999 standard. Include more HVAC technologies such as heat pumps. Go beyond packaged units.</td>
</tr>
<tr>
<td>260</td>
<td>Online trainings on AEDGs are useful. Keep doing them or maybe expand training offerings.</td>
</tr>
<tr>
<td>ws6</td>
<td>No – Guides are well laid out, concise.</td>
</tr>
<tr>
<td>332</td>
<td>Need clarification between what is a recommendation &amp; what is how-to. Clarification needed on which guide to use for certain building types. They had a small clinic in which they used the small office guide and USGBC said that it was not a small office so they couldn’t use the small office guide for LEED points.</td>
</tr>
<tr>
<td>ws1</td>
<td>Guides could be streamlined. He doesn’t think there’s much difference between the K12 and office Guides. Why can’t there just be a single design resource that addresses the nuances of envelope, HVAC etc. design across different building types? Would like to see Guides have a more architectural slant, as this is where they are most useful. Also, it’s not clear the Guides would make sense to someone who doesn’t know 90.1. How-tos are useful but recommendations tables don’t do a good job of highlighting all the good info that’s in there (cross-referencing). Some energy savings opportunities are glossed over. Would like more comprehensive info on new technologies and applicability by building type.</td>
</tr>
<tr>
<td>ws5</td>
<td>Update the Guides as the 1999 standard is out of date. Include more specifics in the “how to implement” sections – particularly on testing, adjusting and balancing and duct sealing sections. The bank’s commissioning agent had questions about what needed to be done to meet duct sealing recommendations. Would have been helpful to have more detailed information.</td>
</tr>
<tr>
<td>ws7</td>
<td>Could be simplified. Clearly written by engineers.</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>ws3</td>
<td>Format is good. Guides don’t say enough about thermal breaks, which can be more important than insulation in cold climates. Insulation levels and window recommendations seem low. More guidance on proper implementation would be useful. For example, compare energy impact of poorly- versus well-sprayed insulation.</td>
</tr>
<tr>
<td>410</td>
<td>No</td>
</tr>
<tr>
<td>ws2</td>
<td>Case studies that reflect how the guides should be applied. Sample calculations and more depth. Right now just a bunch of good ideas with no depth. Maybe try to collate all the tools. Tools are good because it gives us something to reference – because everybody has an opinion now….</td>
</tr>
<tr>
<td>375</td>
<td>Code inspectors need to understand the guides better and integrate them into their process.</td>
</tr>
<tr>
<td>393</td>
<td>Update the Guides as the 1999 standard is out of date. Include more information on payback, cost-effectiveness.</td>
</tr>
<tr>
<td>293</td>
<td>More example projects with more details on what was done. This is a good tool for small firms. Because they work on larger projects, the Guide is more of a starting place for them. They typically have to model alternatives, do lifecycle costing.</td>
</tr>
<tr>
<td>697</td>
<td>It would be great if Guides had a tool on expected costs and savings. Realize this would be tough for things like buildings, but cost information is much needed.</td>
</tr>
<tr>
<td>610</td>
<td>Guides start with information on integrated building design but that doesn’t mean much to owners. Owners are more motivated by high performance design.</td>
</tr>
<tr>
<td>3821</td>
<td>A little redundant; maybe formatting or flagging specific portions of the guide that have not been previously stated.</td>
</tr>
<tr>
<td>2356</td>
<td>This would be difficult to do, but better cost information is needed. Maybe it would be possible to develop a range of costs at the measure level, at least to provide an order of magnitude approximation.</td>
</tr>
<tr>
<td>3186</td>
<td>No. ASHRAE materials used to be too academic, but now he looks forward to receiving the Journal.</td>
</tr>
<tr>
<td>2345</td>
<td>Need to keep the Guides current. Should be reissued every time 90.1 is updated.</td>
</tr>
<tr>
<td>3820</td>
<td>No</td>
</tr>
<tr>
<td>3952</td>
<td>The Guides are pretty basic so they should be reclassified as an introduction on how to design code buildings, not as a high performance design guide. There needs to be more consistency between the LEED and AEDG processes.</td>
</tr>
<tr>
<td>3272</td>
<td>The commissioning process needs to be streamlined and systematized to make it viable for small buildings. As written, it would be too expensive for most buildings in this category. Develop generic commissioning specs/plans that people could follow. Create a standard model.</td>
</tr>
<tr>
<td>2241</td>
<td>Provide more information on why systems that used to be common should no longer be used. This would be helpful in making the case for why Guide recommendations are preferable to the way things used to be done.</td>
</tr>
<tr>
<td>2784</td>
<td>More information on transportation-related energy.</td>
</tr>
<tr>
<td>2878</td>
<td>No – like the Guides very much. They are quick and easy.</td>
</tr>
<tr>
<td>117</td>
<td>Keep updating the Guides with new information and project examples.</td>
</tr>
</tbody>
</table>
| 4012 | Water heating recommendations need substantial revision. As it is, the water heating sections in each Guide are pretty similar, and the Guides don’t reflect the significant
differences in hot water use across different building types as well as within certain building types. For example, recommendations should be different for schools that have no onsite dishwashing and showers and schools that do. Design recommendations need to take into account the location of hot water demand, patterns of hot water use, and the amount of hot water use. Also, Guide recommendations are based on outdated flow rate tables that do not include lower-flow fixtures used today. For example, burners in instantaneous water heaters do not work well with low-flow faucets. Recommends coordinating with TC 6.6 on revisions to water heating recommendations.

<p>| 2564 | No |
| 3015 | No, Guides are pretty easy to use |
| 2966 | Guide is not designed for Canada. Can use Climate Zone 6 for Toronto but there are no applicable Climate Zone for other areas in Canada. |
| 2101 | No |
| 2138 | No |
| 1895 | More instructions on which Guide to use for non-standard building types. |
| 1926 | Can't think of anything. Guides are straightforward. |
| 2327 | No |
| 2543 | More concrete examples on implementation. |
| 1112 | No, resource is very good. |
| 4004 | No, resource is good as-is. |
| 1532 | Update the Guides based on most recent ASHRAE standard. |
| 776 | No, love the simplicity. Recommendations table plus one or two additional paragraphs of more detailed is good. |
| 3938 | More detailed definitions in the back. |
| 608 | Guides are nice and balanced. Biggest advantage is having published value that they can cite to with contractors and architects. Would be preferable if the Guides were organized according to climate zones instead of by building type. A guide for a single climate zone would address each applicable building type. Doesn’t see that much difference between building types. Also, metal building recommendations don’t jibe with what metal building suppliers provide. They don’t sell what’s in the Guide. In Alaska, lots of buildings are on pilings because of permafrost, so Guide recommendations on foundation insulation are not applicable. They have huge battles about the continuous insulation charts. For Zone 7, steel framed values are R13 + 7.5 ci. In Zone 8, the R value for c.i. jumps to R21.6. None of the other R values jump like this from Zone 7 to Zone 8. Lastly, Guides are not used to select equipment, so you don’t need all the values like IPLV, etc. Guides are a scoping tool only. System-level information is more useful. |
| 2132 | Can’t think of anything. |
| 1983 | More education needed on proper ventilation – address building operation, recommend annual retrocommissioning. |
| 2363 | Not really – explanations and discussions are good. Guides should be updated every few years to address new technologies. |
| 111 | No – can’t think of any |
| 1315 | Update the Guides as ASHRAE standards are updated. Add O&amp;M component. Standard 180 does that, but should be highlighted more in the Guide. Lack of training on proper O&amp;M has a big impact on energy use. O&amp;M should be part of the Recommendations |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3513</td>
<td>Guide is nice but they don’t have much occasion to use it. They often go beyond Guide recommendations and use it as a backcheck.</td>
</tr>
<tr>
<td>965</td>
<td>No – can’t think of any</td>
</tr>
</tbody>
</table>

11. Would you like to see ASHRAE develop other resources for design professionals? If so, what?

<table>
<thead>
<tr>
<th>ID</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws9</td>
<td>No answer</td>
</tr>
<tr>
<td>ws8</td>
<td>No answer</td>
</tr>
<tr>
<td>ws4</td>
<td>It’s a challenge to really understand the energy impact of the things they do in designing larger buildings. Not sure an AEDG-type (cookbook) resource would be quite as feasible for larger buildings, however. One idea for LEED projects would be an eQuest template that has 90.1 values built in as defaults, schedules from Appendix G, etc. Then all they would have to do is plug in building geometry and by done.</td>
</tr>
<tr>
<td>282</td>
<td>Take the design guide for hospitals and clinics and make it an energy guide. Same with shopping center design guide.</td>
</tr>
<tr>
<td>119</td>
<td>Prescriptive Guide for healthcare. Would love to work with ASHRAE in developing a Guide for how to achieve 50% energy savings from large hospitals. They are working on a project now that will meet this target. Should be one of the most energy efficient healthcare facilities in the world.</td>
</tr>
<tr>
<td>50</td>
<td>It would be nice to have a consolidated ASHRAE resource for energy-related information. There is lots of good information in past Journal articles but it’s hard to dig it out.</td>
</tr>
<tr>
<td>260</td>
<td>Can’t think of anything</td>
</tr>
<tr>
<td>ws6</td>
<td>No. Noted that healthcare AEDG just came out – that was needed.</td>
</tr>
<tr>
<td>332</td>
<td>Nothing really, maybe more publicity to move the design industry to meet 2030 goals.</td>
</tr>
<tr>
<td>ws1</td>
<td>skipped</td>
</tr>
<tr>
<td>ws5</td>
<td>Can’t think of anything</td>
</tr>
<tr>
<td>ws7</td>
<td>No</td>
</tr>
<tr>
<td>ws3</td>
<td>Resource that shows cost/efficiency tradeoffs of EE technologies. This resource would allow design professionals to compare efficiency upgrade options across different building components that allow them to get to the same place. For example, air sealing versus high efficiency window versus increased attic insulation. Conservation factor: way to compare incremental changes and costs in systems to allow to easily compare differences.</td>
</tr>
<tr>
<td>410</td>
<td>More clarification of Appendix G is needed. It is confusing. Would like to see more examples and maybe even a how-to supplement.</td>
</tr>
<tr>
<td>ws2</td>
<td>No</td>
</tr>
<tr>
<td>375</td>
<td>Now terminating 30% and ramping up 50% series as well as helping 189.1 with additional guides. Case studies for all building types.</td>
</tr>
<tr>
<td>393</td>
<td>No</td>
</tr>
<tr>
<td>293</td>
<td>In the ASHRAE Systems &amp; Equipment Handbook, expand the expected lifetime list to include new technologies. These data are needed for lifecycle costing analysis.</td>
</tr>
<tr>
<td>697</td>
<td>No</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>3186</td>
<td>Would like to see more practical guidance on how to get to net zero energy. Right now there is a vision and some preliminary ideas, but not enough specific guidance. Virtual conferences are a great idea. Would like to see ASHRAE to more virtual meetings where remote participation is possible.</td>
</tr>
<tr>
<td>2345</td>
<td>No</td>
</tr>
<tr>
<td>3821</td>
<td>The 50% series will be very useful.</td>
</tr>
<tr>
<td>2356</td>
<td>No</td>
</tr>
<tr>
<td>3952</td>
<td>Make energy modeling easier through standardized tools/templates. Develop resources to address occupant behavior, since this is the next frontier for energy savings.</td>
</tr>
<tr>
<td>3272</td>
<td>See above response re: commissioning resources</td>
</tr>
<tr>
<td>2241</td>
<td>Not sure</td>
</tr>
<tr>
<td>2784</td>
<td>No. ASHRAE is doing a lot of good work on multiple fronts – it is hard to keep up.</td>
</tr>
<tr>
<td>2878</td>
<td>No – ASHRAE is doing all that can be done</td>
</tr>
<tr>
<td>117</td>
<td>No</td>
</tr>
<tr>
<td>4012</td>
<td>Develop a test facility where different energy efficient technologies can be integrated and tested. Issues usually arise when different technologies are integrated rather than in stand-alone applications. A test facility would allow you to try different technologies in combination and see how they work together.</td>
</tr>
<tr>
<td>2564</td>
<td>No</td>
</tr>
<tr>
<td>3015</td>
<td>More training is needed. There is lots of information out there but it’s not clear how well high performance building certification is catching on. Cost of certification is too high for many owners. Database or other resource that showed the payback from extra engineering expenditures required to design high performance building would be helpful. Need to sell owners on paying more up front for a well-designed building.</td>
</tr>
<tr>
<td>2966</td>
<td>More connections between ASHRAE and USGBC – developing combined resources</td>
</tr>
<tr>
<td>2101</td>
<td>More help with architects</td>
</tr>
<tr>
<td>2138</td>
<td>Existing buildings</td>
</tr>
<tr>
<td>1895</td>
<td>Energy modeling user groups show a lot of confusion/questions about Appendix G. Recommend simplifying Appendix G.</td>
</tr>
<tr>
<td>1926</td>
<td>Existing Building Guide is a limited resource that needs updating. He also sees an emerging problem where people are looking only at how many green design “points” they can get, not how the building works as a whole. For example, increasing outside airflow is problematic in hot, humid climate as increased energy use for dehumidification may offset any savings. ASHRAE needs to provide guidance on interoperability of different systems, interactive effects, importance of considering building function as a whole.</td>
</tr>
<tr>
<td>2327</td>
<td>Continue to push standards more aggressively. Mandates are the most effective way of raising the bar. More simple, practical approach to Standard 62 is needed because demand controlled ventilation is hard to do. Suggest developing software to make the process simpler, and/or simplifying the standard.</td>
</tr>
<tr>
<td>2543</td>
<td>Offer more local training seminars to build awareness among code agencies. Many are uninformed about 90.1.</td>
</tr>
<tr>
<td>1112</td>
<td>None</td>
</tr>
</tbody>
</table>
| 4004 | Handbooks are stuck in the 70s in terms of format. Content is good but the visuals are off-...
<table>
<thead>
<tr>
<th>1532</th>
<th>There is so much information coming out of ASHRAE, better distribution and search capabilities are needed. Finding information on the ASHRAE web site is hard. Publication search feature is bad – needs to be configured for search relevance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>776</td>
<td>No</td>
</tr>
<tr>
<td>3938</td>
<td>A supplementary tool for the 90.1 standard would be helpful – basically a quick reference guide so you don’t have to flip back and forth between the AEDG and the standard.</td>
</tr>
<tr>
<td>608</td>
<td>A resource that provides practical application guidance for the 90.1 standard, similar to the practical application guidance contained in the AEDGs.</td>
</tr>
<tr>
<td>2132</td>
<td>Can’t think of anything</td>
</tr>
<tr>
<td>1983</td>
<td>Establish an ASHRAE standard for commissioning and annual recommissioning to address all the problems with ventilation and indoor air quality in commercial buildings. Make the guidance simple and application-oriented like the AEDGs. Codes should also require annual verification of ventilation operation.</td>
</tr>
<tr>
<td>2363</td>
<td>Recommend developing more AEDGs for other applications. Guides are a great resource for younger engineers. He works on a lot of laboratory buildings and there are not a lot of people who are familiar with energy efficient lab design.</td>
</tr>
<tr>
<td>111</td>
<td>Supports the building benchmarking work ASHRAE is already doing. Would be nice to have a condensed design resource based on the 4 Handbooks. Application-oriented, focused on the parts of the Handbooks that are used most frequently (building material properties, climatic design info, duct and piping design).</td>
</tr>
<tr>
<td>1315</td>
<td>There are a lot of ASHRAE resources and it would be good to have more cross-referencing of the various things that are available.</td>
</tr>
<tr>
<td>3513</td>
<td>Similar to the ASHRAE design guide for hot and humid climates, would like to see one for cold climates. Also, an energy retrofit guide for large or small existing buildings would be useful.</td>
</tr>
<tr>
<td>965</td>
<td>Would like to see a web portal where all ASHRAE resources are available in a single place. Make it easier to find information/resources ASHRAE has produced.</td>
</tr>
</tbody>
</table>
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APPENDIX F: METHODOLOGY FOR ENERGY IMPACT ESTIMATES

The AEDGs are designed to give designers of K-12 schools and small commercial buildings a set of recommendations that, when combined, will lead to at least a 30 percent reduction in building energy consumption as compared with buildings constructed to meet the ANSI/IESNA/ASHRAE Standard 90.1-1999. A key component of this analysis involved using information obtained from AEDG users to develop estimates of actual reductions in design energy consumption that resulted from AEDG use. This Appendix provides detailed information on the approach used to estimate energy savings impacts.

Caveats and assumptions

As noted in the report, the relatively small sample size for this analysis increases the uncertainty associated with energy savings impact estimates. This is especially true in the retail and warehouse markets, where only a few interview participants were able to provide project-specific information.

The report also notes that many interviewees only had partial knowledge about the AEDG recommendations that were implemented or about the characteristics of key components of the building design. We took a conservative approach to dealing with information gaps. If a respondent did not have enough information to confirm whether an AEDG recommendation was implemented, we assumed the design component in question was consistent with the building code.

We also made some simplifying assumptions in regards to installed HVAC systems. Some participants provided details about multiple pieces of installed HVAC equipment with varying sizes and efficiency levels. In such cases, our energy savings estimates were based on the size and efficiency levels of the HVAC unit that constituted the largest percentage of total energy use. In cases where not enough information was known about the HVAC system (i.e. size, air-cooled vs. water-cooled, etc.) to determine what efficiency level was called for in the applicable code, the most efficient and therefore most conservative efficiency was used as the code baseline.

Similar conservative assumptions were used when finding the code-required SHGC and U-value of windows. In order to determine the code requirement for these design elements, information about the projection factor and whether the window is fixed or operable is typically needed. However, few participants were able to provide information about the projection factor, and the interview script did not include a question about whether windows were fixed or operable. In the absence of this information, we assumed the projection factor to be less than 0.25 and that the window was fixed.

Rather than addressing all AEDG recommendations, the technical interviews focused on those recommendations that are responsible for the majority of the energy savings potential. In cases where we did not ask about an AEDG recommendation in the interviews, we left baseline end use energy consumption values unchanged (e.g., equivalent to code). Table F-1 summarizes each recommendation and indicates whether we asked about it in the interviews.
<table>
<thead>
<tr>
<th>End Use</th>
<th>Item</th>
<th>Description</th>
<th>Asked?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>R-Value</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface reflectance/emittance</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td>R-Value</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Floors</td>
<td>R-Value</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Slabs</td>
<td>R-Value</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Doors</td>
<td>U-Value</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Window-to-wall ratio</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U-Value</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHGC</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Orientation</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Projection factor</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Skylights</td>
<td>Percent of roof area</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U-Value</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHGC</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>LPD</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Light source</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ballast</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dimming controls</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occupancy controls</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interior reflectances</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>HVAC</td>
<td>Equipment</td>
<td>Efficiency</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Min. cooling capacity for use</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>End Use</td>
<td>Item</td>
<td>Description</td>
<td>Asked?</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>Ventilation</td>
<td>Outdoor air damper motorized control</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO2 sensors</td>
<td>No</td>
</tr>
<tr>
<td>Ducts</td>
<td></td>
<td>Friction rate</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sealing</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Location</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulation level</td>
<td>No</td>
</tr>
<tr>
<td>SWH</td>
<td>Equipment</td>
<td>Efficiency</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Pipe insulation</td>
<td>Thickness</td>
<td>No</td>
</tr>
</tbody>
</table>

Lastly, we made some simplifying assumptions to account for the variety of state-specific code baselines that were mentioned by interviewees. Using information published by DOE, we assumed that the Washington state code is equivalent to 90.1-2004 and that the Florida state code is equivalent to 90.1-2007. We also assumed that the International Mechanical Code is equivalent to 90.1-2004, and California’s Title 24 is 12.5 percent more stringent than ASHRAE 90.1-2004.

**Impact Estimation Approach**

The report provides a high-level overview of the simplified approach developed to estimate energy savings impacts resulting from AEDG use. The first step of this process was determining the typical building energy end use profile for each building type and climate zone using new construction data compiled by DOE’s Net-Zero Energy Commercial Building Initiative. The tables below present the end use energy consumption breakdowns for each building type by climate zone.

---


§ Personal communication with Bing Liu, Pacific Northwest National Laboratory (December 21, 2009). PNNL estimates that Title 24 is between 10 and 15 percent more efficient than 90.1-2004.

TABLE F-2. END USE ENERGY CONSUMPTION FOR OFFICE BUILDINGS

<table>
<thead>
<tr>
<th>End Use</th>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>0%</td>
<td>12%</td>
<td>19%</td>
<td>32%</td>
<td>42%</td>
<td>49%</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>39%</td>
<td>27%</td>
<td>16%</td>
<td>11%</td>
<td>7%</td>
<td>5%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>32%</td>
<td>33%</td>
<td>36%</td>
<td>30%</td>
<td>26%</td>
<td>23%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>6%</td>
<td>6%</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
<td>5%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>22%</td>
<td>22%</td>
<td>23%</td>
<td>21%</td>
<td>19%</td>
<td>18%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

TABLE F-3. END USE ENERGY CONSUMPTION FOR RETAIL BUILDINGS

<table>
<thead>
<tr>
<th>End Use</th>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>0%</td>
<td>13%</td>
<td>25%</td>
<td>40%</td>
<td>49%</td>
<td>56%</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>35%</td>
<td>23%</td>
<td>12%</td>
<td>8%</td>
<td>5%</td>
<td>3%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>32%</td>
<td>32%</td>
<td>32%</td>
<td>27%</td>
<td>24%</td>
<td>21%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>21%</td>
<td>20%</td>
<td>18%</td>
<td>14%</td>
<td>13%</td>
<td>11%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13%</td>
<td>13%</td>
<td>13%</td>
<td>11%</td>
<td>10%</td>
<td>8%</td>
<td>7%</td>
<td></td>
</tr>
</tbody>
</table>

TABLE F-4. END USE ENERGY CONSUMPTION FOR K-12 SCHOOLS

<table>
<thead>
<tr>
<th>End Use</th>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>1%</td>
<td>8%</td>
<td>16%</td>
<td>26%</td>
<td>33%</td>
<td>42%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>29%</td>
<td>22%</td>
<td>12%</td>
<td>9%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>28%</td>
<td>28%</td>
<td>29%</td>
<td>26%</td>
<td>25%</td>
<td>22%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>5%</td>
<td>4%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>35%</td>
<td>35%</td>
<td>37%</td>
<td>33%</td>
<td>31%</td>
<td>27%</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>
TABLE F-5. END USE ENERGY CONSUMPTION FOR WAREHOUSES††

<table>
<thead>
<tr>
<th>End Use</th>
<th>Climate Zone 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>58%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>13%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The unmodified percentages for heating, cooling, lighting, water heating, ventilation, and other, were assigned the values \( \text{perheat,code} \), \( \text{percool,code} \), \( \text{perlight,code} \), \( \text{perWH,code} \), \( \text{pervent,code} \), and \( \text{perother,code} \), respectively. For each participant, the end use percentages for the relevant climate zone were modified based on the participant’s responses about energy efficiency measures incorporated into the building design. The following sections describe the approach used for modifications within each end use.

**Heating**

The energy required to heat a building is a function of the load on the building as well as the efficiency of the HVAC equipment, \( \eta_h \), and whether demand-controlled ventilation (DCV) or energy recovery ventilation (ERV) was implemented. The heating load is dependent on the roof, wall, and foundation insulation, as well as infiltration, ventilation, and conduction through the windows. As shown in Table F-6, we used a breakdown of the energy consumed by each of these loads that was published by Lawrence Berkeley National Laboratory.‡‡

**TABLE F-6. ENERGY LOAD DUE TO HEATING**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>12%</td>
</tr>
<tr>
<td>Walls</td>
<td>21%</td>
</tr>
<tr>
<td>Foundation</td>
<td>11%</td>
</tr>
<tr>
<td>Infiltration</td>
<td>18%</td>
</tr>
<tr>
<td>Ventilation</td>
<td>15%</td>
</tr>
<tr>
<td>Windows (cond.)</td>
<td>22%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

†† As only one warehouse project was used in this analysis, we only required the end use breakdown for Climate Zone 2.

‡‡ Lawrence Berkeley National Laboratory (June 1998). *Commercial Heating and Cooling Loads Component Analysis*, Table 24, p. 45 and Figure 3, p. 61.
In order to reduce the energy used to heat a building you can either increase the equipment efficiency or decrease the load. The modified heating end use percentage, $\text{per}_{\text{heat,mod}}$, was found by using Equation 1:

$$\text{per}_{\text{heat,mod}} = \text{per}_{\text{heat,code}} \left( \frac{\eta_{\text{h,code}}}{\eta_{\text{h}}} \right) \left[ f_{\text{roof}} \left( \frac{R_{\text{roof,code}}}{R_{\text{roof}}} \right) + f_{\text{wall}} \left( \frac{R_{\text{wall,code}}}{R_{\text{wall}}} \right) + f_{\text{wind}} + f_{\text{int}} + f_{\text{vent}} + f_{\text{win}} \left( \frac{U_{\text{win}}}{U_{\text{win,code}}} \right) \right] \left( 1 - \text{per}_{\text{ERV,DCV}} \right) \right)$$

(1)

In Eq. 1, $\eta_{\text{h,code}}$ is the code-required heating equipment efficiency, $R_{\text{roof,code}}$ is the code-required roof R-value, $R_{\text{roof}}$ is the actual roof R-value, $R_{\text{wall,code}}$ is the code-required wall R-value, $R_{\text{wall}}$ is the actual wall R-value, $U_{\text{win}}$ is the actual window U-value, $U_{\text{win,code}}$ is the code-required window U-value, and $\text{per}_{\text{ERV,DCV}}$ is the percent reduction due to implementing DCV or ERV. This factor is 30 percent for ERV§§ and 20 percent for DCV.*** Note that Eq. 1 is a simplification of the dynamics involved in a building’s energy use. However, for the purposes of this limited analysis, an in-depth energy model was not feasible.

### Cooling

The energy required to cool a building is a function of the load on the building as well as the efficiency of the HVAC equipment, $\eta$, and whether DCV or ERV was implemented. The cooling load is dependent on the roof insulation, solar gain through the windows, lights, electric equipment, non-electric equipment, and people. As shown in Table F-7, we used a breakdown of the energy consumed by each of these loads that was published by Lawrence Berkeley National Laboratory.†††

#### Table F-7. Energy Load Due to Cooling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>$f_{\text{roof,c}}$</td>
</tr>
<tr>
<td>Windows (solar)</td>
<td>$f_{\text{solar}}$</td>
</tr>
<tr>
<td>Lights</td>
<td>$f_{\text{light}}$</td>
</tr>
<tr>
<td>Equip. (elec)</td>
<td>$f_{\text{elec}}$</td>
</tr>
<tr>
<td>Equip. (non-elec)</td>
<td>$f_{\text{non-elec}}$</td>
</tr>
<tr>
<td>People</td>
<td>$f_{\text{people}}$</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

---


††† Lawrence Berkeley National Laboratory (June 1998). *Commercial Heating and Cooling Loads Component Analysis*, Table 24, p. 45 and Figure 3, p. 61.
In order to reduce the energy used to cool a building you can either increase the equipment efficiency or decrease the load. The modified cooling end use percentage, \( \text{per}_{\text{cool}, \text{mod}} \), was found using Equation 2:

\[
\text{per}_{\text{cool}, \text{mod}} = \text{per}_{\text{cool}, \text{code}} \cdot \left( \frac{\eta_{\text{cool}, \text{code}}}{\eta_{\text{cool}}} \right) - \left( \frac{R_{\text{roof}}}{R_{\text{roof}, \text{code}}} \right) + \left( \frac{\text{SHGC}}{\text{SHGC}_{\text{code}}} \right) + \left( \frac{\text{LPD}}{\text{LPD}_{\text{code}}} \right) + f_{\text{elec}} + f_{\text{non-elec}} + f_{\text{people}} \right) \cdot (1 - \text{per}_{\text{REF, DCV}}) \quad (2)
\]

In Eq. 2, \( \eta_{\text{cool}, \text{code}} \) is the code-required cooling equipment efficiency, \( \text{SHGC} \) is the actual solar heat gain coefficient, \( \text{SHGC}_{\text{code}} \) is the code-required solar heat gain coefficient, \( \text{LPD} \) is the actual lighting power density, and \( \text{LPD}_{\text{code}} \) is the code-required lighting power density.

**Ventilation**

The energy required to ventilate a building is dependent on whether DCV was implemented. If DCV was used in the building the ventilation end use percentage, \( \text{per}_{\text{vent}, \text{code}} \), was reduced by 30 percent (\( \text{per}_{\text{DCV}} = 0.3 \)). The modified ventilation end use percentage, \( \text{per}_{\text{vent}, \text{mod}} \), was found using Equation 3.

\[
\text{per}_{\text{vent}, \text{mod}} = \text{per}_{\text{vent}, \text{code}} \cdot (1 - \text{per}_{\text{DCV}}) \quad (3)
\]

**Lighting**

The energy required to light a building is a function of the building’s lighting power density. The modified lighting end use percentage, \( \text{per}_{\text{light}, \text{mod}} \), was found using Equation 4.

\[
\text{per}_{\text{light}, \text{mod}} = \text{per}_{\text{light}, \text{code}} \cdot \left( \frac{\text{LPD}}{\text{LPD}_{\text{code}}} \right) \quad (4)
\]

**Water Heating**

The energy required to heat a building’s hot water is a function of the water heating equipment efficiency, \( \eta_{\text{WH}} \). The modified water heating end use percentage, \( \text{per}_{\text{WH}, \text{mod}} \), was found using Equation 5.

\[
\text{per}_{\text{WH}, \text{mod}} = \text{per}_{\text{WH}, \text{code}} \cdot \left( \frac{\eta_{\text{WH}, \text{code}}}{\eta_{\text{WH}}} \right) \quad (5)
\]

As the interviews did not specifically address information affecting the “other” end use category, we left the end use percentages in this category unmodified, as shown in Equation 6.

\[
\text{per}_{\text{other}, \text{mod}} = \text{per}_{\text{other}, \text{code}} \quad (6)
\]

The percentage of the actual building’s energy consumption with respect to code, \( \text{per}_{\text{mod}} \), may then be found from the modified percentage end uses, as shown in Equation 7.

\[
\text{per}_{\text{mod}} = \text{per}_{\text{heat}, \text{mod}} + \text{per}_{\text{cool}, \text{mod}} + \text{per}_{\text{light}, \text{mod}} + \text{per}_{\text{WH}, \text{mod}} + \text{per}_{\text{vent}, \text{mod}} + \text{per}_{\text{other}, \text{mod}} \quad (7)
\]
The final step is to determine the actual building’s energy consumption with respect to ASHRAE 90.1-1999. This requires knowledge of the relative stringency of the code baseline where the building was constructed to ASHRAE 90.1-1999, $f_{string}$. As discussed in the report, we used the relative stringencies reported in Table F-8.

**TABLE F-8. RELATIVE STRINGENCY OF CODE BASELINES COMPARED WITH 90.1-1999**

<table>
<thead>
<tr>
<th>Code baseline</th>
<th>Stringency increase over 90.1-1999 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.1-1999‡‡‡</td>
<td>0%</td>
</tr>
<tr>
<td>90.1-2004</td>
<td>11.9%</td>
</tr>
<tr>
<td>90.1-2007</td>
<td>18.1%</td>
</tr>
<tr>
<td>Title 24</td>
<td>22.9%</td>
</tr>
</tbody>
</table>

The overall reduction, $per_{tot}$, in energy with respect to ASHRAE 90.1-1999 was then found using Equation 8:

$$per_{tot} = per_{mod} \cdot f_{string}$$  \hspace{1cm} (8)

The percent reduction, $per_{red,tot}$, is given by Equation 9:

$$per_{red,tot} = 1 - per_{tot}$$  \hspace{1cm} (9)

The final step was estimating the percent reduction in energy use that was attributable to the AEDGs, rather than to building codes or other factors. In most cases, a significant percentage of the reduction in building energy use was due to the increased stringency of building code requirements as compared with ASHRAE 90.1-1999. A portion of the remainder is then attributable to the AEDGs. Interviewees were asked to judge the AEDG’s influence on their decisions on a scale of 1-5, with 1 being “not important” and 5 being “very important.” This factor, $\alpha$, was then used to determine the AEDG’s impact, $per_{guide}$, as shown in Equation 10:

$$per_{guide} = \left( f_{string} - per_{tot} \right) \frac{\alpha - 1}{4}$$  \hspace{1cm} (10)

‡‡‡ For two Canadian projects, interviewees reported that the code baseline was similar to 90.1-1989. However, we did not have data comparing the EUI of buildings constructed to meet the 1989 version of 90.1 as compared with buildings constructed to meet the 1999 version. Therefore, we used the 90.1-1999 as the baseline for these two projects.
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