EVALUATION OF THE COMMERCIAL & INDUSTRIAL SECTOR MARKETS AND ACTIVITIES OF VERMONT'S ENERGY EFFICIENCY UTILITY

Volume I: Report

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EXECUTIVE SUMMARY

Efficiency Vermont ("EVT") is the first Energy Efficiency Utility in the United States; it is the only utility whose sole purpose is to help users of electricity save energy through efficiency and conservation. This report provides results from an initial process evaluation of the commercial and industrial ("C&I") portion of EVT's activities and a market assessment of Vermont's C&I sector.[1]

This Executive Summary briefly summarizes EVT's history; describes the research goals and methods used in this evaluation; provides an assessment of EVT's activities in the C&I sector; describes Vermont's C&I firms, market actors, and markets; and presents resulting conclusions and recommendations.

EFFICIENCY VERMONT

Efficiency Vermont began operating in March 2000 offering programs including service to C&I firms (end users) initially built on prior utility sponsored programs. EVT's programs focus on opportunities for energy efficiency in new construction, major renovations, remodeling, and equipment replacements. EVT offers financial incentives and technical assistance to C&I end user firms and the building and equipment professionals they work with. EVT also created a specialized service to educate organizations about and help them meet the energy-efficiency objectives of Act 250, Vermont's land-use planning and development law, using the Department of Public Service's ("DPS") commercial building energy-efficiency guidelines.

During the years 2000 through 2002, EVT built the demand for and participation in its C&I programs through a comprehensive marketing and outreach effort. Targeted audiences included architects, building decision-makers, the media, utilities, trade allies, and each utility's largest C&I firms.

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[1] This study is both a process evaluation and a market assessment. An impact evaluation and verification of savings was conducted separately by the Vermont Department of Public Service.

EVT produced informational materials, and expanded and marketed the popular annual Better Buildings by Design Conference to the C&I sector.

EVT's accomplishments in the C&I sector from its inception in March 2000 through December 2002 include the following:[2]

- EVT actions saved 48,494 MWh (exceeding its goal of 42,267 MWh);
- EVT served 1,181 C&I firms (through 11/30/02);[3]
- EVT offered 25 workshops and seminars; and
- EVT worked with 783 market actors, including architects, consultants, general contractors, electrical contractors, mechanical, and heating, ventilation and air conditioning ("HVAC") contractors, facilities engineers, project engineers and developers.

Additional information detailing EVT's accomplishments can be found in their own annual reports and in other documents prepared by the DPS and EVT.

RESEARCH GOALS AND METHODS

Efficiency Vermont's start-up phase and first three years of operation clearly are impressive. To better understand what EVT has accomplished (through their current programs and delivery methods), and how to make future programs and services even more effective, the primary goals of the initial evaluation were to:

- Develop an understanding and detailed characterization of the C&I markets for energy efficiency products and services in Vermont;
- Establish baselines for long term tracking of program effects on the market;

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[2] Figures are preliminary, obtained from Efficiency Vermont.

[3] Number excludes multifamily dwellings, which involve C&I market actors, but install primarily residential measures.

- Assess how the EVT C&I programs mesh with the market characterization findings and how the programs can be improved to maximize their effectiveness; and

- Provide timely feedback to help managers meet the goals of the energy efficiency utility and improve programs to achieve optimal results.

Primary and secondary research activities included:

- Telephone surveys with hundreds of market participants and other key stakeholders including architects, engineers, contractors, equipment suppliers, real-estate managers/developers, EVT program managers, electric distribution utility staff, and DPS staff;

- Telephone surveys with nearly 600 C&I end user firms in three categories:

    1. Firms that constructed new buildings under permits issued by the Department of Labor and Industry ("DLI") in 1998 or 1999;[4]

    2. Firms adding to, renovating, or remodeling existing structures under permits issued by the DLI in the same time period; and

    3. Firms that did not need and had not received a construction permit (*i.e.*, those not constructing new buildings nor adding to, renovating, or remodeling existing buildings);

- Site visits to C&I facilities that have recently completed new construction, renovation and/or equipment replacement projects to provide a more detailed characterization of the C&I market; and

[4] The years 1998–1999 were chosen based on studies elsewhere showing that the time from permitting to completion of a project is typically two to four years. The objective was to ensure that respondents from completed facilities were interviewed so that they could address what, in fact, was installed, rather than what was planned and might not come to pass. Projects that progressed from permitting to completion quickly did not have an opportunity to receive services from EVT, which began operating in March 2000.

- Review of dozens of reports, studies and documents relating to Vermont's and other regional C&I energy efficiency activities and markets.

C&I firms constitute the end users in the building construction and equipment market. Other participants in this market include those who supply the construction goods and services, collectively termed "market actors." Interviews were conducted with random samples of four types of market actors:

1. Designers—architects and engineers;
2. Contractors—general, mechanical, and electrical;
3. Suppliers—of mechanical, electrical, window, and motor equipment; and
4. Real estate professionals—property developers and mangers.

Site visits were conducted at 76 C&I facilities drawn from the telephone survey pool to round out survey data collection on end users by supplementing self-reported results from the phone surveys with direct field observation. Significant data have been collected during these site visits and are currently being analyzed. Therefore, where appropriate, only preliminary findings from the on-sites surveys are included in this Executive Summary.

Table ES.1 identifies each C&I market actor and end user group and provides estimates of the population sizes, sample sizes, and survey methods used. In total, nearly 600 C&I end users and over 150 designers, contractors, suppliers and real estate professionals were interviewed.

Table ES.1

SAMPLING PLAN 2001-2002 BASELINE DATA COLLECTION ACTIVITIES

C&I MARKET ACTOR GROUPS	ESTIMATED POPULATION[5]	SAMPLE PLANNED	COMPLETED INTERVIEWS	APPROACH
DESIGNERS				
Architects	126	30	30	Phone
Mechanical & Electrical Engineers	67	15	16	Phone
CONTRACTORS				
General Contractors	205	30	31	Phone
Electrical Contractors	152	25	23	Phone
HVAC/ Mechanical Contractors	149	25	19	Phone

Continued

[5] Population estimates were based on US Census data, supplemented by data purchased from Info USA, DLI permit files, EVT lists and other sources where available.

C&I MARKET ACTOR GROUPS	ESTIMATED POPULATION[5]	SAMPLE PLANNED	COMPLETED INTERVIEWS	APPROACH
EQUIPMENT SUPPLIERS				
Lighting/ Electrical Suppliers	39	10	7	Phone
HVAC/ Mechanical Suppliers	48	5	4	Phone
Windows Suppliers	154	5	7	Phone
Motor Suppliers	41	5	5	Phone
REAL ESTATE PROFESSIONALS				
Property Developers & Managers	163	15	16	Phone
C&I FIRMS (END USERS)				
C&I Construction Permit Holders	**839**	**200**	**200**	
• Permits for New Buildings	471	100	92	Phone
	__	36	36	On site
• Permits for Renovations	368	100	108	Phone
	__	29	29	On site
General C&I Firms	**20,000**	**230**	**396**	
• Purchased Equipment In Past 2 Years (Replacement Equipment)	8,000	__	158	Phone
	__	15	11	On site
• No Equipment Purchased in Past 2 Years (No replacement)	12,000	__	238	Phone

HOW EFFICIENCY VERMONT IS DOING

Efficiency Vermont has made a positive contribution to the number and kinds of energy-efficiency measures installed within C&I projects in Vermont. It has succeeded in establishing good visibility and awareness in the state. All of the engineers interviewed recognized EVT, as well as over 80% of the architects, about 75% of the contractors and real estate professionals, and about half of the C&I firms (end users).

In fact, 90% of the engineers spontaneously identified EVT as the name of an organization that promotes energy efficiency throughout Vermont. Fewer than half of the general contractors, however, made this spontaneous identification. This difference in recognition between the two types of professionals is significant because general contractors are used on about 80% of C&I construction projects, whereas engineers are used on only about 40% of projects. As a result of this finding, EVT has already begun to consider ways to expand their outreach to the general contractor group.

Approximately 80% of the engineers, half of the designers, and one-third of the contractors and developers reported using one or more EVT services (see Table ES.2). Seventeen percent of C&I firms (end users) interviewed with permitted construction projects reported using EVT services, as did about one-fourth of the C&I firms replacing equipment. These findings indicate both that EVT has been making a positive impact and that there remains a large pool of market actors and C&I firms in Vermont that have not made use of EVT services.

Table ES.2

PROPORTION OF INTERVIEWED MARKET ACTORS AND END USERS USING EVT SERVICES

MARKET ACTOR	USED ANY EVT SERVICE	USED ONLY FINANCIAL INCENTIVES	USED ONLY ASSISTANCE/ INFORMATION SERVICES	USED BOTH FINANCIAL AND ASSISTANCE SERVICES
DESIGNERS				
Architects	47%	3%	17%	27%
Engineers	81%	19%	12%	50%
CONTRACTORS				
General Contractors	29%	15%	6%	6%
Mechanical Contractors	31%	5%	0%	26%
Electrical Contractors	30%	9%	4%	17%

MARKET ACTOR	USED ANY EVT SERVICE	USED ONLY FINANCIAL INCENTIVES	USED ONLY ASSISTANCE/ INFORMATION SERVICES	USED BOTH FINANCIAL AND ASSISTANCE SERVICES
DEVELOPERS				
Developers	38%	6%	6%	26%
C&I FIRMS (END USERS)				
C&I Construction Projects	17%	3%	4%	10%
C&I Equipment Replacement Projects	27%	6%	8%	13%

For each respondent group that reporting using EVT services, respondents were more likely to use both financial incentives and technical assistance or other information services than they were to use either financial or technical assistance alone. General contractors were an exception to this; they were most likely to use only financial incentives. Comparing financial and technical assistance, financial incentives were used with equal or greater frequency than technical assistance by engineers and contractors. Architects and end users more frequently reported using technical assistance than financial incentives.

Across all the market participant groups, about 60% of respondents who had reported using EVT rated EVT services highly in each of four areas explored, as shown in Table ES.3. The table provides the proportion of respondents rating EVT services a “4” or a “5” on a 5-point scale with “5” being the highest rating.

Table ES.3

PROPORTION OF RESPONDENTS HIGHLY RATING THE EVT SERVICES THEY RECEIVED

MARKET PARTICIPANT	USEFULNESS OF INFORMATION	RESPONSIVENESS TO PROJECT NEEDS	QUALITY OF SERVICES	KNOWLEDGE
Architects	64%	57%	71%	50%
Engineers	62%	38%	46%	46%

General Contractors	63%	50%	50%	63%
Mechanical Contractors	50%	83%	50%	33%
Electrical Contractors	86%	71%	86%	86%
Developers	60%	60%	40%	40%
C&I Construction Projects	80%	70%	83%	89%
C&I Equipment Replacement Projects	74%	60%	72%	43%

Designers and contractors identified *insufficient information about efficiency options* and *limitations in their ability to analyze efficiency options* as major barriers to energy efficiency, as noted below. For those that rated EVT's services highly, EVT is succeeding in reducing barriers to energy efficiency in Vermont. As shown in Table ES.3, there still remains much room for improvement.

C&I firms that have received services from EVT are more likely than other firms to report having installed efficiency measures in their permitted construction projects or their purchased equipment systems (e.g., newly replaced heating or lighting systems).

Review of EVT's programs and documents and interviews with EVT staff and staff in several of the state's electric utilities reveal EVT is addressing participants in the C&I market in a professional and well-thought out manner.

Finally, the data, conclusions and recommendations from this evaluation (along with draft findings that have been shared directly with EVT and the DPS as they became available upon completion of specific evaluation activities) have been useful to EVT to improve its C&I programs for 2003. Recent EVT actions include:

- Actively recruiting trade allies through direct outreach to architects, engineers, and suppliers of motors and HVAC equipment;

- Increasing trade allies' participation in the Northeast Energy Efficiency Partnerships' effective Cool Choice HVAC program and Motor UP motors program;
- Fully implementing a new market-focused approach; and
- Expanding the program to help C&I firms follow the DPS energy-efficiency guidelines for meeting Act 250 objectives.

ASSESSING THE ENERGY-EFFICIENCY MARKET IN VERMONT

EVT already is having a positive impact on energy efficiency in Vermont. It can do even better by meeting the specific needs of each type of market actor and market segment, as is planned for 2003. In other words, EVT can use evaluation data to pinpoint which services each group already is using, which ones they still want and need, how to stimulate their interest in energy efficiency, and how to provide those services. The market assessment looked at:

- Firm size, location, and other characteristics;
- The people involved in the projects and decisions, including C&I firms, market actors, and real estate professionals;
- Barriers to energy-efficient designs, products, and practices;
- The rate at which organizations and market actors are implementing energy efficiency measures and practices; and
- Involvement with and opinions about the Act 250 energy criteria.

Brief findings within each of these market assessment areas are summarized below:

Vermont's C&I Firms

Understanding the size and location of Vermont's C&I firms and the nature of their construction and renovation activity is crucial for knowing how to best encourage them to choose the energy-efficient alternative.

Size

Overall, firms in Vermont's C&I sector show the same variation in size as other New England firms. More than half of the state's C&I firms occupy buildings under 5,000 square feet in size, and fewer than 15% occupy buildings of 25,000 square feet or more. In total, there are about 20,000 C&I firms in the state;[6] about 3,000 of these are large, occupying 25,000 square feet or more. To put Vermont's C&I stock in perspective, a nearby out-of-state utility serving an area about half the size of Vermont has approximately 4,000 large C&I accounts.

Location

For the purposes of this evaluation, the state is divided in three regions: Chittenden County; cities and towns outside of Chittenden County with population greater than 7,500 (termed "small urban areas"); and rural areas of the state. Table ES.4 shows the distribution of C&I firms in these areas. The rural areas of the state have more construction projects for their population than the rest of the state, but the projects are smaller than elsewhere, so the total square footage affected is more in proportion to the population. Conversely, Chittenden County has few projects for the size of its population, but these projects are larger and so the total square footage affected is also in rough proportion to its population.

Table ES.4

DISTRIBUTION OF RESIDENTIAL AND COMMERCIAL ACTIVITY IN VERMONT

PERCENT OF VERMONT'S:	CHITTENDEN COUNTY	SMALL URBAN AREAS	RURAL AREAS
Residential Population	25%	33%	42%

[6] Data from 1997 Economic Census, U.S. Census Bureau (19,717 establishments with payrolls). A published business list for 2002 reported 32,262 firms, including sole proprietorships without payroll. Statewide, there are 42,303 commercial and 413 industrial electricity accounts.

C&I Firms	30%	35%	35%
C&I Permitted Construction Projects	15%	25%	60%
C&I Constructed Floorspace (square footage)	24%	29%	47%

C&I Construction and Equipment Projects

Construction Activity and Professionals Used

About 16% of Vermont's C&I end-user firms (839) applied to DLI for a construction permit during the two year of period 1998 to 1999. Just over half of these firms applied for permits to construct a new building; the rest applied for permits for construction within an existing facility (primarily additions, with renovations a distant second). Approximately 120 of the permits were for large projects over 25,000 square feet.

A synopsis of the professionals used in these construction projects is presented below:

- Architects designed half the permitted projects (about 410 projects, including 70 large ones, for a total of nearly 60% of the constructed floorspace);
- Contractors worked directly with the project owners, usually without the services of an architect (in a construction approach termed "design-build") on the remaining projects (about 430 projects, including 50 large ones, for a total of about 40% of the constructed floorspace)
- Fifty percent of contractors report at least half their work is design-build, and all but 25% report they do some design-build work.
- Ten percent of architects and 50% of engineers report doing a little design-build work.

The design of the building is a significant determinant of how energy efficient the occupied facility will be. Given that half of the projects do not involve an

architect, Efficiency Vermont needs to work with contractors and building owners in order to affect the building's design.

Briefly, the construction professionals have the following characteristics:

- Most construction companies are small. The proportion of firms having four or fewer employees are:
  - Architects—80%,
  - Engineers—46%,
  - Contractors—25 to 35% (depending on type);
- Most construction firms work in both the residential and C&I sector, although 29% of general contractors work exclusively in the C&I sector;
- The construction firms are located throughout the state in rough proportion to the level of construction activity in the area; and
- Half of the real estate firms manage less than 75,000 square feet, a relatively small amount.

Major Equipment Purchases and Equipment Suppliers

About 40% of Vermont's approximately 20,000 C&I firms purchased major building equipment systems (lighting, heating, and/or windows) in the two years prior to our surveys (mid-2000 to mid-2002). Purchases were equally divided among heating, lighting, and window equipment, with approximately half of the firms purchasing more than one type of equipment. Firms purchased and installed the equipment through contractors and equipment suppliers.

Most C&I equipment suppliers were found to be small companies with annual revenues of $5 million or less. The supply firms are scattered throughout the state, with many small firms located in the rural areas. A few firms located in neighboring states sell equipment in Vermont. With just a few exceptions, the supply firms interviewed sold equipment to residential as well as C&I

customers. This finding was true for motor suppliers as well as for suppliers of other types of equipment.

Decision-Making for Construction and Equipment Projects

In order to influence the energy-efficiency of construction and renovation projects, it is important to understand who influences the decisions about building construction and equipment selection.

C&I firms with permitted construction projects used a lighting contractor, general contractor, and mechanical contractor on about 85%, 80%, and 70% of their projects respectively. About half of the projects used architects, and about 40% used mechanical and/or electrical engineers (about one-third of firms reported using each type of engineer). Approximately one-third of the firms that were interviewed reported using five or six professionals on their projects; about one-third used three or four; and one-third used one or two professionals.

The C&I end-user firms and construction professionals interviewed reported decisions about HVAC equipment were influenced most often by general and mechanical contractors. Decisions about lighting equipment were influenced most often by lighting contractors. When engineers were involved in a construction project, they frequently had a strong influence on equipment decisions. For both HVAC and lighting systems, owners and suppliers also influenced the decisions.

Nearly 90% of the architects and engineers reported their clients were concerned about energy efficiency, yet only about half had marketing materials that showed the firm's capabilities in energy-efficient design. Mechanical contractors were the most likely contractor group to have marketing materials that address energy-efficiency capabilities (40%), followed by electrical contractors (25%), and general contractors (15%).

Energy Efficiency in C&I Construction and Equipment Projects

Barriers to Energy Efficiency

Factors that may hinder or prevent the use of energy efficiency measures are often referred to as "market barriers". EVT is successful in promoting energy efficiency to the extent it reduces market barriers.

The research found some substantial barriers to selecting, specifying and procuring energy efficient equipment and building practices in C&I construction projects.

- About two-thirds of designers (architects and engineers) said a major barrier is clients' unwillingness to fund their analysis of the applicability of energy-efficiency options. Designers are less likely to specify these options if they can't fund the analysis of whether the options will meet the demands of the specific situation, their effects on other features and systems, and the expected costs and benefits.

- Designers (architects and engineers) and contractors reported getting accurate information about energy-efficiency options and getting reliable estimates of energy-efficiency costs and benefits was often difficult. (Between 25 and 60% of each group rated each of these factors as substantial barriers.)

- About one-third of contractors identified the higher cost of energy-efficient products as a considerable barrier.

Apparent barriers from the small samples of suppliers interviewed include:

- Lack of awareness and knowledge of efficient equipment - which appeared to be a barrier among some C&I equipment suppliers. Mechanical suppliers rated themselves as moderately knowledgeable about efficient equipment. Motor suppliers rated themselves as having little knowledge of efficient motor drives. Two noteworthy exceptions to this knowledge barrier were: lighting/electrical and window suppliers who rated themselves as highly knowledgeable about efficient equipment.

- The marketing approach of windows and motor suppliers appears to be a barrier. Both supplier groups reported their clients are most interested in non-energy savings-related product performance criteria, yet both groups reported promoting energy-efficient equipment on the basis of energy savings alone.

Attitudes about the quality of light output of high-efficiency lighting were found to be a barrier for some C&I end user firms that undertook construction. The attitudes of end users with respect to high-efficiency HVAC equipment did not reveal any additional barriers.

Finally, interviews with end users revealed *limited discussion about energy efficiency options between contractors and C&I firms* is also a significant barrier to the more widespread use of energy efficient construction practices and the installation of energy efficient equipment.

EVT reduces many of these barriers by providing information to designers, contractors, developers, and owners on available energy-efficiency options, their costs and benefits. Assistance in the analysis of options offered by EVT is also valuable, including technical assistance to analyze the applicability of efficient options to a specific construction project and monetary incentives offered to owners to offset the cost of analysis activities their design teams engage in. EVT rebates for high-efficiency equipment address the barrier cited by contractors of higher equipment costs.

Current Energy-Efficiency Practices

Perhaps as a result of a long history of energy efficiency programs in Vermont, including EVT's efforts, C&I firms, designers, contractors, and developers in the state were found to demonstrate high levels of awareness of many energy efficiency measures. Converting this awareness into actual installation and use of energy efficient equipment is more difficult to achieve. Table ES.5 presents the proportions of C&I firms reporting the installation of efficiency measures in their construction and equipment projects, and their rates of awareness of the

measures.[7] Although EVT has been effective in encouraging the installation of efficiency measures, much work remains to be done.

Table ES.5 shows only three measures that have been installed by more than about half of the respondents. No distinction is made in this table between firms that were or were not involved with Act 250 or that did or did not use EVT services. However, the study found that C&I firms using EVT services installed more efficiency measures than other firms.

Table ES.5

INSTALLATION AND AWARENESS OF EFFICIENCY MEASURES AMONG C&I FIRMS (END USERS) WITH CONSTRUCTION AND EQUIPMENT PROJECTS

EFFICIENCY MEASURES	INSTALLED MEASURE IN PROJECT		AWARE OF MEASURE	
	CONSTRUCTION PROJECT	EQUIPMENT PROJECT	CONSTRUCTION PROJECT	EQUIPMENT PROJECT
Electronic Ballasts	70%	58%	84%	84%
Installed Any Electronic Controls	68%	NA	NA	NA
Low-E Glass*	62%	44%	83%	85%
Programmable Thermostat*	52%	31%	90%	92%
LED Exit Signs	49%	29%	78%	66%
Compact Fluorescent Lamps	45%	40%	82%	72%
T-8 Lights*	38%	31%	47%	35%
Lighting Controls	26%	11%	58%	45%

[7] Many of the efficiency measures included in this table have been commercially available for many years. EVT encourages the use of these measures, as well as the use of newer, more "cutting edge" measures and practices. Assessing the use of newer measures and practices, however, is difficult to do in telephone survey research because of the respondents' general unfamiliarity with these newer measures and their difficulty in accurately answering questions about them. Detailed analysis of this evaluation's recently completed site visits may provide additional insight into the use of these newer energy efficiency measures.

Economizer	25%	8%	48%	44%
Condensing Furnace*	23%	12%	52%	40%
Occupancy Sensors	19%	14%	58%	53%
Energy Management System	18%	13%	59%	58%
Variable Frequency Drive	18%	35%	NA	NA

* *Preliminary results from the onsite surveys suggest C&I firms moderately over-reported (by approximately 10%age points) the installation of programmable thermostats, low-e glass, and condensing furnaces. The C&I firms moderately under-reported the installation of T-8 lamps.*

Variations by Size of Firm

Larger C&I firms are more likely than smaller firms to install each measure, although size of firm is not a factor in awareness of measures among firms undertaking construction. The following factors contribute to the finding that larger projects and firms install more efficiency measures than smaller ones:

- Larger firms have more capital, more access to capital, more staff, and more specialized staff, all of which provide resources for installing energy efficient measures;
- Larger projects bring together more professionals and have greater varieties of space, increasing the odds of involving a professional committed to, and finding evident opportunities for, efficiency; and lastly,
- EVT has targeted larger firms, conducting meetings in 2001 with firms identified by the state's utilities as their largest customers.

Baselines for Long Term Tracking of Market Effects

Consistent with its primary goals, the study identified over 50 market indicators for the long-term tracking of market effects, and estimated baseline values for these indicators. Table ES.6 provides, as an example, one indicator for each market actor group. The interested reader will find all of the indicators

in the Conclusions and Recommendations section (chapter nine) of this report. A forthcoming analysis of data collected from the on-site surveys of C&I firms may yield additional market indicators.

Table ES.6

SELECTED MARKET INDICATORS

MARKET ACTOR	INDICATOR	BASELINE MEASURE: PERCENT MEETING CRITERION
All Designers, Contractors, Suppliers	Aware of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%
Architects	Specify less lighting or automatic dimming due to day lighting features on at least 50% of projects	27%
Engineers	Design or size HVAC system taking passive systems into consideration on at least 50% of projects	6%
General Contractors	Use independent, third-party commissioning of building systems on at least 50% of projects	6%
Electrical Contractors	Lighting system exceeds ASHRAE 90.1 1999 standards on at least 50% of projects	4%
		Continued
Mechanical Contractors	Heating system exceeds ASHRAE 90.1 1999 standards on at least 50% of projects	32%
Electrical Equipment Suppliers	Photo-cells with dimming ballasts	43% of suppliers sell; equipment about 2% of sales
Window Suppliers	Aware of SHGF rating on products sold	Less than 10%
Motor and VFD Suppliers	Knowledge of VFDs	80% below "4" on 10-point scale rating knowledge
End Users with Construction Projects	Install occupancy sensors	19%

MARKET ACTOR	INDICATOR	BASELINE MEASURE: PERCENT MEETING CRITERION
End Users with Equipment Projects	Install programmable thermostats	31%
Real Estate Developer Projects	Install energy management systems	20%

Act 250

Those involved in the C&I construction market were asked about their experience with and opinions on Act 250. About half of the developers and C&I firms with construction projects permitted in 1998 and 1999 and about one-fifth of C&I firms without such construction projects reported having had an Act 250 energy review at some point. Three-fourths of the engineers and two-thirds of architects reported having been involved in at least one Act 250 review, as did about half of the general contractors, one-fourth of mechanical contractors, and about 15% of electrical contractors.

Engineers and property developers held the most favorable opinion of the energy impact of Act 250; about two-thirds of both groups thought projects reviewed under Act 250 had either more or a higher level of energy-efficiency features than they would have had without the Act 250 review. About half of the architects, general contractors, and C&I firms with permitted construction projects shared this view. Smaller proportions of electrical and mechanical contractors expressed this opinion. Larger general contractors were more likely than smaller ones to have been involved in Act 250 and to rate its effect highly. No other differences by respondent size were found.

Interpretation of C&I Construction and Equipment Market

Vermont's building and construction designers, contractors, and suppliers seize the opportunities that present themselves: large or small projects, commercial or industrial or residential clients, nearby or farther away, new construction, renovation or remodeling. In Vermont's comparatively small C&I

market, research through this study is showing word-of-mouth communication and social networks are particularly important.

It is frequently assumed in markets outside Vermont that the largest building and equipment firms specialize in serving the largest C&I end users and are the most knowledgeable about energy-efficiency opportunities. As a consequence, it is assumed these firms comprise an important niche and targeted services are designed for them. Yet, this research revealed that, in Vermont, size does not predict which designers and contractors are the most informed and proactive in regards to energy efficiency, nor does it predict which C&I firms they are working with.

Larger C&I firms tend to *install* the most efficiency measures for a variety of reasons, but smaller and larger construction professionals are equally likely to *encourage* their clients to choose energy-efficiency options. Also, it is apparent the characteristics of the professionals used on a project contribute as much or more than size to the number of efficiency measures used. Projects during which the end user discussed energy use with a mechanical engineer (or, to a somewhat lesser degree, with architects or general contractors) had more energy efficiency measures installed than other projects. In addition, projects with a greater number of design and contractor professionals had more measures installed than projects with a fewer number of professionals, independent of the size of the project.

To date, engineers and contractors that have used EVT services have used rebates more frequently than technical assistance. This fits with the finding that contractors report higher costs of efficient equipment as a barrier to efficiency. Architects have more frequently used the technical assistance offered by EVT than its rebates. Architects and engineers both identified as significant barriers a lack of information about efficiency options, costs, and benefits, and architects identified limitations on their ability to analyze options within the financial constraints of their contracts.

Although C&I firms, designers, contractors and developers reported for some efficiency measures fairly high proportions of installations, for all measures there was room for increased installation; for many measures, there is considerable room for increased installation rates.

MAKING EFFICIENCY VERMONT EVEN BETTER

The research conducted during Phase I of this C&I evaluation effort, shows EVT is working well for Vermonters. It also reveals EVT can do even more to improve the markets and increase the use of energy efficient equipment and services in the state's C&I sectors.

Following are some key Phase I conclusions and recommendations that may help to make EVT and its C&I energy-efficiency programs even more effective. They have been divided into two categories: (1) program-related improvements; and (2) additional research. It is the researcher's belief that these program-related opportunities will increase building and construction professionals' knowledge of and communication with C&I firms about energy-efficiency options. In addition, these conclusions and recommendations will help the DPS identify how it can enhance this first evaluative effort to increase its positive impacts on energy efficiency in Vermont. Chapter nine of this evaluation report provides more detail about these conclusions and recommendations.

EVT Programs

1. Impacts on C&I Firms' Energy-Efficiency Decisions

CONCLUSION: EVT is successfully reaching those involved in the design and construction of new and existing building projects throughout the state, and is influencing their decisions to invest in energy efficiency. C&I firms (end users) and market actors are using both EVT's financial incentives and its technical assistance.

> ***Recommendation:*** EVT should continue its incentives, promotion, and outreach efforts.

2. Statewide Services

CONCLUSION: EVT appears to be serving firms throughout the state, but its technical assistance is reaching fewer of the non-Act 250 projects in rural and small urban areas than it is in other project/location combinations.

> ***Recommendation:*** EVT should increase technical assistance in these areas through meetings, and/or strategically placing staff to provide these services directly.

3. Educating C&I Construction Service Providers

CONCLUSION: C&I firms are more likely to use energy-efficient technologies and practices if they discuss them with their architects, mechanical and electrical engineers, and general, mechanical and electrical contractors.

Architects and mechanical engineers are the most effective at incorporating energy-efficiency options in their clients' projects. However, clients hire them less often than other building professionals. Therefore, other market actors must also have information about energy-efficiency options so they can present them to clients with small and medium permitted and non-permitted construction projects.

> ***Recommendation:*** EVT should continue to work closely with designers and contractors to increase their awareness of and skills with energy-efficiency solutions so they can effectively present them to clients. EVT should continue adding sessions at the Better Buildings by Design Conference about how to discuss energy efficiency with skeptical clients.

EVT should follow-through with plans to increase educational efforts with contractors, and with real estate developers to expand their awareness and use of energy-efficiency solutions. One option is to offer sessions geared for these actors at the Better Buildings by Design Conference.

4. Equipment Suppliers and Manufacturers

CONCLUSION: Based on the limited sample of suppliers interviewed, Phase I research found equipment suppliers to be among the least informed market actors about energy efficiency. This suggests manufacturers are not educating them about energy-efficient products, and contractors and C&I firms are not demanding the products from suppliers.

Recommendation: It appears from this study sample that EVT should continue and expand efforts recently begun to target outreach to suppliers, and continue to collaborate with regional and national organizations that work with manufacturers.

5. Lighting

CONCLUSION: Many C&I firms seek "high-quality" lighting; while some portion of firms spontaneously equated energy-efficient lighting with high quality, an equal proportion explicitly described it as being of low quality. Contractors and real estate developers are concerned about the cost of efficient lighting equipment.

Recommendation: EVT should continue to offer rebates to address cost concerns, and continue actively promoting the DesignLights Consortium's Knowhow™ educational lighting guidelines series. EVT should consider creating a lighting design lab or demonstration site to showcase the high quality lighting that high-efficiency lighting systems can provide. In addition, EVT should go forward with plans to more aggressively promote comprehensive lighting efficiency services and incentives under its "Comprehensive Track".

Research Recommendations

1. Process Evaluation 2003-04

CONCLUSION: In the coming years, EVT plans to embark on an effort to focus on market sectors while also expanding its relationships with trade allies.

Recommendation: A process evaluation conducted throughout 2003-04 will be very useful to determine if program processes are successfully reaching and influencing market participants to increase their use of energy efficiency technologies and practices.

2. Opinion Leader Research

CONCLUSION: In Vermont's comparatively small C&I building marketplace word-of-mouth communication and social networks appear to be particularly important. Market actors of all sizes work with residential and commercial/industrial clients of all sizes, on all types of projects.

> ***Recommendation:*** As part of the process evaluation, interviews should be conducted with market actors who have used EVT services to get more information about their experiences with EVT, and to help determine how EVT can reach other firms in Vermont.

3. Supplier Research

CONCLUSION: EVT and DPS may want a better estimate of baseline market conditions for key products offered by suppliers. Phase I data about suppliers are weak because the suppliers were particularly hard to reach and sample sizes were small.

> ***Recommendation:*** Future supplier research should focus on the measures most frequently promoted by EVT. Experience elsewhere has shown suppliers and manufacturers rarely cooperate with studies seeking detailed information on their inventories in the absence of monetary compensation. For a research strategy focused solely on Vermont suppliers to be cost effective the inquiry should focus on a limited number of equipment options; thus an investigation of the items most relevant to EVT's activities would be recommended. Alternatively, EVT or the DPS should participate in various regional and national efforts being considered to track product market shares by state. This would provide economies of scale that cannot be achieved in a single state study.

4. Market Indicator Study

CONCLUSION: The current, comprehensive study provides a market assessment and a baseline evaluation of EVT's initial C&I program efforts (including identification of key market progress tracking indicators). Thus, in

2004 or 2005, a second study will need to determine, in comparison with the baseline results, if EVT has helped the market expand its knowledge, awareness, and use of energy-efficient solutions.

> ***Recommendation:*** The next market study should focus on market indicators of energy efficiency improvement, and include samples of designers, contractors, suppliers, C&I firms, and real estate professionals, as interviewed for the current study.

5. Act 250 Impacts Study

CONCLUSION: Of those who have had experience with Act 250, as many believe it has improved the energy efficiency of projects as believe it has had little effect. Sorting out the effects of Act 250, EVT, and the new guidelines and procedures relating to Act 250 is very difficult. As a consequence, the impacts of the Act 250 process on energy efficiency are currently inconclusive.

> ***Recommendation:*** Additional effort to sort out the effects of Act 250 on energy efficiency should be conducted in separate studies from this evaluation of EVT. The evaluation, however, should continue to examine the effect of EVT efforts with Act 250 projects and to explore whether these effects are reaching to non Act 250 projects as well.

6. Other Recommended Evaluation Priorities for 2003-04

In addition to these research recommendations, a number of other research activities planned for the 2003–04 time period are presented in the main body of this report, including the need for a more detailed analysis of on-site survey results.

> ***Recommendation:*** Once the on-sites analysis is completed, relevant findings should be integrated with the results presented in this report.

1. INTRODUCTION

Efficiency Vermont (EVT) is the first Energy Efficiency Utility in the United States; it is the only utility whose sole purpose is to help users of electricity save energy through efficiency and conservation. This report provides results from an initial process evaluation of the commercial and industrial (C&I) portion of EVT's activities and a market assessment of Vermont's C&I sector.[8]

BACKGROUND

Enabling Legislation

On June 1, 1999, Vermont Governor Howard Dean signed into law Senate Bill 137 to establish an Energy Efficiency Utility (EEU). The law enabled the Vermont Public Service Board to deliver core statewide energy efficiency and conservation programs throughout the State. It further established the authority for the Board to institute an energy efficiency charge to fund these efforts. It also placed a limit on the charges, ensuring the proceeds will not exceed a total of $17.5 million dollars per fiscal year.[9] The law requires that all retail consumers have an opportunity to benefit from cost-effective energy efficiency programs and initiatives designed to overcome barriers to participation. Furthermore, it requires the Board to promote coordinated program delivery.

The legislation was the direct result of a litigation settlement between Vermont's electric utilities and the Department of Public Service (DPS). In the course of a few short months in 1999, a Memorandum of Understanding

[8] This study is both a process evaluation and a market assessment. An impact evaluation and verification of savings was conducted separately by the Vermont Department of Public Service.

[9] The charge is only on electricity usage. The gas utility continues to provide natural gas efficiency measures.

(MOU) agreeing to the creation of an Energy Efficiency Utility (EEU) was signed by all parties to Docket No. 5980.[10] Senate bill 137 reflected this agreement.[11]

In September 1999, as a result of the legislation, the Board issued a request for proposals for entities to provide efficiency services as an EEU for the state of Vermont. The project was awarded to Vermont Energy Investment Corporation, headquartered in Burlington, VT. The first EEU in the nation, Efficiency Vermont (EVT) began operation in March 2000, with a three-year contract and budget of $27,035,970. The projected annualized MWh savings for the first three years are 83,766.[12] EVT offers seven programs to citizens of Vermont, two of which exclusively target commercial and industrial utility customers. By December 31, 2001, EVT documented savings of 60,359 MWh, of which 50% are in the commercial and industrial electric utility customer sector—the focus of this report.

With the passage and signing of Senate Bill 137, the role of the Department of Public Service shifted from overseeing multiple demand-side management (DSM) utility programs to overseeing EEU services and conducting an evaluation of the EEU. While the Department retains its responsibility under Vermont law to assure investments in energy efficiency are cost-effective and comprehensive, with EVT the Department oversees a single statewide entity instead of 22 electric utilities, as in previous years. The DPS is responsible for conducting a formal evaluation of energy efficiency program performance and markets, activities that were previously carried out by the utilities and overseen by the DPS.

In October 2000, the DPS issued a request for proposals to conduct an evaluation of EVT. The team of GDS Associates, Research Into Action, Inc., Megdal & Associates, B&B Resources, Action Research and SAIC (collectively

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10 Vermont Department of Public Service Biennial Report, July 1, 1998 – June 30, 2000. January 2001.

11 Docket No. 5980 was opened by the Board in the spring of 1997, after the Department filed its proposal for statewide delivery of seven core DSM Programs. That proposal was entitled: *The Power to Save: A Plan to Transform Vermont's Energy Efficiency Markets.*

12 The efficiency utility serves all service territories of Vermont's electric utilities except Burlington Electric Department (BED), which deliver s the core statewide programs in its service territory. Some municipal and public utilities continue to offer programs in addition to the statewide efforts and for distribution system maintenance and improvement purposes.

the GDS team) were selected to conduct an evaluation of the commercial and industrial market programs of EVT. The GDS team met with the DPS and EVT staff to initiate the project in February 2001.

Efficiency Vermont

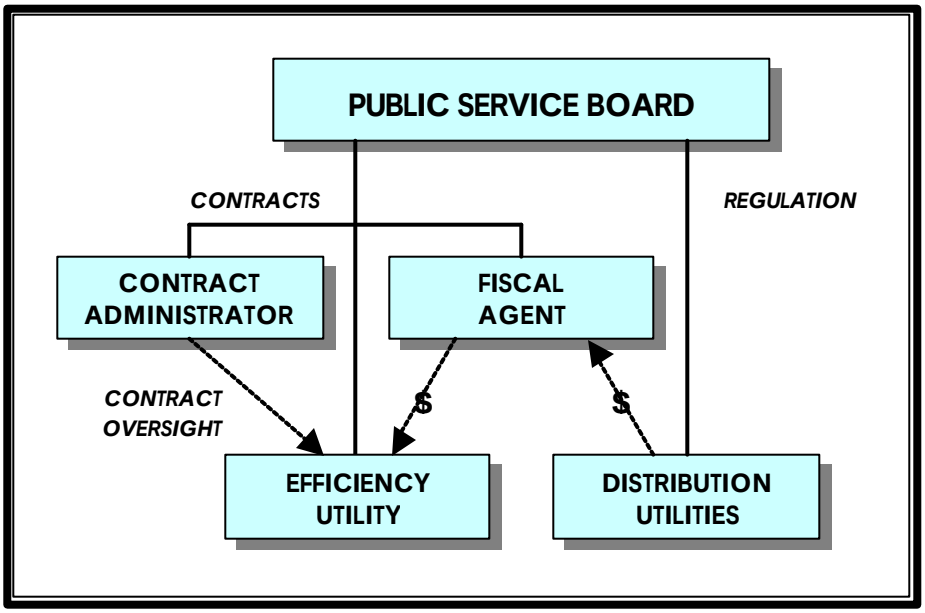
The organizational structure for Efficiency Vermont is noted as follows. The Public Service Board contracted with a Contract Administrator and a fiscal agent to manage the contractual and financial issues for EVT. The energy efficiency charge funds are sent by the multiple electric utilities to the fiscal agent, who then pays EVT invoices once the Contract Administrator approves them. The Contract Administrator oversees the business issues of the efficiency utility contract, ensuring contractual obligations are met, reviewing invoices, and making recommendations to the Public Service Board on the contractual performance of EVT. The Contract Administrator is also responsible for making recommendations to the Board on any issues about which the Department of Public Service and EVT have not reached agreement.

The DPS is charged with planning and evaluation activities for demand and supply side electrical issues. It must make recommendations to the Public Service Board regarding the performance of EVT in terms of efficiency and renewable services and for identifying opportunities for efficiency and renewable services. This evaluation is being prepared for the Vermont Department of Public Service. Figure 1.1 displays the structure of the efficiency utility in the Vermont utility regulatory environment.[13]

Figure 1.1

EFFICIENCY VERMONT STRUCTURE

[13] Hamilton, B. J. Plunkett & M. Wickenden (2002) *Gauging Success of the Nation's First Efficiency Utility: Efficiency Vermont's First Two Years.* In Proceedings of the 2002 Energy Efficiency in Buildings Summer Study. American Council for and Energy Efficient Economy, Asilomar, CA.



EVT C&I PROGRAMS

As part of this evaluation, it was important that the GDS team familiarize itself with EVT's current menu of commercial and industrial program offerings, overarching policy documents, and other relevant reports and studies. Therefore, before designing and fielding the market actor and end-user surveys, a number of interviews were conducted with EVT staff, BED and other electric utility staff, and a select group of market actors. Key EVT program materials also were reviewed, along with a number of Vermont-specific policy documents and reports, and studies of similar programs that have been conducted throughout the Northeast. Appendix A provides a list of all documents reviewed. At the end of 2002, we conducted a second round of interviews to update our understanding of the EVT program efforts.

Description of Programs 2000-2002

Beginning in 2000 and through 2002, EVT has offered two programs for commercial and industrial businesses: the Commercial Energy Opportunities (CEO) program and the Commercial Industrial Emerging Markets (CIEM) program. These programs function primarily as resource acquisition programs. As an underlying strategy, they also are designed to create a strong market trade-ally network and support system. In 2002, the programs became less

differentiated in practice as the staff moved to a market focus that will be implemented fully in 2003. Yet, the programs remain differentiated for purposes of reporting.

CEO activities have consumed the majority of EVT's C&I staff effort since 2002. The CEO activities are those that focus on new construction and major renovations as well as replacement and remodeling opportunities. Technical assistance, customized incentives and prescriptive incentives for building lighting, LED exit signs, motors, unitary HVAC equipment, and dual enthalpy economizers provide the tools for working with customers on these projects.

The CIEM portion of the program was initiated during 2001. The goal of this program was to focus on large comprehensive retrofit opportunities and specialized services for schools, and water and wastewater facilities. In addition, CIEM—as the emerging markets area—was initially the location of efforts for day lighting, training for variable frequency drives and coordination with other New England states on efficient lighting system design.

Program Planning for 2003

Reorganizing the Business Energy Markets Group

In 2002, the distinction between the two program areas ceased to have as much internal value for EVT. They had never meant much to customers and trade allies since the incentive process was the same, regardless of the market event. These distinctions serve primarily as tools for reporting, for allocating resources between different activities, and for analyzing savings and cost-effectiveness. As a consequence, EVT began to change the organizational structure of the Business Energy Markets group to change the focus more generally to whether the project was in an existing building or involved a new building. It has also begun to look at different market actors and the market segments (grocery, retail, etc.) in which they operate rather than on the market event: new, retrofit, remodel, etc.

Strengthening the Trade Ally Network

A subcomponent of EVT's efforts from 2000 through 2002 has been to develop a strong market trade-ally network, providing outreach to the trade-ally

community, with the goal that trade allies will come to EVT with projects. Part of this has been the annual Better Building by Design Conference each February. The conference introduces efficiency solutions to design, development and building professionals. In 2003, EVT will move to be less reactive and become more proactive in recruiting trade allies. An initiative with architects and engineers will be launched as well as efforts with distributors for motors and HVAC equipment.

Supporting Act 250

Part of the trade ally effort will be a natural outgrowth of EVT taking over the fieldwork for the Northeast Energy Partnerships' (NEEP) *Cool Choice* HVAC program and the *Motor UP* motors program. The lack of much change in the motors and HVAC markets over the period from 2000 to 2002 appears to reflect in part the fact that NEEP program resources allocated to Vermont were limited. EVT staff will readily be able to conduct the fieldwork for these two initiatives as part of on-going efforts throughout Vermont. Meanwhile, EVT will continue to use NEEP program materials and will remain active participants in the initiative, but will ensure Vermont trade allies are actively engaged in the program.

In 2001, EVT was working on how to position its role in the thinking of building decision-makers during the Act 250 process.[14] This has now been resolved. The State of Vermont adopted the 2001 Guidelines for Energy Efficient Commercial Construction October 15, 2001. The Guidelines will be used for Act 250, have been adopted by the City of Burlington as their energy code, and are likely to be adopted by all public agencies in Vermont. There are a variety of issues concerning Act 250 and its guideline that the building should include the "best available technology." Among these issues is the

[14] Act 250 is a land-use law enacted in Vermont in 1970. The law applies to projects on ten acres of land or buildings of ten or more units, according to specific characteristics of their location. There are ten criteria that must be met for permit approval, including within Criteria 9, a requirement for energy conservation. In October 1998, the Department of Public Service introduced the Vermont Consolidated Act 250 Energy Guidelines for Typical Commercial and Industrial Buildings (known as the 1998 Consolidated Guidelines) to assist people in meeting the Act 250 requirements. These guidelines were updated in October 2001 (the 2001 Vermont Guidelines for Energy Efficient Commercial Construction) to incorporate much of the 1999 ASHRAE amendments.

response of customers to EVT. Customers sometimes view EVT's role in the Act 250 process as "regulatory" rather than advisory, particularly if advice from EVT becomes permanently attached to the Act 250 permit. EVT staff also expressed concern about the degree of consistency in the application of these guidelines. They also wondered about the effect of the DPS's promotion of IECC 2000.1 and ASHRAE 90.199 energy codes as part of compliance with Act 250.

In 2002, EVT and the DPS met several times and developed an approach that will be implemented in 2003. This approach, it is hoped, will reduce the appearance of EVT as a regulatory arm of the DPS while stimulating increased involvement with and commitment to the solutions EVT proposes to Act 250 applicants. Applicants to Act 250 review who are working with EVT will be posted each month on a list that EVT will provide to the DPS. As long as the Act 250 applicant continues to work with EVT, the approach provides a presumption that the energy requirements of Act 250 are being met.

Administrative Activities

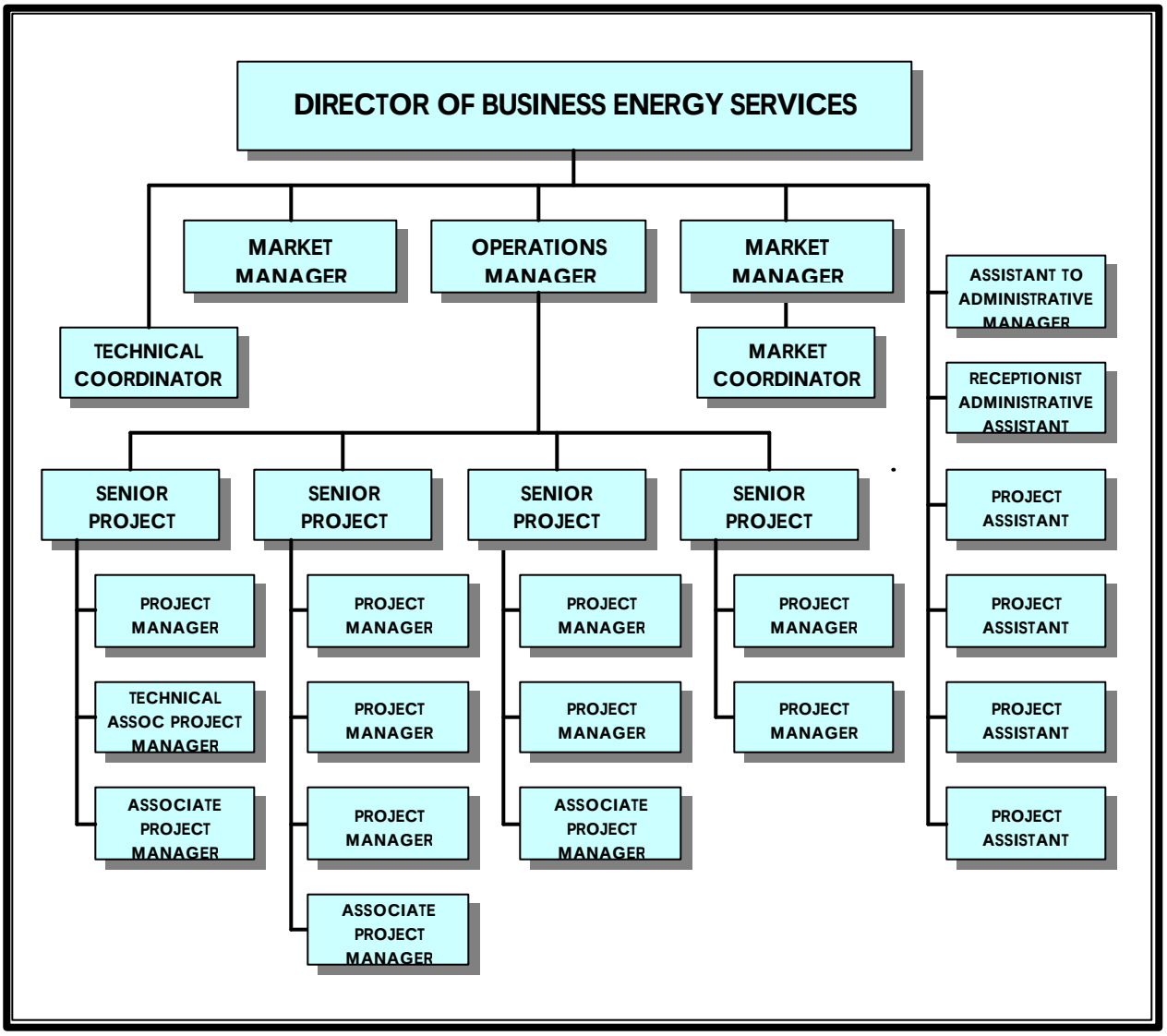
Efficiency Vermont's program administrative activities include staffing, incentives and marketing.

Staffing

The Business Energy Services Group of EVT is responsible for commercial and industrial energy efficiency services. This includes multi-family housing, since most multi-family projects are commercial enterprises. Figure 1.2 shows the organization chart for the Business Energy Service Group.

Figure 1.2

EVT BUSINESS ENERGY SERVICES ORGANIZATION CHART (12/10/02)



The Business Energy Services Group has 28 staff members including the director. Project managers work directly with customers who are designing or constructing projects. The technical coordinator provides support to the Business Energy Services Group to screen measures, set prescriptive incentives, etc. The market mangers coordinate overall outreach and decision making for new construction projects or existing building projects. The administrative group assists in processing incentives and other support functions for the project managers.

The staff is primarily located in Burlington, Vermont. Two project managers are located outside of Burlington: one near Rutland and one (a subcontractor

specializing in the dairy market) in Plainfield. Many of the project managers commute to Burlington from communities outside of Chittenden County, and are easily able to visit project sites throughout the state. There are no plans to locate any other project managers outside of Burlington.

In addition to the Business Energy Services Group, EVT's Business Development Group supports marketing and outreach activities to the residential and the commercial industrial sectors.

Incentives

EVT has developed screening tools for determining incentive options for projects. EVT uses both prescriptive and custom incentive structures no matter what type of market event. Customers choosing the "Express" version of a program are offered prescriptive incentives, which require applicants to complete a one-page form. These incentives apply to lighting, motors and packaged cooling and heating units. The motors and HVAC equipment incentives and forms are consistent with those used in the *Motor Up* and *Cool Choice* programs sponsored throughout New England by NEEP (NEEP).

In general, custom measures involve more effort to calculate the savings and interaction effect; screening tools and modeling are required. Incentives typically are negotiated, with a maximum of 80% of incremental cost possible. According to staff, this approach is very effective in ensuring customers contribute to the investment and can be useful in leveraging more efficiency measures into projects than might otherwise be considered. Most incentives have been in the range of 20-50% of incremental cost.

In 2002, additional measures were added to both prescriptive and custom efforts including: LED traffic lights, services to the dairy industry and to multi-family construction (formerly under its own initiative), and a Vending Miser prescriptive rebate. In 2003, a prescriptive rebate will be offered for customer-owned ENERGY STAR® transformers. EVT also has considered shifting other measures to prescriptive rather than custom incentives. Some measures that have been quite common and have fairly standard savings, such as refrigeration door heaters, anti-sweat measures, and economizers, could be treated as prescriptive in the future.

Marketing

EVT conducts broad-based advertising of all its programs through radio, print ads, limited television advertising, directly to customers in billing inserts and through various professional associations and on their website, *www.efficiencyvermont.org*.

The Business Development Group's marketing approach for EVT's C&I programs has multiple avenues.

- EVT staff monitors the *Works In Progress* (WIP) publication on a weekly basis to identify new construction projects that are just getting underway. A series of filters are used to identify:
  - Those already in the process with EVT;
  - Those with new activity not noted before; and
  - Those with previous experience with EVT, etc.
- EVT Business Development staff use the filtering process to follow up on WIP and other leads to identify projects just getting underway or that may be further in the process but were missed earlier.
- DPS typically directs project sponsors in the Act 250 process to go to EVT for help in responding to the Act 250 energy guidelines.
- EVT monitors the DPS comments list on Act 250 projects to catch any projects that may have been missed.
- Leads come from utilities throughout the state that have direct contact with customers through requests for temporary/construction service, etc.
- Trade allies notify EVT of projects and work with EVT to complete the projects. EVT Business Development staff members attend meetings of trade allies to inform them about EVT activities and also place articles in trade publications.

- EVT does direct outreach to architectural firms to inform them of EVT services and to try to catch projects at the early stages of conceptual design.
- EVT does some marketing to inform Vermont building decision makers about EVT opportunities.

When we interviewed EVT and utility staff in 2001, they expressed little concern about identifying non-Act 250 projects. Both groups were confident that utilities and the EVT business development staff generally are able to identify these projects. In 2002, EVT staff indicated they believe they are getting a large number of new construction projects, but recognize that the replacement and remodel market has been more difficult to track. Their efforts in 2003 to reach out to trade allies is likely to capture more of those opportunities.

"Top 100" Firms

A key effort on the part of the Business Development Group staff in 2001 was to meet with the "Top 100" firms in Vermont, a list which actually comprises closer to 200 to 300 firms. It includes the largest customers of every utility in the state. Thus, the largest customer for a small municipal utility could be relatively small compared to the largest firms in Chittenden County, yet even so it would be included as a key customer for EVT. Business Development staff met with these firms to identify project opportunities and explain EVT services.

This outreach has continued in 2002 and has resulted primarily in retrofit projects. It is clear to EVT staff that some projects developed with the Top 100 list have not come to fruition. In 2003, the focus will continue and the efforts to understand the barriers to "closing" the deal will be increased.

Better Buildings by Design

In 2001, the Better Buildings by Design Conference began including commercial and industrial construction topics. Previously (1999 and 2000), only residential construction was covered. The 2001 conference had over 408 attendees, and the 2002 conference attracted about 508 attendees and exhibitors, including 78 architects, 33 engineers, 73 builders, 155 other trade

allies or customers, and 89 exhibitors. About 50% of the attendees work in the commercial/industrial sector.

Collateral

According to EVT staff, the use of collateral materials—though continuing—has been the least effective marketing approach, and TV and radio marketing are kept at a very low level to keep costs low, yet maintain a presence (through such efforts as EVT's sponsorship of Vermont Public Radio). All the other methods are usually linked to projects and seem to be effective.

Marketing in 2003

November 2002 saw 100 projects come into the Business Energy Services Group. This was the largest single month since program initiation in 2000 and substantially exceeds the average of 50-75 projects per month that had been true during most of the program period. This growth in projects could signal an upsurge that will continue. If so, pressure on resources will become critical both in terms of staff ability to work on projects and funds available for incentives. As a consequence, efforts to generate retrofit opportunities likely would take a back seat while projects that must be done are dealt with.

Results from EVT Annual Report 2002

Participation Rates

EVT's accomplishments in the C&I sector from its inception in March 2000 through the 2002 include the following:[15]

- EVT actions saved 48,494 MWh (exceeding its goal of 42,267 MWh);
- EVT served 1,181 C&I firms (through 11/30/02);[16]

[15] Figures are preliminary, obtained from Efficiency Vermont.

[16] Number excludes multifamily dwellings, which involve C&I market actors, but install primarily residential measures.

- EVT offered 25 workshops and seminars; and
- EVT worked with 783 market actors, including architects, consultants, general contractors, electrical contractors, mechanical, and heating, ventilation and air conditioning (HVAC) contractors, facilities engineers, project engineers and developers.

Additional information detailing EVT's accomplishments can be found in their own annual reports and in other documents prepared by the DPS and EVT.

Estimated Savings

The DPS performed an assessment and verification of both electric savings and total resource benefits claimed by EVT in its annual report. This study does not deal with estimated savings.

DESCRIPTION OF THE REPORT

Chapter 2 provides an overview of the Vermont commercial and industrial construction market. It gives a context for C&I activity by discussing the state's population and population distribution. It then discusses C&I construction activity through an analysis of data for construction permits—construction of new buildings or changes to existing facilities. It concludes with an identification and brief description of the participants in the C&I construction market.

Chapter 3 gives the study approach, beginning with the objectives of the study. The chapter discusses the sampling plan and provides an assessment of data quality. It concludes with an overview of the analysis and the types of conclusions the study yields.

Chapter 4 gives the major findings across all market participants, providing a comparison across groups. The chapter also explores size differences in the behavior of market participants.

Chapter 5 provides a detailed discussion of the findings from the surveys of market actors (designers—architects, engineers; contractors—general, electrical, and mechanical; and suppliers—lighting/electrical, HVAC/mechanical, window, and motor/variable speed drives).

Chapter 6 provides the findings from surveys of real estate professionals, firms that both develop and manage properties and those that only manage properties.

Chapter 7 gives a detailed discussion of the findings from the C&I end-user surveys. Respondents include firms with permitted construction projects (both new construction and renovation/remodeling) and firms without permitted construction projects (both those who have purchased equipment systems in the last two years and those who have not).

Chapter 8 discusses the findings from the on-site visits of C&I firms that participated in the telephone surveys. The team conducted on-site visits at newly constructed facilities, remodeled and renovated facilities, and facilities with new equipment. The chapter compares data obtained from the on-site visits and phone surveys.

Chapter 9 presents the conclusions and recommendations that flow from the research. It includes an identification of appropriate market indicators.

Appendix A provides a list of all documents reviewed as part of the evaluation.

Appendix B lists the researchable questions identified for the evaluation.

Appendix C contains copies of all telephone survey instruments used for the study. These should be referred to by the reader interested in learning how the issues discussed in this report were explored.

Appendix D provides the sampling plans for all market participant groups.

2. OVERVIEW OF THE VERMONT COMMERCIAL AND INDUSTRIAL CONSTRUCTION MARKET

This chapter provides an overview of Vermont's population and its commercial and industrial (C&I) construction activity for new and existing structures. It identifies and briefly describes the market participants in this construction activity. The approach to the study is based on this understanding of the construction activity and market participants.

The chapter is organized into the following topics:

- Vermont's population density and distribution,
- Vermont's C&I construction activity, and
- Market participants in C&I construction activity.

VERMONT'S POPULATION DENSITY AND DISTRIBUTION

To provide a context for understanding the commercial and industrial markets in Vermont, we provide a brief description of the state's population density and distribution. The data reported are from the 2000 US Census, the most recent available.

Vermont is a small and rural state, with 608,827 residents. The average number of persons per square mile is 66, less than the national average of 80 people per square mile, which includes large amounts of sparsely populated territory in northern Alaska and other Western states. Comparisons with Vermont's neighbors show the following:

- Upstate New York has significant rural areas, yet the state as a whole has 402 persons per square mile.
- Western Massachusetts is somewhat rural, yet Massachusetts has 810 persons per square mile.

- Vermont's eastern neighbor, New Hampshire, has double Vermont's density, with 138 persons per square mile.

Small farms and towns characterize Vermont. Its low population density is about twice that of major farming states in the nation, which are distinguished by large farms. For example, Kansas and Nebraska have 33 and 22 persons per square mile, respectively.

Chittenden County has a more urban/suburban mix than the rest of the state. For example, although Rutland is the third largest city in Vermont, Rutland County has 68 persons per square mile compared to Chittenden's 272 persons per square mile. There are fourteen counties in Vermont; Table 2.1 gives the population by county. (A map showing the geographic size and locations of Vermont's counties appears in the next section as part of a discussion of C&I new construction permits.)

Table 2.1

POPULATION BY COUNTY

COUNTY	2000 POPULATION
Chittenden	146,571
Rutland	63,400
Washington	58,039
Windsor	57,418
Franklin	45,417
Windham	44,216
Bennington	36,994
Addison	35,974
Caledonia	29,702
Orange	28,226
Orleans	26,227

Lamoille	23,233
Grand Isle	6,901
Essex	6,459

The largest city in Vermont is Burlington, which has a population of almost 39,000 people. Its second largest city is Essex, with less than 19,000 people. Third is the city of Rutland, with just over 17,000 people. Both Burlington and Essex are in Chittenden County, along with the fourth and fifth largest towns, Colchester and South Burlington City.

The state has fifteen urban areas with population greater than 7,500 residents, as shown in Table 2.2. Five of these fifteen areas lie within Chittenden County.

Table 2.2

URBAN AREAS WITH POPULATION GREATER THAN 7,500

	GEOGRAPHIC AREA	TOTAL POPULATION	WITHIN CHITTENDEN COUNTY
1.	**Burlington City**	38,889	X
2.	**Essex Town**	18,626	X
3.	**Rutland City**	17,292	
4.	**Colchester Town**	16,986	X
5.	**So Burlington City**	15,814	X
6.	**Bennington Town**	15,737	
7.	**Brattleboro Town**	12,005	
8.	**Hartford Town**	10,367	
9.	**Barre City**	9,291	

10.	**Springfield Town**	9,078	
11.	**Middlebury Town**	8,183	
12.	**Montpelier City**	8,035	
13.	**St. Albans City**	7,650	
14.	**Williston Town**	7,650	X
15.	**St. Johnsbury Town**	7,571	

Analyses conducted for this study looked at three geographic distinctions in Vermont. Given the more urban nature of Chittenden County, it comprised its own category. The populations of all towns with more than 7,500 residents that are outside of Chittenden County comprise the small urban category. The third category—rural—encompasses all other locations in the state.

VERMONT'S C&I BUILDING STOCK

Overall, firms in Vermont's C&I sector show the same variation in size as other New England firms. More than half of the state's C&I firms occupy buildings under 5,000 square feet in size, and fewer than 15 percent occupy buildings of 25,000 square feet or more.

In total, there are about 20,000 C&I firms in the state;[17] about 3,000 of these are large, occupying 25,000 square feet or more. To put Vermont's C&I stock in perspective, a nearby out-of-state utility serving an area about half the size of Vermont has approximately 4,000 large C&I accounts.

Nearly 400 randomly-selected C&I firms were surveyed as part of this study. They provide a good representation of Vermont's C&I stock. Tables 2.3 through

[17] Data from 1997 Economic Census, U.S. Census Bureau (19,717 establishments with payrolls). A published business list for 2002 reported 32,262 firms, including sole proprietorships without payroll. Statewide, there are 42,303 commercial and 413 industrial electricity accounts.

2.5 identify the distribution of building locations, types, and sizes of these surveyed firms. Chapter 7 provides additional detail on these firms.

Table 2.3

BUILDING LOCATION

LOCATION	PERCENT
Chittenden County	30%
Small Urban (excluding Chittenden County)	35%
Rural	35%

Table 2.4

BUILDING TYPE

BUILDING TYPE	PERCENT
Office	29%
Retail	32%
Industrial	14%
School (Non-College)	5%
Warehouse	4%
Public Buildings, Health Care, College, Church, or Other Institutions	10%
Multi-family, 4+ Stories	0.3%
Other	6%

Table 2.5

SIZE OF FACILITY

SIZE IN SQUARE FEET	PERCENT
Under 5,000	54%
5,000 to Under 10,000	16%
10,000 to Under 25,000	11%
25,000 to Under 75,000	8%
75,000 and Over	4%
Don't Know	7%

VERMONT'S C&I CONSTRUCTION ACTIVITY

This section reviews permit Vermont Department of Labor and Industry data for new construction and renovation projects to provide an overview of the C&I construction activity in the state. Prior to the discussion of permit data, we draw upon data from the 1997 US Census of Construction to characterize the market.

Characterization Drawn from US Census Data

The 1997 Census of Construction indicates $1.7 billion was spent on construction in Vermont during the year. One-fourth of this total, however, was devoted to heavy construction such as highways, streets, bridges, and water and power systems. The remaining construction money includes land development, excavation, and water well drilling, in addition to building construction.

Nonresidential building construction was roughly $319 million and residential construction was slightly larger at about $341 million. In addition to both these figures, $587 million went to special contractors, including the trades of plumbing, air-conditioning, carpentry, roofing, and glass. Allocating this spending in the same proportions that building construction was split between

the residential and C&I sectors suggests C&I building construction constituted a market size of $603 million in 1997.

The Vermont construction businesses that are large enough to have payrolls (and thus be included in census data) conduct over 75% of their business in Vermont ($1.3 billion of the $1.7 billion total construction industry). The rest of their business is conducted in New Hampshire, New York, Massachusetts, and Maine (in order of dollar value done in these states).

The construction businesses with payroll did over $765 million of building, developing, and general contracting business in the residential and nonresidential sectors in 1997. This sum can be broken into the following categories:

- Fifty-nine percent for building construction on land owned by others, with the businesses working in the role as either a general contractor or design-builder;
- Seventeen percent for construction management of buildings;
- Fifteen percent for remodeling general contractors or remodeling design-build business; and
- Eight percent for building construction on land owned by the builder for sale.

About 30% of the construction activity (in dollars) was devoted to the construction of manufacturing and light industrial facilities; construction of educational buildings follows at about half that amount (see Table 2.6).

Table 2.6

1997 C&I CONSTRUCTION VALUE*

BUILDING USE	$ MILLIONS	PERCENT
Manufacturing & Light Industrial	$214.8	28%
Educational Buildings	$125.3	16%

Office Buildings	$70.6	9%
Hotels and Motels	$62.1	8%
Health Care and Institutional Buildings	$41.2	5%
Commercial Warehouses	$40.0	5%
Public Safety Buildings	$28.5	4%
Amusement, Social, and Recreational Buildings	$9.4	1%
All Other Commercial Buildings	$88.4	12%
Other Building Construction	$84.7	12%

** For Vermont construction businesses with payroll.*

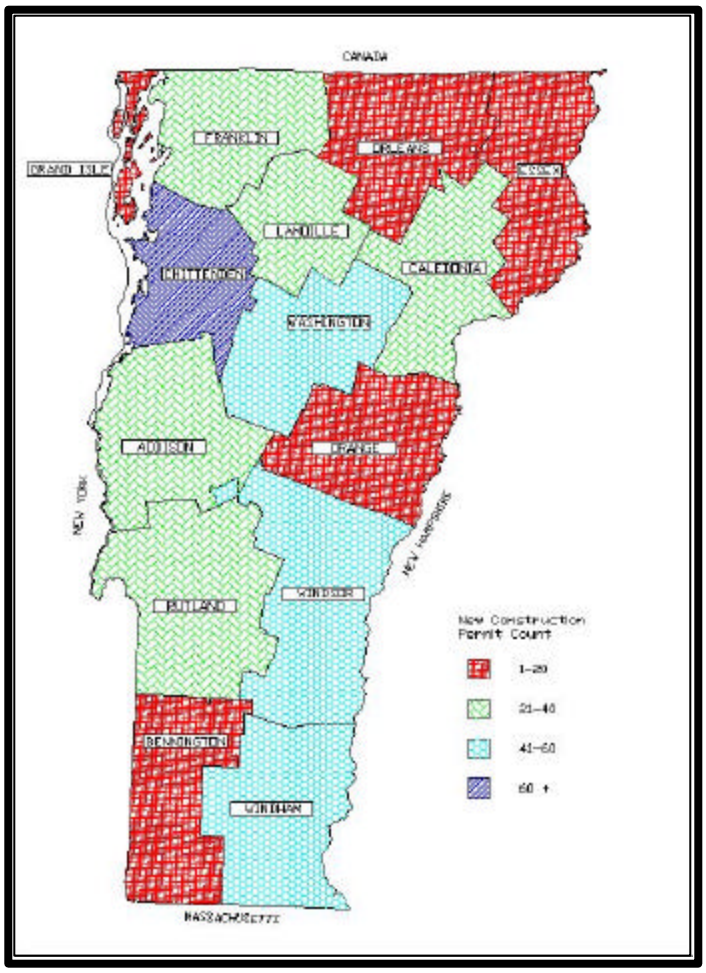
Characterization Drawn from Permit Data: New Construction

We used the Vermont permit data held by the Department of Labor and Industry to extract permit data for this study's surveying and analysis. Based on an assessment of the time it typically takes to move a nonresidential project from permitting to completion, we examined 1998 and 1999 permit data.

The number of new construction permits issued in 1998 and 1999 vary widely between the counties, from more than 60 in Chittenden County to less than 20 in Bennington, Orange, Orleans, and Essex (see Figure 2.1).

Figure 2.1

1998 AND 1999 VT C&I NEW CONSTRUCTION PERMITS BY COUNTY



Retail establishments had more permits for new construction than any other building use, followed by warehouse/storage and office establishments (as shown in Table 2.7). Although the breakdown of construction activities by dollar value given above in Table 2.6 shows the industrial and education sectors to be the largest, they comprise few permits (8% industrial, less than 3% schools and colleges—included in institutional). These findings suggest that industrial and educational construction projects are few in number but are large, high-value projects.

Table 2.7

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS

BUILDING TYPE	1998/1999 PERMITS	
	NUMBER	PERCENT
Office: Total	**75**	**16%**
• Office	54	11%
• Mixed use	21	4%
Retail: Total	**129**	**27%**
• Retail	85	18%
• Service	23	5%
• Grocery	13	3%
• Food Service	8	2%
Industrial: Total	**40**	**8%**
Warehouse, Storage: Total	**90**	**19%**
Institution: Total	**73**	**15%**
• Public Assembly	51	11%
• Health Care	11	2%
• Institution (Non School)	11	2%
School (Non-College): Total	**3**	**1%**
Other: Total	**61**	**13%**
• Hotel	22	5%
• Lodging	17	4%
• Utility (Wastewater, Pumping)	14	3%
• Apartments	5	1%
• Agriculture	1	0%
• Animals	2	0%
Total	**471**	**100%**

Over half of the permits are for construction in the rural portions of the state, and within each building use type there are more permits for rural areas than for either Chittenden County or small urban areas (see Table 2.8). Chittenden

County has higher proportions of new offices and retail space than it has of any other building use types, yet these proportions are nonetheless lower than the rural share of these building types.

Table 2.8

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS BY GEOGRAPHIC TYPE

BUILDING TYPE	1998/1999 PERMITS	PERCENT BY GEOGRAPHIC TYPE		
		CHITTENDEN	SMALL URBAN	RURAL
Office	75	35%	23%	43%
Retail	129	31%	20%	49%
Industrial	40	15%	23%	63%
Warehouse	90	16%	21%	63%
Institution, health care, assembly	75	23%	8%	69%
School	3	0%	0%	100%
Other	61	28%	15%	57%
Total	471	25%	18%	56%

The statistics given in Table 2.9 provide a context for the permitted construction activity in the three types of geographic areas in the state.

Table 2.9

DISTRIBUTION OF RESIDENTIAL AND COMMERCIAL ACTIVITY IN VERMONT

PERCENT OF VERMONT'S:	CHITTENDEN COUNTY	SMALL URBAN AREAS	RURAL AREAS
Residential Population	25%	33%	42%
C&I Firms	30%	35%	35%
C&I Permitted Construction Projects	15%	25%	60%
C&I Constructed Floorspace (square footage)	24%	29%	47%

** Cities and towns outside of Chittenden County with population greater than 7,500.*

The rural areas of the state have more construction projects for their population than the rest of the state, but the projects are smaller than elsewhere, so the total square footage affected is more in proportion to its population. Conversely, Chittenden County has few projects for the size of its population, but these projects are larger and so the total square footage affected is also in rough proportion to its population.

Almost half of the new construction permits that included square footage data were for projects smaller than 5,000 square feet (see Table 2.10). Thirteen percent are over 25,000 square feet. This size distribution is roughly comparable to the size distribution of C&I firms in the state, as well as of C&I firms in the Northeast region as a whole.

Table 2.10

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS BY SIZE

SQUARE FEET	1998/1999 PERMITS	PERCENT OF PERMITS
Under 1,000	28	10%
1,000 – 4,999	108	37%
5,000 – 9,999	58	20%
10,000 – 24,999	61	21%
25,000 – 49,999	26	9%
50,000 – 74,999	7	2%
75,000 – 99,999	5	2%
100,000 or more	1	0%
Total With Square Footage Data	294	100%
Total Lacking Square Footage Data	177	NA
Total Permits	471	NA

As Table 2.10 shows, 10% of the projects were very small—less than 1,000 square feet—and two-thirds of the permits were for less than 10,000 square feet. Yet among the 471 projects are 13 projects that dwarf these small ones, ranging from 50,000 square feet to over 100,000 square feet. These larger projects result in an average project size that suggests a building larger than the typical building. Table 2.11, therefore, provides a comparison of the mean (the average) and the median (the size for which 50% of the buildings are larger and 50% are smaller) for each building type.

Table 2.11

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS, SIZE BY BUILDING TYPE

BUILDING TYPE – AGGREGATE	MEAN SF	MEDIAN SF	BUILDING TYPE – DISAGGREGATE	MEAN SF	MODE SF
Office	12,641	5,688	Office	9,032	5,616
			Mixed Use*	19,859	5,785
Retail	11,162	7,200	Retail	13,542	8,500
			Service*	4,866	4,800
			Grocery*	7,443	2,400
			Food Service*	8,486	2,570
Industrial	22,015	7,500	Industrial	22,015	7,500
Warehouse, Storage	11,741	4,680	Warehouse, Storage	11,741	4,680
Institution, Health Care, Assembly	8,996	6,000	Public Assembly	6,709	4,966
			Institution (Non School)*	6,763	7,069
			Health Care*	18,597	12,600
School (Non-College)*	29,108	29,108	School (Non-College)*	29,108	29,108
Other	12,206	6,000	Hotel*	17,997	16,600
			Lodging*	13,464	8,557
			Utility (Wastewater, Pumping)*	3,201	1,890
			Apartments*	8,281	8,983
			Animals*	18,576	18,576

* *Few permits were issued for these building types. Thus, their size characteristics may not be a good predictor of future facility sizes. The single permit for an agricultural project (categorized under "Other")lacked square footage data.*

Table 2.12 shows for most building use types, the number of permits as a proportion of the total number is a proxy for the amount of square footage as a proportion of the total new construction square footage. Industrial facilities are an exception to this generalization. Industrial facilities constitute a rather small proportion of the number of permits yet a large proportion of the square footage being newly constructed. This observation is consistent with the conjecture made in the discussion of Table 2.6, that industrial facilities are high value projects. The same comparison suggested educational facilities are also high value projects, however there are too few educational projects with square footage data to draw any conclusions.

Table 2.12

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS, BUILDING TYPE COMPARISONS BY PERCENTAGE OF FLOOR SPACE AND NUMBER OF PERMITS

BUILDING TYPE	BUILDING TYPE AS PERCENT OF TOTAL	
	SQUARE FOOTAGE	NUMBER OF PERMITS
Office	17%	16%
Retail	25%	27%
Industrial	15%	8%
Warehouse, storage	18%	19%
Institution, health care, assembly	12%	15%
School (non-college)	1%	1%
Other	12%	13%

* *Of the 471 permits for new construction, 294 had square footage data.*

As previously shown, only 39 of the 471 permits (8%) for new construction were for projects of 25,000 square feet or more. However, as shown in Table 2.13, these large projects were more likely to be located in Chittenden County (44%) than in small urban (20%) or rural areas (36%). As a consequence,

Chittenden County projects overall have a larger mean square footage than do the other areas. This finding is true overall and for 13 of the 18 disaggregated business types. As an example of a business type for which this was not true, the mean square footage for grocery stores permits was much higher in the small urban area than in Chittenden County due to one quite large grocery discount warehouse being built there. It is hard to extrapolate from the small number of permits in some geographic areas/building type categories to what might be expected in future years with respect to project size.

Table 2.13

1998 AND 1999 C&I NEW CONSTRUCTION PERMITS, LARGE PROJECTS BY BUSINESS TYPE AND LOCATION

BUILDING TYPE	LARGE PROJECTS		LARGE PROJECTS BY LOCATION		
	NUMBER	PERCENT OF TOTAL PROJECTS	CHITTENDEN	SMALL URBAN	RURAL
Office: Total	**7**	**9%**	**3**	**3**	**1**
• Office	2	4%	2	0	0
• Mixed Use*	5	24%	1	3	1
Retail: Total	**7**	**5%**	**5**	**1**	**1**
• Retail	6	7%	5	0	1
• Grocery*	1	8%	0	1	0
• Service & Food Service*	0	0%	0	0	0
Industrial: Total	**6**	**15%**	**2**	**2**	**2**
Warehouse, Storage: Total	**9**	**10%**	**2**	**2**	**5**
Institution: Total	**2**	**3%**	**1**	**0**	**1**
• Public Assembly	2	4%	1	0	1
• Health Care, Other	0	0%	0	0	0
School (Non-College): Total*	**1**	**33%**	**0**	**0**	**1**
Other: Total*	**5**	**8%**	**4**	**0**	**1**

• Hotel*	4	18%	3	0	1
• Lodging*	1	6%	1	0	0
Total	**39**	**8%**	**17 (44%)**	**8 (20%)**	**14 (36%)**

* *Few permits were issued for these building types. Thus, their size characteristics may not be a good predictor of future facility sizes.*

The table also shows the highest share of large projects are in the building use types of schools (1 of 3), mixed use office space (5 of 21), hotels (4 of 22), and industry (6 of 40).

Characterization Drawn from Permit Data: Renovation

We also extracted the 1998 and 1999 permit data for Vermont's nonresidential renovation, remodeling, and additions for sampling and analysis. Retail establishments were the building use type most likely to have permits for changing their existing facilities, followed by institutions and industrial facilities (see Table 2.14).

A comparison of Tables 2.7 and 2.14 provides insight into whether new construction or changes to existing construction dominate the construction activity for each building type. In the office sector, twice as many permits were issued for new construction as for renovation/remodeling (75 versus 38). In the warehouse/storage sector, new construction permits were triple those of renovation/remodeling (90 versus 29). Permits for new construction in the retail sectors exceeded those for renovation/remodeling by 25%. On the other hand, in the institution, schools, and industrial sectors, renovation/remodeling permits exceeded those for new construction by 25% or more. Thus, the different building sectors will be differentially affected by efforts relating to new construction and efforts relating to construction on existing buildings.[18]

[18] It is possible that some facilities undergoing renovation or remodeling do not obtain permits. It is similarly possible that public or quasi-public facilities—institutions and schools—get permits more frequently that

Table 2.14

1998 AND 1999 C&I RENOVATIONS, REMODELING, AND ADDITIONS PERMITS

BUILDING TYPE	1998/1999 PERMITS	
	NUMBER	PERCENT
Office: Total	**38**	**10%**
• Office	32	9%
• Mixed use	6	2%
Retail: Total	**103**	**28%**
• Retail	46	13%
• Service	27	7%
• Grocery	18	5%
• Food service	12	3%
Industrial: Total	**59**	**16%**
Warehouse, storage: Total	**29**	**8%**
Institution: Total	**84**	**23%**
• Public assembly	48	13%
• Health care	22	6%
• Institution (non school)	14	4%
School (non-college): Total	**21**	**6%**
Other: Total	**34**	**9%**
• Hotel	12	3%
• Lodging	5	1%
• Utility (wastewater, pumping)	5	1%
• Apartments	2	1%
• Agriculture	4	1%
• Animals	0	0%
• Miscellaneous/Unknown	6	2%

private facilities. If so, that would contribute to the higher rates of renovation seen in these sectors. On the other hand, professional designers, engineers, and contractors may push all of their clients to conform to the laws of their trades.

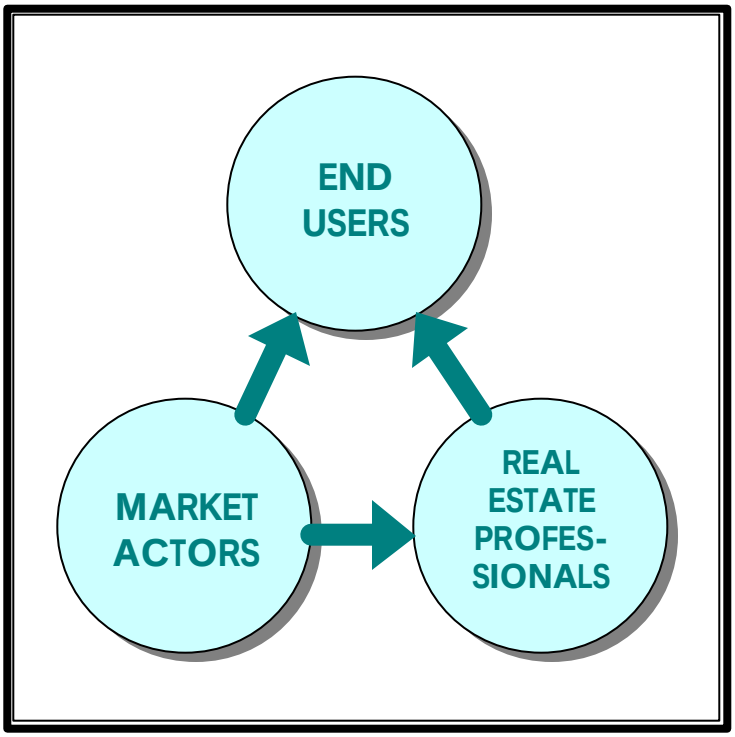
Total	**368**	**100%**

MARKET PARTICIPANTS IN C&I CONSTRUCTION ACTIVITY

Market participants in C&I construction activity can be grouped into three sets: end users (C&I firms), market actors (building and construction professionals and suppliers), and real estate professionals (property developers, brokers, and managers). The flow of goods and services between these three sets of market participants is shown in Figure 2.2.

Figure 2.2

FLOW OF GOODS AND SERVICES AMONG MARKET PARTICIPANT GROUPS



End Users

End users are C&I establishments that occupy the C&I building stock or are in the process of constructing buildings to occupy. End users with existing buildings are current market participants when they renovate, remodel, or add on to their buildings. Otherwise, these end users are potential market participants, as they may decide at any time to renovate, remodel, or add on to their building or to retrofit their building systems. End users in the process of constructing buildings are current market participants.

This study surveyed three end-user populations:

- C&I establishments with permits issued in 1998 or 1999 to construct new facilities in Vermont,
- C&I establishments with permits issued in 1998 or 1999 to renovate, remodel, or add on to existing facilities in Vermont, and

- C&I establishments with facilities in Vermont that did not have construction permits in the years 1998 or 1999.

Market Actors

Market actors comprise all of those people who provide goods and services to the C&I construction market. They include designers (architects and engineers), construction contractors (general contractors, mechanical contractors, and electrical contractors), and product suppliers (retail and wholesale suppliers of mechanical equipment, electrical equipment, windows, motors, and drives).

This study surveyed nine market actor populations, within three groups:

- Designers
  - Architects
  - Engineers (mechanical and electrical)
- Contractors
  - General contractors
  - Electrical contractors
  - HVAC and mechanical contractors
- Suppliers
  - Lighting and electrical suppliers
  - HVAC and mechanical suppliers
  - Window suppliers
  - Motor/ variable speed drive (VSD) suppliers

All market actors surveyed conduct a minimum of 10% of their total business in Vermont.[19]

Real Estate Professionals

Real estate professionals—including property developers, brokers, and mangers—participate in the market as both end users and as suppliers. Real estate professionals are end users because they demand goods and services from market actors. They demand these goods and services on behalf of the building tenants and owners (which may be themselves). Real estate professionals also supply goods and services to their tenants.

The study surveyed two real estate professional populations:

- Property developers
- Property managers

Property development firms often manage the properties they develop—properties that they own or that they develop and manage for a third party. Both property development and management firms conduct brokerage activities.

[19] A 10% threshold was used in order to ensure some market actors located out of state could qualify for the survey.

3. STUDY APPROACH

OBJECTIVES OF THE STUDY

In preparing a description of evaluation activities to be conducted, the DPS identified as a key problem the need to balance the competing issues of the evaluation:

> "The Department will seek to balance its concern for defining markets broadly (thus attempting to take account of many market factors), with the reality of its limited evaluation budget. Achieving this balance will require the DPS to prioritize market characterization activities and, in some cases, limit the scope of such activities. The DPS will seek input from EVT and the Contract Administrator in establishing the priorities and scope of these activities."[20]

The struggle to balance these interests has proved to be among the most complex aspects of the evaluation.

The first evaluation activities focused on the development of a work plan. The work plan had two primary goals: (1) to collect information on market characterization and structure for use by EVT and the DPS in program planning; and (2) to collect data for assessing market progress. Specific objectives included:

- **Objective 1:** Improve understanding of the markets in Vermont and of current levels of awareness and utilization of energy-efficient products and services;
- **Objective 2:** Assess EVT's ongoing implementation activities within the context of these markets;
- **Objective 3:** Assure that best approaches are being utilized by EVT to maximize savings and overcome barriers;

[20] Memo from Scudder Parker to Vermont Public Service Board Evaluation RE: Effort: Report, and Plans for Energy Efficiency Utility Evaluation Projects. December 29, 2000.

- **Objective 4:** Identify modifications to the existing program to improve effectiveness within key markets; and
- **Objective 5:** Help develop the "story": the chain of linkages between barriers, interventions, outcomes, and outputs to document progress and identify opportunities for continued improvements in the interventions for maximum movement towards the EEU goals.

The GDS team's initial research focus was designed to provide a broad basic understanding of the C&I building and construction markets in Vermont. This market understanding includes some specific measurements from key market actors that can be used as baselines to track market progress within new construction, renovation, and retrofit activities. At the same time, the broad scope of this market characterization, structure, and assessment project and the limited number of market actors in Vermont led the evaluation team to believe this look at the market could also provide useful information for future EVT program development and refinements across several program areas. By seeking to address both goals, the resulting evaluation is truly more of a qualitative look at the Vermont markets than a quantitative measurement tool.

To meet these goals and objective, the GDS team developed a set of researchable questions following interviews with EVT staff, BED and other electric utility staff, and some key market actors in Vermont. In addition, an initial set of researchable questions was sought from EVT directly, to ensure questions EVT had regarding the direction, content and quality of their programs were covered. The initial list provided by EVT was extensive.

The number and scope of questions identified by EVT reinforced the need for conducting a market characterization to guide ongoing program and evaluation activities. Using the initial EVT list, results from staff and key market actor interviews and careful review of the evaluation objectives, the GDS team developed a final set of researchable questions. These researchable questions, provided in Appendix B, formed the framework for the data collection instruments for the analysis of baseline market conditions, structure and

indicators reported on here. Copies of all telephone survey instruments are included as Appendix C to this report.[21]

SAMPLING

The GDS team developed draft and final sampling plans and survey instruments for the telephone interviews with seven market actor populations, three end-user populations, and two real estate professional populations. In addition, the team developed sampling plans for the end-user on-site visits. The DPS and EVT approved all the plans, which are presented in Appendix D.

The samples of designers, contractors, suppliers, and real estate professionals were drawn from lists compiled from two sources. Lists of professionals doing business in the state were purchased from a national vendor of commercial establishment data. These lists were augmented with names provided by the DPS and EVT of professionals with whom they had been in contact. The samples of firms with permitted construction projects were drawn from permit data held by the Department of Labor and Industry. The samples of C&I firms in the state were purchased by the vendor of commercial data used for list of professionals.

Interviews with market actors across Vermont began in November 2001 and continued into late spring 2002. C&I end-user surveys, real estate developer interviews and site visits were performed throughout the summer and fall of 2002. In total, telephone interviews were completed with 140 market actors, 596 end users, and 16 real estate professionals. Site visits were conducted with 76 C&I firms. The sample design for these interviews is shown in Table 3.1. The population size of each group was estimated from the disposition results for each survey.

[21] Development of these survey instruments was a collaborative effort, starting with a draft instrument prepared by the GDS team, an extensive comment period where DPS and EVT parties provided feedback and suggestions, and a revised and ultimately final version of each instrument.

Table 3.1

SAMPLING PLAN 2001-2002 BASELINE DATA COLLECTION ACTIVITIES

C&I MARKET PARTICIPANT GROUPS	ESTIMATED POPULATION*	SAMPLE PLANNED	COMPLETED INTERVIEWS	APPROACH
GROUPS SUPPLYING TO THE MARKET: DESIGNERS				
Architects	126	30	30	Phone
Mechanical & Electrical Engineers	67	15	16	Phone
				Continued
GROUPS SUPPLYING TO THE MARKET: CONTRACTORS				
General Contractors	205	30	31	Phone
Electrical Contractors	152	25	23	Phone
HVAC/ Mechanical Contractors	149	25	19	Phone
GROUPS SUPPLYING TO THE MARKET: EQUIPMENT SUPPLIERS				
Lighting/ Electrical Suppliers	39	10	7	Phone
HVAC/ Mechanical Suppliers	48	5	4	Phone
Windows Suppliers	154	5	5	Phone
Motor Suppliers	41	5	5	Phone
GROUPS PURCHASING FROM AND SUPPLYING TO THE MARKET				
Property Developers	108	5	11	Phone
Property Managers	55	10	16**	Phone
GROUPS PURCHASING FROM THE MARKET				
C&I Construction Permit Holders	**839**	**200**	**200**	
• Permits for New Buildings	471	100	92	Phone
	—	36	36	On site
• Permits for Renovations	368	100	108	Phone

C&I MARKET PARTICIPANT GROUPS	ESTIMATED POPULATION*	SAMPLE PLANNED	COMPLETED INTERVIEWS	APPROACH
	—	29	29	On site
General C&I Firms	**20,000**	**230**	**396**	
• Retrofit/Replacement (Purchased Equipment In Past 2 Years)	8,000	—	158	Phone
	—	15	11	On site
• Non-Retrofit/Replacement (No Equipment Purchased in Past 2 Years)	12,000	—	238	Phone

* *Populations for all groups supplying to the market were estimated from the survey call lists and the disposition results for each survey. The population of C&I construction permit holders is known. The population of total (or "general") C&I firms was estimated from the 1997 Economic Census, U.S. Census Bureau (19,717 establishments with payrolls). The division of those firms into retrofit and nonretrofit is based on survey results.*

** *Sample of real estate professionals totals 16, of which 11 both develop and manage properties and 5 manage, but do not develop, properties.*

We note the sample sizes for all groups except architects, general contractors, and C&I firms are too small to draw statistical inference (see Table 3.2). There are two interrelated reasons the sample sizes are so small. The first is that the populations for Vermont market actors, shown in the population estimate column of Table 3.1, are so small that the population was often nearly exhausted in obtaining even the small samples we targeted (as shown by the percent of population contacted in Table 3.2). For seven of the nine groups supplying to the market, the GDS team contacted between 67% and 90% of the population to achieve the completed interviews. The second reason, related to the first, is that achieving statistically valid sample sizes would have required three to four times the resources that were available for this project. Thus, the DPS and EVT agreed information at a more qualitative level provided sufficient value to meeting the project objectives.

Table 3.2

ASSESSMENT OF SAMPLE QUALITY

C&I MARKET PARTICIPANT GROUPS	PERCENT OF POPULATION		ASSESSMENT OF DATA QUALITY
	CONTACTED	INTERVIEWED	
GROUPS SUPPLYING TO THE MARKET: DESIGNERS			
Architects	67%	24%	Representative of populations; data support qualitative description of groups
Mechanical & Electrical Engineers	88%	22%	
GROUPS SUPPLYING TO THE MARKET: CONTRACTORS			
General Contractors	70%	15%	Representative of populations; data support qualitative description of groups
Electrical Contractors	56%	15%	
HVAC/ Mechanical Contractors	64%	13%	
GROUPS SUPPLYING TO THE MARKET: EQUIPMENT MANUFACTURERS			
Lighting/ Electrical Suppliers	85%	18%	High refusal rates; non-response bias is probable; small sample sizes; data unlikely to represent populations; data support broad description of groups and recommendations for future research
HVAC/ Mechanical Suppliers	42%	8%	
Windows Suppliers	66%	3%	
Motor Suppliers	89%	12%	

Continued

C&I MARKET PARTICIPANT GROUPS	PERCENT OF POPULATION		ASSESSMENT OF DATA QUALITY
	CONTACTED	INTERVIEWED	
GROUPS PURCHASING FROM AND SUPPLYING TO THE MARKET			
Property Developers	100%	10%	Data support broad description of groups and recommendations for future research
Property Managers	56%	9%	
GROUPS PURCHASING FROM THE MARKET			
C&I Construction Permit Holders	**100%**	**24%**	**Phone:** Representative of populations; data support description of group at 95/5 confidence/ precision; comparisons of subgroups within population can be made **On-Site:** Data support qualitative description of buildings
• Permits for New Buildings			
Phone	100%	20%	
On-Site	NA	8%	
• Permits for Renovations			
Phone	100%	29%	
On-Site	NA	8%	
General C&I Firms			
Phone	19%	2%	
On-Site	NA	0.5%	

Sampling of C&I Firms with Construction Projects

As discussed in Chapter 2, permit data were drawn from Vermont's Department of Labor and Industry. Based on an assessment of the time it typically takes to move a nonresidential project from permitting to completion, we examined 1998 and 1999 permit data. We explored DPS records kept for Act 250 and determined they were not as complete as the permit data for two reasons. One, Act 250 applies to construction projects meeting certain criteria, not every construction project. According to our internal communication with staff at the DPS, the DPS estimates that about two-thirds of projects and about three-quarters of constructed floor space have an Act 250 review. Two, the information in the permit database relevant to our sampling needs were more complete than that in the Act 250 database.

We have no way of confirming, within the scope of this study, that construction projects required by law to obtain permits do, in fact, obtain such permits. However, we can approach the issue from the available data.

Looking at the general C&I sample, we can take the percentage of equipment installations completed by C&I firms in the two years prior to the interviews (mid-2000 to mid-2002). We can assume any firm installing heating, lighting, and windows had completed a construction project. The percent of firms installing the three systems was 4.7%. The C&I population is about 20,000 firms. From these figures, we estimate the total number of construction projects occurring during the two-year period is 940 establishments, plus or minus 5%. This number is comparable to the 839 construction permits issued for the two-year period 1998-1999.

This analysis suggests the permit data are, in fact, a very close indicator of the actual number of projects being completed in Vermont.

Sampling by Respondent Size

In any population of organizations of varying sizes there will always be more small firms than large ones. With the size of samples used in this study to investigate market actors, a purely random sample would likely generate too few large firms to support any investigation of respondents by size. To support an investigation by size of market actor respondent, we conducted a stratified random sample. As shown in Table 3.3, we oversampled larger market actor firms, while still obtaining an approximately random sample.

Table 3.3

OVERSAMPLING OF MARKET ACTOR FIRMS WITH FIVE OR MORE EMPLOYEES (LARGE FIRMS)

MARKET ACTOR FIRMS	POPULATION	SAMPLE
Architects (n=30)	20%	50%
Engineers (n=16)	54%	31%
General Contractors (n=31)	30%	68%

Electrical Contractors (n=23)	25%	52%
Mechanical Contractors (n=19)	35%	56%

The number of truly large market actor firms in Vermont is small. For example, there are seven architectural firms in the state with ten or more employees (as reported by a purchased list of the state's architectural firms). We interviewed five of these seven firms.

To accurately characterize the largest designer and contractor firms in Vermont, those with more than ten or twenty employees, we would have needed to interview nearly every one of these firms because the total number is so small. Such a sampling approach is termed a stratified sample with a census or near census of one or more strata. The drawback to this approach for the sample sizes used in this study is that most of the data collection resources would go to the largest firms; the majority of the firms (the smaller ones) would receive very little effort.

The sampling and research methodology used in this investigation is termed "goal free" or "theory neutral" evaluation. The DPS and EVT sought to learn about, or characterize, the C&I market without imposing *a priori* theories about how the market functions. The evaluation was designed to learn about all of the market participants, their relationships, and behaviors. This perspective is consistent with the mandate of EVT to serve all of Vermont's utility customers. The evaluation was not designed to find the opportunities for the largest energy savings in the fewest number of firms. The rationale for the study drove the decision to oversample larger market actor firms yet not conduct a census of them.

When analyzing differences between subgroups in relatively small samples (such as the samples of 15 to 30 respondents for the designer and contractor groups), one cannot draw sound conclusions for subgroups much smaller than 7 to 10 respondents. When a variable has more than two response categories (such as "low", "medium", "high"), even 10 respondents in a subgroup may be too few to support a comparison between groups.

Because of the size limits on subsamples that can be compared for differences, in this study we define small market actor firms as those having four or fewer employees and large market actor firms as those having five or more employees. Perhaps it would be more accurate to describe these latter firms as medium-size and large market actors. The cut-off of five employees divides the market actor samples into roughly equal portions, enabling us to analyze the difference between small and large (medium/large) market actor firms.

Due to the characteristics of Vermont's population and our "theory neutral" research plan, we cannot provide a characterization of truly large market actor firms—such as those firms with more than 10 or 20 employees.[22]

For end users—general C&I firms—large firms are those occupying 25,000 square feet or more.

ANALYSIS

The small sample sizes support qualitative results, which has important ramifications for this analysis. In no case other than C&I firms is it possible to apply statistical analysis methods beyond that of counts and frequencies.[23] The results do not describe the market actors with levels of accuracy such as would result from a statistically representative sample. Rather the results are indicators of how each market actor group is behaving and how the building and construction market as a whole is behaving relative to energy efficiency.

At an aggregate level, each market actor group can be compared, and we do so throughout the report. However, within each market actor group, comparisons between large and small firms, between firms that do remodeling or new construction, and along other dimensions are only suggestive and not definitive.

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22 See the next section "Analysis", and the subsection "Analysis by Size of Firm" for a discussion of the analyses done by size of firm.

23 Even for end users, statistical validity is only possible at the aggregate level for the populations of new construction, renovations and additions, retrofit equipment purchase, no construction or retrofit equipment , not at the sub-group level (e.g., building type).

In this report, counts and percentages have been provided for all responses and cross tabulations of answers by different subgroups. With the exception of the architect, general contractor, and end-user results, the percentages are suggestive of the population, but not descriptive. The percentages are for the purpose of enabling the reader to more readily interpret the counts of responses obtained across the different subgroups. Means (averages) or other measures of central tendency have not been used when these would imply a level of precision that is lacking. In addition, our data were usually ordinal or nominal, not continuous—the only condition for which it is appropriate to use such measures of central tendency.[24]

The text primarily reports findings for each market participant group as a whole. However, many analyses were conducted to determine whether subgroups within a group behaved differently. Where applicable, we note findings from any subgroups that account for findings observed for the group as a whole. The variables used to define subgroups are potential explanatory variables: if the resulting subgroups differ, one has support for the hypothesis that the variable used to create the subgroups (e.g., size of respondent) partially explains the respondents' behavior. If the resulting subgroups do not differ, than the variable used to create the subgroups is not explanatory.

Table 3.4 shows the potential explanatory variables used in the analysis.

[24] By ordinal, we mean scales such as 1 to 5, or 1 to 10. By nominal we mean categories such as yes, no, or options a, b, c. By continuous we refer to interval or ratio data such as commonly found in income, age, revenue, or other such data with integers and fractions that are consistent throughout the scale.

Table 3.4

POTENTIAL EXPLANATORY VARIABLES EXPLORED IN THE ANALYSES

POTENTIAL EXPLANATORY VARIABLES EXPLORED IN THE ANALYSES	NUMBER OF STAFF	NUMBER OF PROJECTS	TOTAL SQUARE FOOTAGE OF PROJECTS	LOCATION	PERCENT OF PROJECTS IN PUBLIC SECTOR	OTHER (KEY TO SYMBOLS IN TABLE NOTES)
Architects (n=30)	Yes	Yes	Yes	Yes	Yes	A, B
Engineers (n=16)	Yes	Yes	Yes	Yes	Yes	C, D
General Contractors (n=31)	Yes	Yes	Yes	Yes	Yes	E, F
Electrical Contractors (n=23)	Yes	No	No	Yes	No	E
Mechanical Contractors (n=19)	Yes	Yes	No	Yes	No	E
C&I Firms with Construction Permits (n=200)	No	NA	Yes	Yes	No	C, G
General C&I Firms (n=396)	No	NA	NA	Yes	No	G, H

Key to Symbols Denoting Other Analysis:

A. Owner to occupy project versus owner to sell or lease (speculative construction).

B. Sales volume.

C. New construction versus renovation/remodeling/addition project.

D. Client expressed concern for energy efficiency.

E. Percent of work design/build.

F. Large firms serving only C&I customers versus all other firms (one small firm serving only C&I customers and all firms that serve both residential and C&I clients).

G. Square footage of establishment.

H. Purchased building systems equipment in the past two years versus no purchases.

Only two of these variables—number of staff and location—were found to be explanatory. Throughout the discussion of findings, any differences found by number of staff (referred to as size of firm throughout the report) and location are explicitly called out. When size or location are not mentioned, the reader should understand the results do not vary by this factor. Nor do the results vary for any of the other factors shown in the table.

Throughout the discussion of findings, any differences found by number of staff (referred to as size of firm throughout the report) and location are explicitly called out. When size or location are not mentioned, the reader should understand the results do not vary by this factor. Nor do the results vary for any of the other factors shown in the table, unless explicitly mentioned in the text.

Analysis by Size of Firm

Throughout the report, as summarized in the next chapter (Chapter 4), we discuss any findings that differ by size of firm. "Large" market actor firms have five or more employees. Large C&I firms (end users) occupy 25,000 square feet or more.

The analysis of market actors is sufficient to identify differences due to size of respondent for behaviors or characteristics assumed to vary somewhat "smoothly" or gradually or continuously with size. That is, if small firms take an action rarely, medium firms take it some of the time, and truly large firms take the action a lot, then the analysis by size using the cut-off of five employees will be sufficient to identify when size of firm is related to outcome.

However, suppose the underlying behavior is that small and medium-size firms have the same characteristics, which truly large firms differ from. In this case, the analysis will only show such a size effect when the responses of the truly large firms stand in stark contrast to the responses of the other firms.

In summary, the delineation of "large" market actor firms in this study includes medium and large firms—those with five or more employees. The analysis by size conducted in this study is sufficient to identify characteristics that change somewhat gradually by size of respondent. It is also able to identify size effects for characteristics that change abruptly between very large firms and all other firms when the characteristics of the two groups differ substantially. The analysis is unable to identify size effects for characteristics that differ between very large firms and all other market actor firms when the difference between the two groups is moderate or small.

We explored alternative definitions of market actor size. Other break points, using larger firm sizes, were rejected for two reasons. One, the conclusions rarely differed from what was learned at the breakpoint of five employees. Two,

only the breakpoint of five employees enabled us to be consistent across market actor groups and across analyses within market actors (i.e., for the analysis of non-binary responses). Without consistency it is difficult to put the findings into context and determine whether they described patterns or anomalies. We judged the detrimental effects of inconsistency to outweigh the benefits of additional precision in a few analyses.

Analysis of Market Actors that Do Only C&I Work

Further discussion of one of the analysis variables in Table 3.4—firms serving only C&I customers, described in table note F—is warranted due to the hypothesis put forth by members of the evaluation team. According to the hypothesis, firms that serve only C&I customers necessarily specialize in C&I practices and equipment. They likely would serve the sophisticated projects and thus might constitute a unique market niche.

Less than 10% of most market actor groups serve exclusively the commercial and industrial market. The proportion and characteristics of firms in each group that exclusively serve the C&I market follows.

- **Architects:** Four of the thirty architects surveyed reported they serve commercial and industrial clients exclusively. Three of the four are headquartered outside of Vermont and each conducted only one project in Vermont in the last year and so have a small influence on Vermont construction practices. Only one of the twenty-five Vermont-based firms (or 4%) exclusively serves the commercial and industrial market. This firm is small and located in a rural area of Vermont. The difference between this firm and others was not subject to further analysis.

- **Engineers:** One of the sixteen engineering firms works exclusively for commercial and industrial clients. This firm is small and located in Chittenden County. The difference between this firm and others was not subject to further analysis.

- **General Contractors:** Nine of the thirty-one general contractors work exclusively for commercial and industrial clients. Of these nine, eight are large. We compared the responses concerning energy efficiency practices, Act 250, and EVT given by these eight large C&I-focused

firms to the responses of all other general contractors (those serving a mix of residential, commercial and industrial clients) and found no systematic differences between the two groups.

- **Mechanical Contractors:** None of the mechanical contractors reported they serve commercial and industrial clients exclusively.
- **Electrical Contractors:** Two of the twenty-three electrical contractors serve commercial and industrial clients exclusively. One of these contractors is small and located in rural Vermont, the other contractor is large and located in Chittenden County. The difference between these firms and others was not subject to further analysis.

When designing survey instruments and conducting interviews, the GDS team included the same set of questions, as closely as possible, across the different market participant groups. The 140 market actors and 596 end users we spoke with represent a substantial number of participants in the building and construction market for Vermont. By comparing and contrasting their responses to the questions we are able to draw conclusions about how the commercial/industrial building market is functioning, its structure and characteristics, the awareness of energy efficiency and the prevalence of energy efficiency behaviors. These conclusions are presented in the next chapter.

Analysis of Act 250

Act 250 is Vermont's land-use planning and development law. The survey instruments for each group included a few questions on the energy efficiency requirements of Act 250. Questions addressed the number of times the respondent had projects subject to an Act 250 review and asked the respondent to assess the effect of the act's energy efficiency requirements on construction in the state.

These few questions enable us to conduct a very limited assessment of the act's effectiveness in promoting energy efficiency.

Two factors led to the decision not to pursue this topic more thoroughly. One factor is resource constraints; the study's primary objectives lay elsewhere and were addressed by the bulk of the evaluation effort. As a second and equally

important factor, it is not in the interest of EVT to have a survey create an impression among respondents that EVT and Act 250 are somehow linked. Act 250 is a law. EVT is a service to voluntary recipients. EVT wants to partner with market participants to meet the requirements of Act 250. It does not want market participants to perceive EVT as a police officer or judge. It is not in the interest of EVT, the DPS, or the evaluation itself to imply a strong link between Act 250 and EVT.

4. MAJOR FINDINGS ACROSS MARKET PARTICIPANTS

Most commercial and industrial program evaluations do not have sufficient resources to conduct comprehensive market characterization studies. Generally, the population is so large that it is impossible to allocate sufficient resources to capture information about all market participants. The Vermont Department of Public Service, recognizing that although their resources were limited, so was their market, requested an evaluation that would include a characterization of the Vermont commercial and industrial market as part of the evaluation of the Efficiency Vermont C&I sector programs.

The resulting evaluation, described in this report, is quite possibly the most comprehensive market assessment of any C&I building construction and equipment market to date. We interviewed:

- 24% of the state's construction designers (architects and engineers);
- 14% of the contractors (general, mechanical, and electrical);
- 7% of the equipment suppliers (electrical, mechanical, windows, and motors);
- 10% of the real estate professionals;
- 2% of the C&I firms; and
- 24% of the C&I firms with construction projects that were issued permits during a two-year period.

Few if any other studies of this magnitude have been conducted.

The subsequent three chapters in this report provide an in-depth discussion of each of the three types of market participants—market actors (the building and equipment professionals), real estate professionals, and end users (C&I firms).

4. Major Findings Across Market Participants

In this chapter, we compare the research findings across all the market participants.[25] The findings reveal the process by which decisions are made to use energy efficiency solutions from the perspective of all market actors.

This chapter provides a comparison and synthesis of the responses of designers (architects and engineers), contractors (general, electrical, and mechanical), C&I firms (end users with and without construction permits),[26] and real estate professionals (developers—who develop and manage properties—and firms that only manage properties). The findings on suppliers are not discussed in this section because, owing to high refusal rates among survey contacts, the quality of the supplier samples is considerably poorer than the quality of the other samples.

The chapter uses graphs to comparatively illustrate the responses of the different groups with respect to each area of inquiry. The graphs enable a direct comparison across the market participants for a given topic, and across related topics for the market participants as a whole. The text accompanying each graph draws conclusions from the comparisons.

The chapter also explores whether large and small market participants behave differently in any area of inquiry. For market actors, large firms are defined as those having five or more employees.[27] For end users (C&I firms), large firms are those occupying 25,000 square feet or more of space. An exploration by size is shown for each area of inquiry because findings of differences in behaviors and attitudes between large and small market participants might warrant different program approaches tailored to each size group, depending

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25 We omit from this comparison the findings from the supplier interviews because the sample sizes for the supplier groups are very small (seven observations for two groups, five observations for one group, and four observations for one group). This chapter compares results among respondent groups ranging in size from sixteen to 396. For the samples of sixteen, a single respondent accounts for 6% of the observations. To include samples of seven respondents, a single respondent accounts for 14% of the observations. Thus, it does not make sense to compare percentages generated from the larger samples with those generated from samples of five observations.

26 C&I firms without construction permits constitute a general C&I sample.

27 In other states, five employees would not demarcate large firms. However, in Vermont, this definition of large results in market actor samples that are roughly 50% large firms and 50% small. Were we to use a more stringent definition of large, there would be too few cases within the relatively small samples to support an analysis by size.

on the direct relevance of the behavior or attitude to the various program components.[28]

CHARACTERISTICS OF MARKET PARTICIPANTS

Size

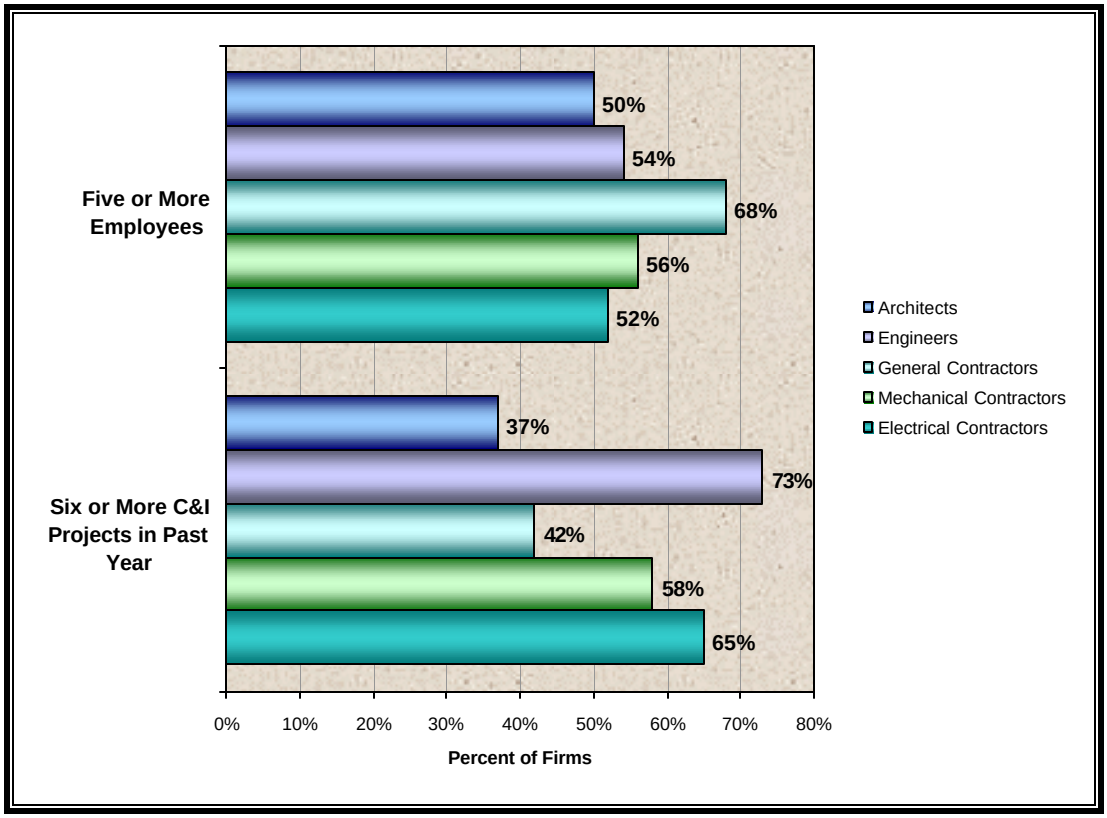
Figures 4.1 through 4.3 illustrate the proportion of respondents in each market participant sample that is, in some sense, "large." Figure 4.1 demonstrates over half of the market actor groups surveyed have five or more employees.[29]

[28] See Chapter 3 for a discussion of the various definitions of size (e.g., based on number of employees, number of projects, total square footage of all projects) explored in the analysis of each market participant data set. The discussion also identifies a number of other factors (e.g., percent of projects for the public sector, firms exclusively serving C&I clients, sales volume) also explored in the analysis of each data set.

[29] Note that in the general population, market actor firms of five or more employees comprise about 30% of the population. (Chapter 3 shows the proportions of the populations and samples that are large—five or more employees). The reader should bear in mind that the distributions of the characteristics plotted in Figures 4.1 and 4.2—measures of size—describe the market actor samples and overstate the degree to which these characteristics are present in the general populations. Chapter 3 describes the intentional oversampling of large market actors that occurred.

Figure 4.1

CHARACTERISTICS: LARGE MARKET ACTOR FIRMS

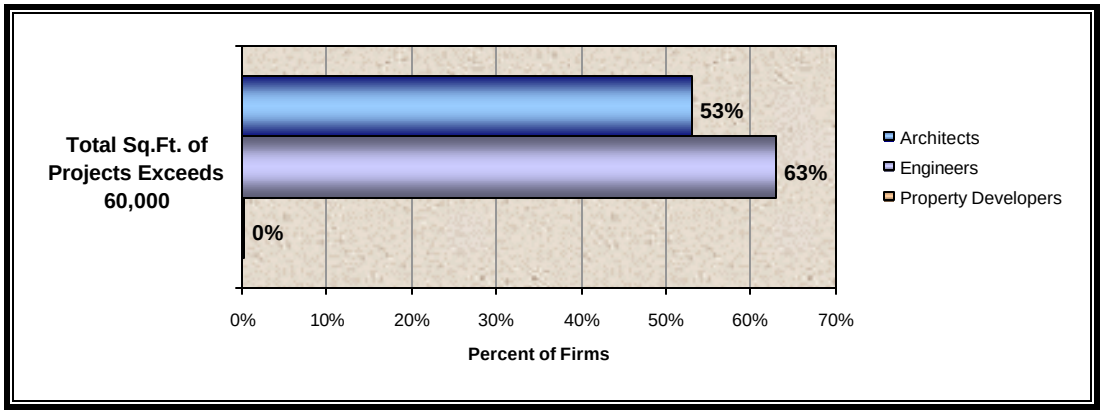


It also shows three-quarters of the surveyed engineering firms conducted six or more C&I projects in Vermont in the past year, compared with just over one-third of the architectural firms. The proportions among the contractor groups varied between 42% and 65%.

Figures 4.2 and 4.3 illustrate the size of firms as demonstrated by square footage. Between about 55% and 65% of designers (architects and engineers) worked during the previous year on projects totaling more than 60,000 square feet (see Figure 4.2). No developers were responsible for projects of 60,000 square feet or more.

Figure 4.2

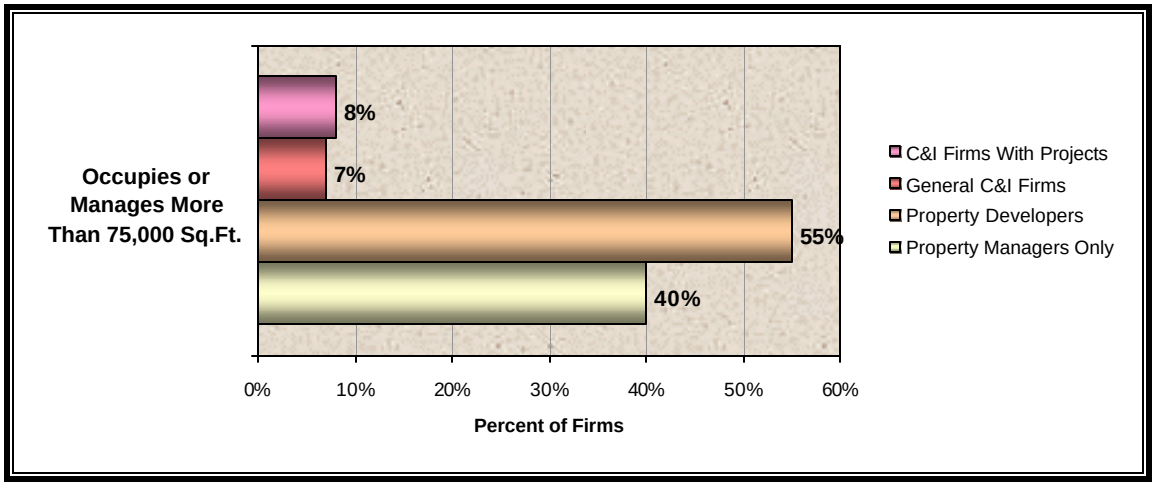
CHARACTERISTICS: LARGE PROJECTS OF DESIGNERS AND DEVELOPERS



As Figure 4.3 shows, a larger proportion of developers than property managers manage more than 75,000 square feet in total. About equal proportions of C&I firms with construction projects and general C&I firms occupy properties exceeding 75,000 square feet.

Figure 4.3

CHARACTERISTICS: LARGE PROPERTIES OF END USERS AND REAL ESTATE PROFESSIONALS



Location

Figure 4.4 shows nearly 25% of architects, 17% of engineers, and 10% of electrical contractors doing business in Vermont are headquartered outside the state. No general or mechanical contractors surveyed were located out of state.

Figure 4.4

CHARACTERISTICS: FIRMS HEADQUARTERED OUTSIDE VERMONT

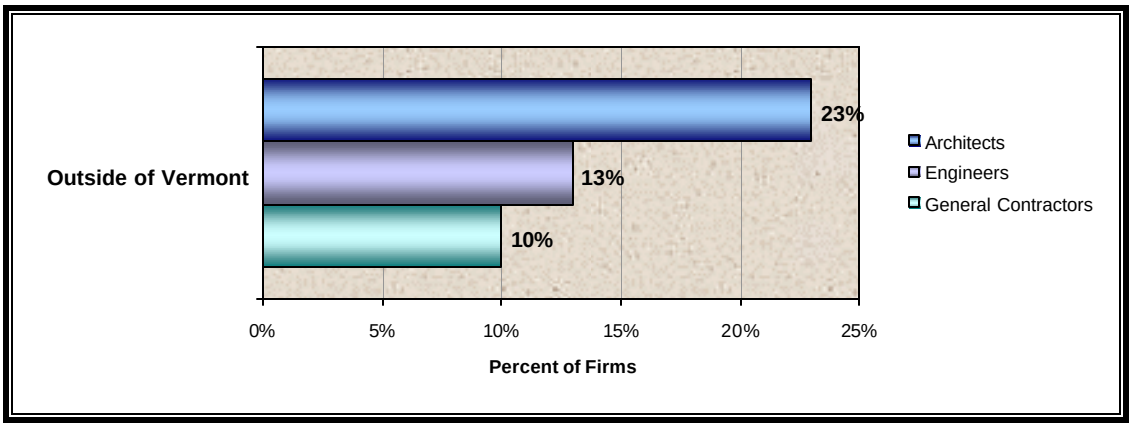
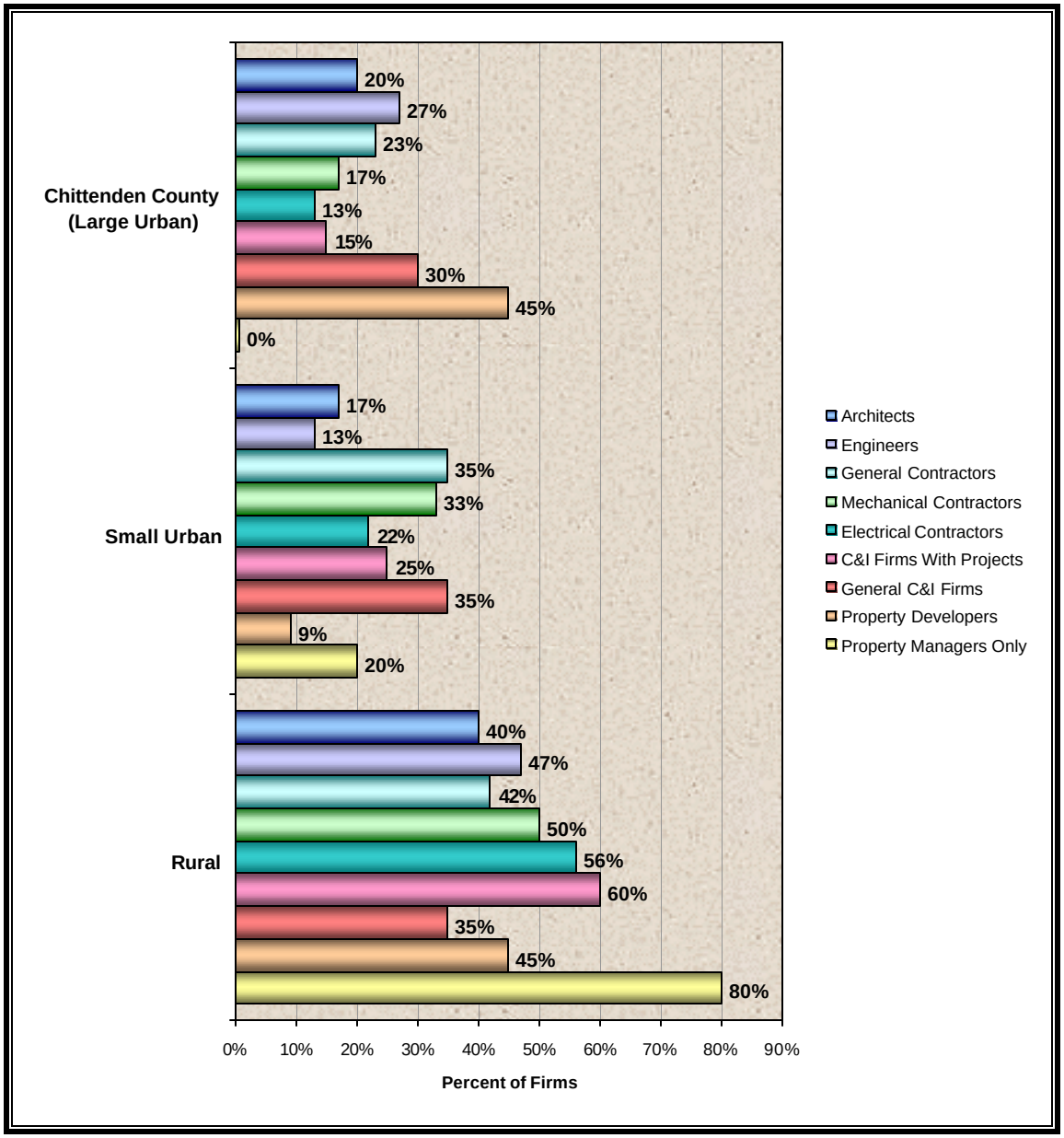


Figure 4.5 shows the distribution of the Vermont-based firms. For all market participants, the proportion located in the rural areas of the state is equal to or exceeds the proportions in either large or small urban areas. (This mirrors the pattern for new construction permits, shown in Table 2.5.)

Figure 4.5

CHARACTERISTICS: FIRMS LOCATED WITHIN VERMONT



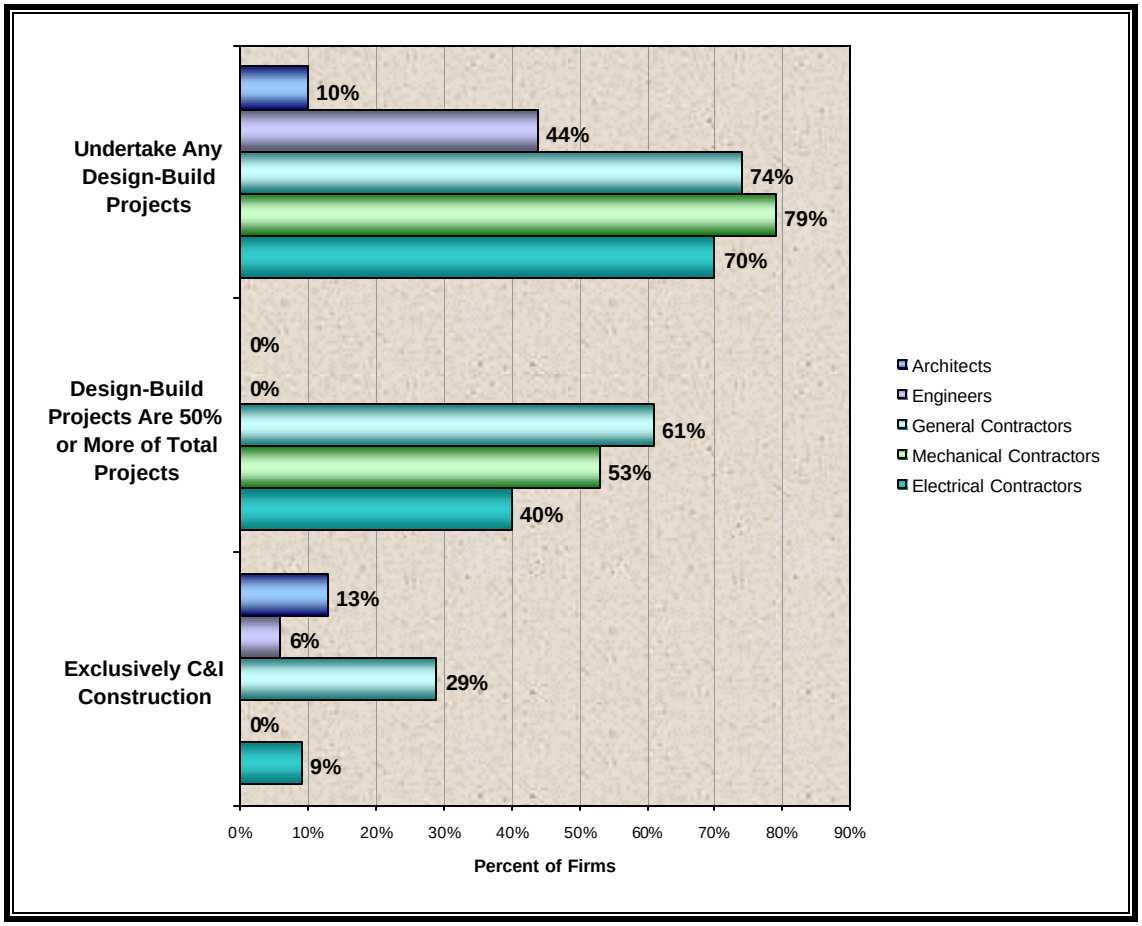
For most of the market groups, their next most frequent location is in small urban areas. Only architects, engineers, and developers are more likely to be located in the large urban area of Chittenden County than in the small urban areas.

Project Type

Architects are unlikely to be involved in design-build projects, while close to half of the engineers and three-quarters of the contractors are quite likely to do some design-build work (see Figure 4.6). Design-build projects comprise less than half the work of all designers. More than half of the general and mechanical contractors, on the other hand, had work dominated by design-build projects, as did 40% of electrical contractors.

Figure 4.6

CHARACTERISTICS: DESIGN-BUILD AND EXCLUSIVELY C&I WORK BY MARKET ACTORS



Relatively few designers and contractors work exclusively in the C&I sector. General contractors are the exception: 29% of general contractors do only C&I construction. (For a more detailed discussion of this topic, see the end of Chapter 3.)

About half of architects (43%) and contractors (general 61%, mechanical 58%, and electrical 48%) report their projects are entirely for private sector clients. Less than one-third (31%) of engineers report exclusively private sector work.

Number of Projects

Figure 4.7 shows the proportion of designers and contractors that have done four or more new construction or four or more renovation projects in the past year. Less than half of each market actor group (with one exception) worked on four or more of each type of project; thus, more than half of each group worked on three or fewer projects of each type. Across all market actor groups, renovation projects were more common than new construction projects. This tally does not account for project size.

Figure 4.7

CHARACTERISTICS: NEW CONSTRUCTION AND MAJOR RENOVATION PROJECTS BY MARKET ACTORS

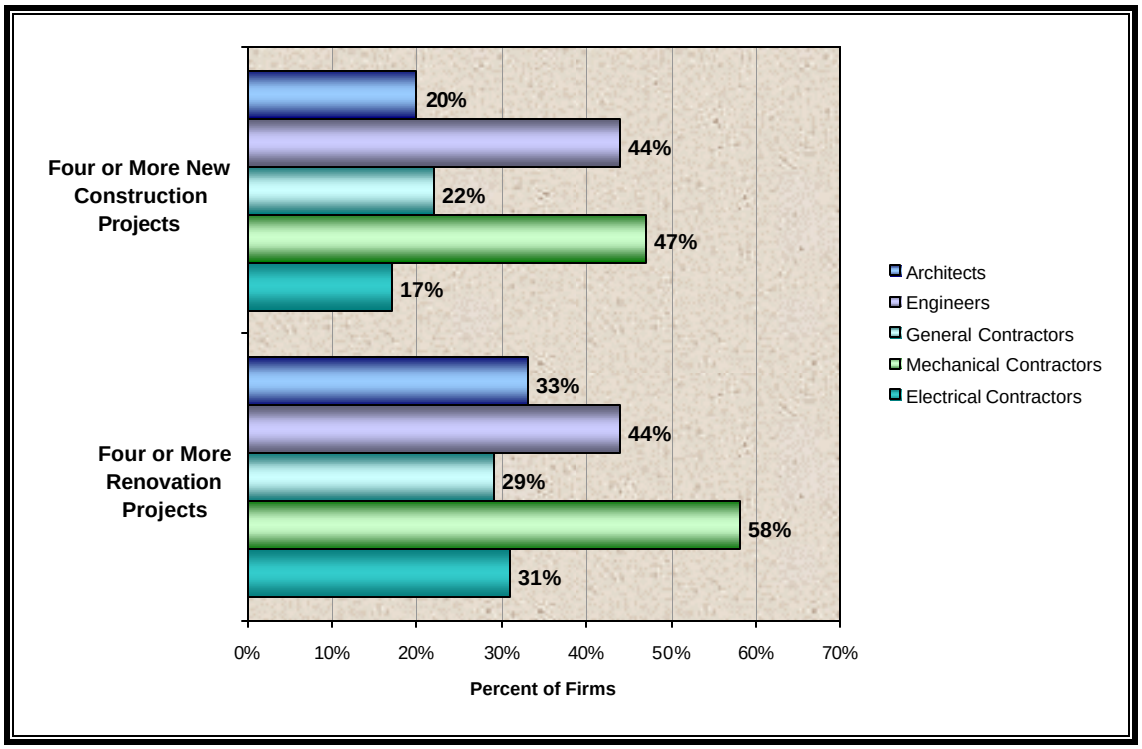
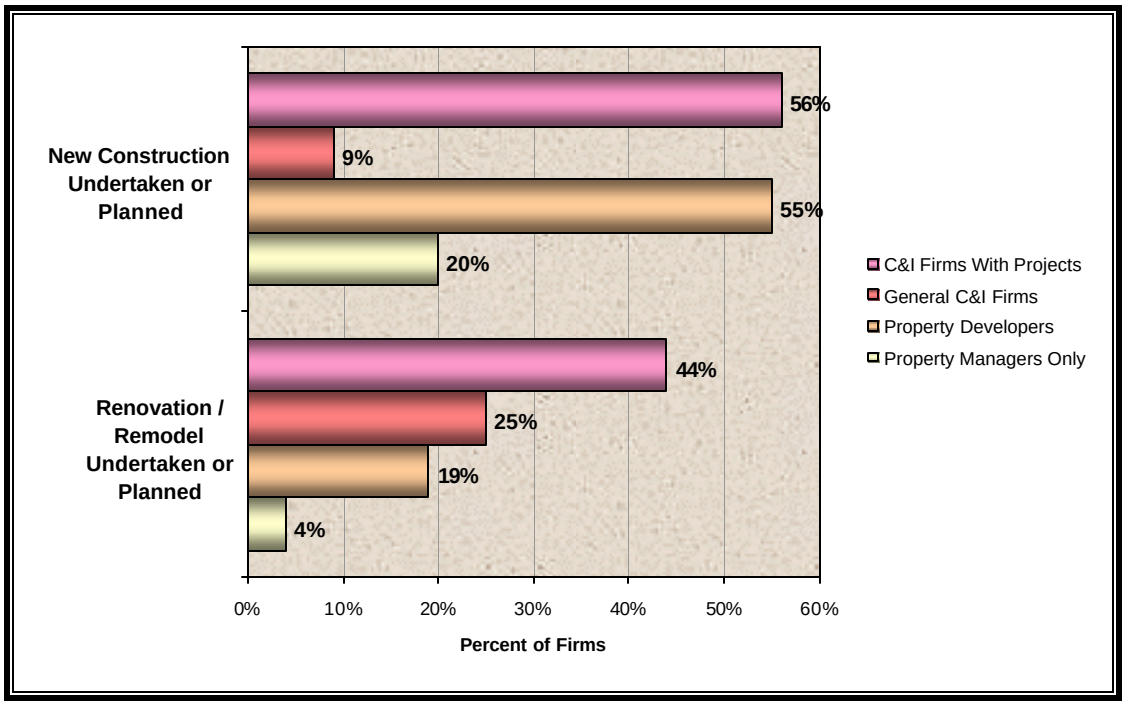


Figure 4.8 shows C&I firms with construction projects were more likely to be undertaking new construction than renovation.[30] Half of the developers were planning new construction projects, while about 20% were planning renovations. Nine percent of general C&I firms (without construction permits) and 20% of property managers that do not do development were planning to construct new buildings, and about 5% of both groups were planning renovation/remodeling projects.

[30] This percentage describes the population. In the sample, 46% of respondents had new construction projects.

Figure 4.8

CHARACTERISTICS: NEW CONSTRUCTION AND MAJOR RENOVATION UNDERTAKEN OR PLANNED BY END USERS AND REAL ESTATE PROFESSIONALS

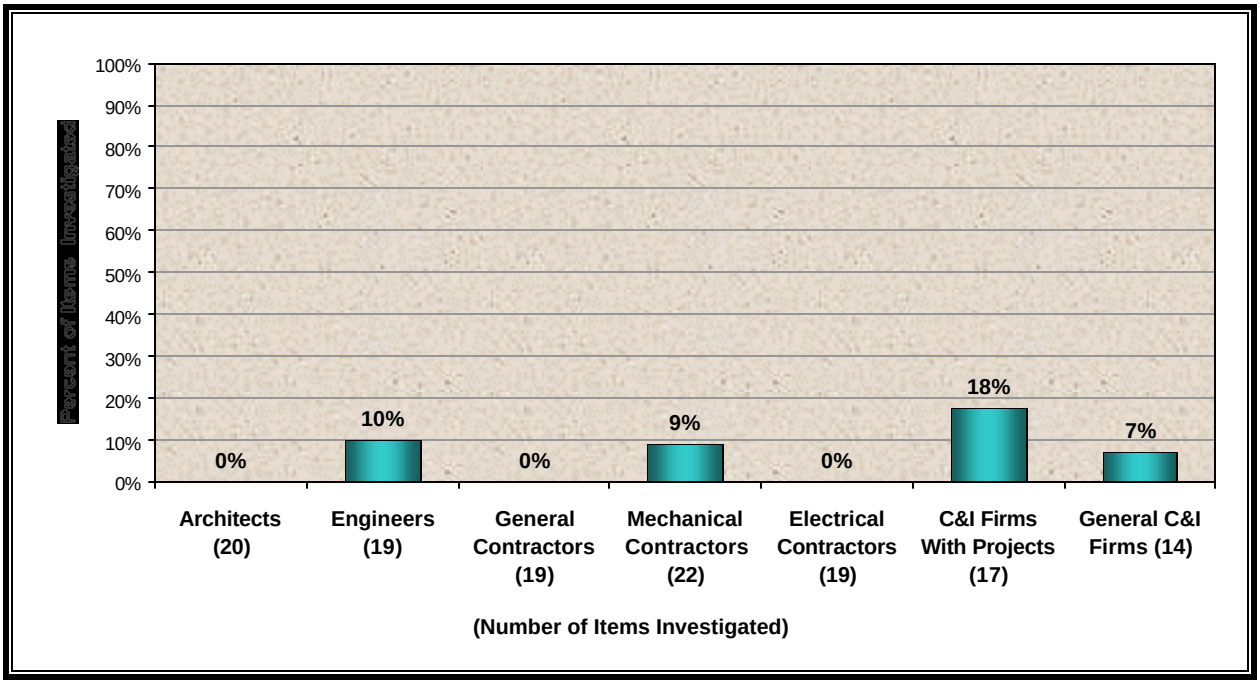


Differences in Firm Characteristics by Respondent Size

The characteristics of respondent firms, summarized in Figures 4.1 through 4.8, do not vary by size of firm. We reached this conclusion by examining whether the responses to each of the questions exploring firm characteristics vary by size of firm (as defined for market actors by number of employees and for C&I firms by square footage of facilities occupied). For each market participant, we tallied the number of questions addressing firm characteristics (excluding the question used to define size) and the number of questions whose responses vary by firm size. The ratio of these numbers gives some sense of the degree to which the firm characteristics as a whole vary by size of firm. The low proportions of characteristics varying by size (as a percent of total questions on characteristics) suggest that, in general, firm characteristics do not vary by size of firm within each market participant group (see Figure 4.9).

Figure 4.9

DIFFERENCES BY FIRM SIZE IN FIRM CHARACTERISTICS



The numbers in parentheses next to each group label in the figure report the total number of questions asked of the group about firm characteristics. The parenthetical number thus provides the denominator of the percentage shown in the graph for the group.

We conclude each subsection in this chapter with a similar analysis of how the responses to the questions explored in the subsection vary by firm size as defined for market actors by number of employees and for C&I firms by square footage. Each figure describing the findings on size depicts, for each market participant, the proportion of the questions reported on in the subsection whose responses vary by size. Each parenthetical number beneath the name of the market participant gives the fraction's denominator.

USE AND AWARENESS OF ENERGY EFFICIENCY MEASURES

Use and Awareness Among C&I Firms

Table 4.1 shows the efficiency measures installed by C&I firms in their permitted construction projects and in their equipment replacement projects. The shaded cells indicate the measures that more than 50% of C&I firms reported installing. (Note that programmable thermostats is not shaded even through 52% of respondents reported it. Preliminary results from the on-site survey suggest this value, as well as the values for low-e glass and condensing furnaces, may be about ten percentage points higher than the actual field incidence of these measures.)

Ten of the thirteen measures were used in less than 50% of the projects. These measures represent areas of key opportunity for EVT.

Table 4.1

INSTALLATION AND AWARENESS OF EFFICIENCY MEASURES AMONG C&I FIRMS (END USERS) WITH CONSTRUCTION AND EQUIPMENT PROJECTS

EFFICIENCY MEASURES	INSTALLED MEASURE IN PROJECT		AWARE OF MEASURE	
	CONSTRUCTION PROJECT	EQUIPMENT PROJECT	CONSTRUCTION PROJECT	EQUIPMENT PROJECT
Electronic Ballasts	70%	58%	84%	84%
Installed Any Electronic Controls	68%	NA	NA	NA
Low-E Glass*	62%	44%	83%	85%
Programmable Thermostat*	52%	31%	90%	92%
LED Exit Signs	49%	29%	78%	66%
Compact Fluorescent Lamps	45%	40%	82%	72%
T-8 Lights*	38%	31%	47%	35%
Lighting Controls	26%	11%	58%	45%
Economizer	25%	8%	48%	44%
Condensing Furnace*	23%	12%	52%	40%
Occupancy Sensors	19%	14%	58%	53%
Energy Management System	18%	13%	59%	58%
Variable Frequency Drive	18%	35%	NA	NA

* *Preliminary results from the onsite surveys suggest C&I firms moderately over-reported (by approximately ten percentage points) the installation of programmable thermostats, low-e glass, and condensing furnaces. The C&I firms moderately under-reported the installation of T-8 lamps*

Real estate developers who had installed heating, lighting, or windows in the past two years reported on their use of energy efficiency measures. The proportion of developers using each measure for at least one of the end use systems they installed is given in Table 4.2, along with the proportion of developers aware of each measure. Four of the twelve measures are shaded, as

more than half of the developers included these measures in the end use systems they installed. The other eight measures represent areas of key opportunity for EVT.

Table 4.2

INSTALLATION AND AWARENESS OF EFFICIENCY MEASURES AMONG REAL ESTATE DEVELOPERS (N=11)

EFFICIENCY MEASURES	INSTALLATION AMONG THOSE INSTALLING END USE	AWARENESS
Electronic Ballasts	7 (88%) (n=8)	11 (100%)
CFLs	5 (63%) (n=8)	11 (100%)
Programmable Thermostat	4 (80%) (n=5)	11 (100%)
LED Exit Signs	4 (50%) (n=8)	10 (91%)
Multi-Level Switching Controls for Lighting	3 (38%) (n=8)	8 (73%)
Energy Management System	2 (20%) (n=5)	10 (91%)
Low-E Glass	2 (40%) (n=5)	10 (91%)
Occupancy Sensors for Lights	2 (25%) (n=8)	10 (91%)
T-8 Lights	2 (25%) (n=8)	6 (55%)
Variable Frequency Drives	2 (66%) (n=3)	--
Economizer	1 (20%) (n=5)	10 (91%)

Condensing Furnace or Boiler	1 (20%) (n=5)	8 (73%)
Features to Bring Daylight In	--	6 (55%)
Distributed Generation	--	3 (27%)

In comparing the awareness rates of developers and C&I end users, both groups have high awareness of electronic ballasts, low-e glass, programmable thermostats, LED exit lights, and compact fluorescent lamps. However, developers also had high awareness of three measures that C&I firms had only mid-level awareness of: energy management systems, occupancy sensors, and economizers.

Looking across the five measures shown with the highest awareness rates, the following relationships prevail among the groups. Property developers tend to have the highest levels of awareness of all measures, followed by C&I firms with construction projects, followed by C&I firms who have purchased equipment (but are not engaged in permitted construction). These groups are followed by C&I firms who have not purchased equipment (see Chapter 7). Property managers who do not do any development work tend to have the least awareness of measures (see Chapter 8). An exception to this latter statement is LED exit signs, for which property managers have the second highest level of awareness, following that of property developers.

Practices of Market Actors

The efficiency practices that architects and engineers have engaged in during the year preceding the survey are shown in Table 4.3. The designers were asked if they had engaged in the practice at least once in the past year. In addition, for some of the practices, respondents were asked the number of projects on which they used the practice. The table shows the proportion of designers engaging in the practice for at least 50% of their projects (for measures having this data) and the proportion of designers engaging in the practice at least once.

The shaded cells indicate those practices that were used by the majority of designers (at least 50% of designers) on the majority of their projects (at least 50% of projects) or were used at least once during the past year by at least three-quarters of the designers. Eleven practices meet these criteria for architects; the remaining 26 practices provide key opportunities for EVT's work with architects. For engineers, eight practices meet these criteria; the remaining 30 practices provide key opportunities for EVT's work with engineers.

Table 4.3

EFFICIENCY PRACTICES OF ARCHITECTS AND ENGINEERS

EFFICIENCY PRACTICE	ARCHITECTS (N=30)*		ENGINEERS (N=16)**	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
Low-E Glass	93%	97%	13%	19%
Use Any Lighting Efficiency Measure	93%	93%	60%	70%
Use Any Heating Efficiency Measure	83%	88%	83%	100%
Use Any Passive Systems or Envelope Design to Reduce HVAC Loads	67%	80%	6%	31%
Design or Size HVAC System Taking Passive Systems into Consideration	60%	80%	6%	19%
Use Any Day Lighting Features	60%	77%	13%	38%
Conduct Any Pre-Design Activities to Address Energy Efficiency	63%	63%	50%	75%
Design Efficient Air Distribution System	--	71%	17%	100%
Include Variable Air Volume (VAV) System	--	NA	17%	58%
Use Any Computer Models	43%	47%	19%	56%
HVAC Exceeds ASHRAE 1999 Standards	38%	54%	--	100%
Ask HVAC Designers to Exceed	--	38%	92%	92%

4. Major Findings Across Market Participants

EFFICIENCY PRACTICE	ARCHITECTS (N=30)*		ENGINEERS (N=16)**	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
ASHRAE 90.1 1999 Standards				
Develop a Day Lighting Strategy	30%	48%	6%	19%
Lighting Exceeds ASHRAE 1999 Standards	30%	41%	NA	60%
Use Any Alternative, Efficient Water Heating Option	30%	47%	13%	56%
Use Formal Life-Cycle Cost Comparisons	30%	43%	6%	31%
				Continued
Specify Less Lighting or Automatic Dimming Due to Day Lighting Features	27%	33%	0%	13%
Site or Orientation Selected in Large Part Based on Resource Use Considerations	20%	33%	0%	31%
Use Independent Third-Party Commissioning* **	3%	3%	0%	0%
Use Economizer	--	NA	75%	83%
• Single Enthalpy Economizer			25%	58%
• Dual Enthalpy Economizer			25%	50%
• Dry Bulb Economizer			25%	25%
Ask Designers for Energy-Efficient Lighting	--	89%	--	70%
Use Lighting Controls	--	81%	--	50%
Design Building to Reduce HVAC Needs	--	79%	--	--
Use Fewer Lights than Typical/ Spot Lighting	--	78%	--	60%
Use Indirect Lighting	--	78%	--	40%

EFFICIENCY PRACTICE	ARCHITECTS (N=30)*		ENGINEERS (N=16)**	
	At Least 50% Of Projects	At Least Once In Past Year	At Least 50% Of Projects	At Least Once In Past Year
Select Alternatives to Packaged HVAC Based on Energy Use	--	67%	--	83%
Optimize Window/ Floorplate Configuration (Daylighting)	--	63%	--	19%
Use HVAC Controls	--	63%	--	100%
Use Sensors (Occupancy & Light)	--	59%	--	70%
Clerestories/ Skylights/ Roof Designs (Daylighting)	--	53%	--	31%
Use Shading Devices (Daylighting)	--	50%	--	19%
Select Chiller Based On Efficiency	--	50%	--	92%
				Continued
Computer Modeling to Simulate Lighting	--	43%	--	31%
Heat Recovery or Reclaim Water Heating	--	37%	--	38%
Instantaneous Heating Water Heating	--	30%	--	31%
Computer Modeling to Simulate Cooling and Heating Loads	--	23%	--	91%
Solar Water Heating	--	13%	--	6%
Geothermal Water Heating	--	10%	--	13%
Computer Modeling to Simulate Building Energy Use	--	3%	--	38%

* *Architect sample size is 30 except for lighting systems, where the sample size is the 27 respondents who participated in the design of any lighting systems in past year, and HVAC, where the sample size is the 24 respondents who participated in the design of any heating systems in past year.*

** *Engineer sample size is 16 except for lighting systems, where the sample size is the 10 respondents who participated in the design of any lighting systems in past year, and HVAC, where the sample size is the twelve respondents who participated in the design of any heating systems in past year.*

*** *Respondent reported using "building commissioning as a strategy to ensure quality buildings that perform efficiently and properly."*

Table 4.4 shows the efficiency practices used by contractors in the past year in their new construction and renovation projects. Practices used by the majority of contractors in the majority of their projects, and used by 75% of contractors at least once, are shaded. For general contractors, one of eight measures met these criteria. For mechanical contractors, two of sixteen measures met these criteria and for electrical contractors, two of seventeen did. The 27 measures that are not shaded represent areas of key opportunity for EVT's work with contractors.

Table 4.4

EFFICIENCY PRACTICES OF CONTRACTORS IN NEW CONSTRUCTION AND RENOVATION PROJECTS

EFFICIENCY PRACTICE	GENERAL (N=31)		MECHANICAL (N=19)		ELECTRICAL (N=23)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
Low-E Glass[1]	81%	96%	--	--	--	--
Discussions with Owners, Designers, Contractors	29%	65%	42%	100%	35%	74%
Any Day Lighting Feature	26%	39%	16%[2]	21%	13%	35%
Commissioning[3]	6%[4]	26%	21%	47%	13%	17%
On-Site Generation	0%	3%	--	16%[5]	--	--
Use Modeling to Size HVAC Equipment	--	--	58%	68%	--	--
Use Any Economizer	--	--	53%	63%	--	--
• Single Enthalpy			37%	58%		
• Dual Enthalpy			21%	32%		
• Dry Bulb Economizer			5%	26%		
System Exceeds ASHRAE 90.1 1989	--	--	37%	68%	13%	26%
System Exceeds ASHRAE 90.1 1999	--	--	32%	68%	4%	17%

EFFICIENCY PRACTICE	GENERAL (N=31)		MECHANICAL (N=19)		ELECTRICAL (N=23)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
HVAC or Lighting Exploits Day Lighting	--	--	16%	21%	9%	30%
Review of Life Cycle Costs in Discussions	--	39%	--	53%	--	43%
Energy Analysis of Options Discussed	--	35%	--	89%	--	61%
Roof Designs for Light	--	32%	--	--	--	--
Shading Devices	--	23%	--	--	--	--
Photocells with Dimming Ballasts	--	--	--	--	--	26%
Programmable Thermostats	--	--	--	95%	--	--
						Continued
Energy Management System Controls For Optimal Start	--	--	--	63%	--	--
Occupancy Sensors	--	--	--	--	--	65%
Lighting Controls	--	--	--	--	--	43%
Building-Wide Scheduling (Lighting)	--	--	--	--	--	13%
High-Efficiency Packaged HVAC	--	--	--	74%	--	--
Variable Fan Speeds, VAV Systems, etc.	--	--	--	68%	--	--
Thermal Energy Storage	--	--	--	32%	--	--
High-Efficiency Chillers	--	--	--	16%	--	--
Ground Source Heat Pumps	--	--	--	11%	--	--
Compact Fluorescents	--	--	--	--	--	83%
T8 Fixtures	--	--	--	--	--	78%

EFFICIENCY PRACTICE	GENERAL (N=31)		MECHANICAL (N=19)		ELECTRICAL (N=23)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
High Intensity Discharge (HID) Lamps	--	--	--	--	--	70%
High-Bay Fluorescents	--	--	--	--	--	52%
T5 Fixtures	--	--	--	--	--	48%
Pulse-Start Metal Halide Lamps	--	--	--	--	--	48%
T12 Fixtures (Not An Efficiency Measure)	--	--	--	--	--	43%

1. *Sample size is 26 respondents.*
2. *Represents three respondents who worked on seven new construction/ renovation projects during the past year, out of 582 new construction/ renovation projects reported by the entire sample of nineteen mechanical contractors.*
3 *Projects commissioned "by a Certified Independent third party."*
4. *Two respondents reported 50% of their projects; both had two projects, one of which used commissioning.*
5. *Project type (new construction versus remodel/equipment replacement) not specified. Two respondents had installed microturbines.*

Mechanical and electrical contractor's use of efficiency practices in remodeling and equipment replacement projects is shown in Table 4.5. Not a single efficiency measure was used by the majority of contractors in the majority of their projects or by 75% of contractors at least once. Thus, EVT has a key opportunity to work with mechanical and electrical contractors on all efficiency measures suited to the remodeling and equipment replacement market.

Table 4.5

EFFICIENCY PRACTICES OF MECHANICAL AND ELECTRICAL CONTRACTORS IN REMODELING AND EQUIPMENT REPLACEMENT PROJECTS

CONSTRUCTION EFFICIENCY PRACTICES	MECHANICAL CONTRACTORS (N=19)		ELECTRICAL CONTRACTORS (N=23)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
System Exceeds ASHRAE 90.1 1989	5%	5%	13%	13%
System Exceeds ASHRAE 90.1 1999	5%	5%	4%	4%
Commissioning*	0%	5%	9%	22%
HVAC or Lighting Exploits Day Lighting	0%	0%	0%	0%
Programmable Thermostats	--	63%	--	--
Energy Management System Controls for Optimal Start	--	53%	--	--
Occupancy Sensors (Lighting)	--	--	--	57%
Lighting Controls—Switching Strategies, Staging Sequences, Stepped Controls	--	--	--	35%
Building-Wide Scheduling (Lighting)	--	--	--	13%
Use Modeling to Size HVAC Equipment	47%	63%	--	--
Use Any Economizer	47%	53%	--	--
• Single Enthalpy	26%	56%		
• Dual Enthalpy	21%	32%		
• Dry Bulb Economizer	5%	21%		
				Continued
High-Efficiency Packaged HVAC Systems	--	63%	--	--
Variable Fan Speeds, VAV Systems, etc.	--	53%	--	--
Thermal Energy Storage	--	21%	--	--
High-Efficiency Chillers	--	11%	--	--

CONSTRUCTION EFFICIENCY PRACTICES	MECHANICAL CONTRACTORS (N=19)		ELECTRICAL CONTRACTORS (N=23)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
Ground Source Heat Pumps	--	5%	--	--
On-Site Generation System	--	16%	--	--
T8 Fixtures	--	--	--	70%
Compact Fluorescent Lamps (CFLs)	--	--	--	65%
High Intensity Discharge (HID) Lamps	--	--	--	48%
High-Bay Fluorescent Fixtures	--	--	--	43%
T12 Fixtures (Not An Efficiency Measure)	--	--	--	39%
Pulse-Start Metal Halide Lamps	--	--	--	30%
Photocells With Dimming Ballasts	--	--	--	26%
T5 Fixtures	--	--	--	26%

** Projects commissioned "by a Certified Independent third party."*

Data are available for general contractors in the remodeling/ equipment market for one measure, not shown in the table. Eighty-three percent of general contractors reported using low-e glass in the majority (at least 50%) of their remodeling and equipment projects, and 89% reported using low-e glass at least once in the past year.

Contractors rated their experience with various energy efficiency practices using a five-point scale, with "5" indicating very experienced. Table 4.6 shows the proportion rating their experience a "4" or "5". Mechanical contractors rated themselves as experienced with more of the efficiency practices related to their trade than did electrical contractors, who in turn exceeded general contractors in the proportions rating themselves experienced the practices.

Table 4.6

PROPORTION OF CONTRACTORS RATING THEMSELVES AS EXPERIENCED WITH EFFICIENCY PRACTICES

EFFICIENCY PRACTICES	PERCENT RATING THEMSELVES AS EXPERIENCED WITH EFFICIENCY PRACTICE		
	GENERAL	MECHANICAL	ELECTRICAL
Third-Party Commissioning of Equipment Installation and Operation	43%	29%	13%
High Efficiency HVAC	32%	79%	--
High Efficiency Lighting	29%	--	65%
Energy Management Systems	27%	67%	17%
Day Lighting	25%	--	--
High-Efficiency HVAC Alternatives	23%	58%	--
Variable Speed Drives	21%	61%	--
Energy Analysis of Equipment Options	21%	53%	22%
Life-Cycle Costing	16%	31%	13%
Building-Wide Lighting Control System	13%	--	26%
On-Site Electricity Generation	6%	21%	26%
Variable Air Volume Fans	--	39%	--
LED and Low Voltage Lights	--	--	57%
Occupancy Sensors	--	--	48%
T-5 Fixtures	--	--	26%
Automatic Day Light Dimming	--	--	17%

Comparison of End User and Professional Responses

For seven of the 13 measures reported on by C&I end users, data were also obtained from one or more of the designer and contractor groups. Comparing these responses facilitates our interpretation of the data.

- **Low-E Glass:** 62% of C&I firms with construction projects users reported installing low-e glass; 93% of architects and 81% of general contractors reported installing low-e glass on 50% or more of their projects. The preliminary on-site data found low-e glass was over-reported by C&I survey respondents. Together, these data suggest low-e glass is used in about 50% to 60% of construction projects.

- **Programmable Thermostats:** 52% of C&I firms with construction projects reported installing programmable thermostats; 95% of mechanical contractors reported installing them on at least one project during the year. The preliminary on-site data found 39% of sites had programmable thermostats. Together, these data suggest programmable thermostats are used in about 40% to 50% of construction projects.

- **Compact Fluorescent Lamps:** 45% of C&I firms with construction projects reported installing CFLs; 83% of electrical contractors reported installing CFLs on at least one project during the year. The preliminary on-site data found some moderate over-reporting of CFLs by survey respondents. Together, these data suggest CFLs are used in about 40% to 45% of construction projects.

- **T-8 Fixtures:** 38% of C&I firms with construction projects reported installing T-8 fixtures; 78% of electrical contractors reported installing T-8 fixtures on at least one project during the year. The preliminary on-site data found C&I survey respondents under-reported T-8 fixtures. Together, these data suggest T-8 fixtures are used in about 40% to 45% of construction projects.

- **Lighting Controls:** 26% of C&I firms with construction projects reported installing lighting controls; 43% of electrical contractors reported installing lighting controls on at least one project during the year. Together, these data suggest lighting controls are used in about 20% to 25% of construction projects.

- **Economizer:** 25% of C&I firms with construction projects reported installing economizers; 75% of engineers and 53% of mechanical contractors reported installing economizers on at least 50% of their projects during the year. The preliminary on-site data found C&I

survey respondents, in aggregate, were reasonably accurate in their reporting of economizers. Together, these data suggest economizers are used in about 25% to 30% of construction projects.

- **Occupancy Sensors:** 19% of C&I firms with construction projects reported installing occupancy sensors; 70% of engineers, 65% of electrical contractors, and 59% of architects reported installing occupancy sensors on at least one project during the year. Together, these data suggest occupancy sensors are used in about 20% to 25% of construction projects.

Differences in Use and Awareness by Respondent Size

Among C&I firms with construction projects, awareness of efficiency measures shows some tendency to increase by firm size. This tendency was explored through statistical analyses of various aggregations of the data. Although size was correlated with response for four of the thirteen measures, it was not correlated with response for the aggregations of all lighting measures, all HVAC measures, and total measures. We conclude awareness of efficiency measures among C&I firms with permitted construction projects does not increase with firm size.

Of those C&I firms that are not involved with construction (those without permitted projects), larger firms are more aware of efficiency measures than smaller firms. These differences are statistically significant.

Among contractors, respondents from larger firms were more likely to describe themselves as “very experienced” with efficiency practices than were those from smaller firms.

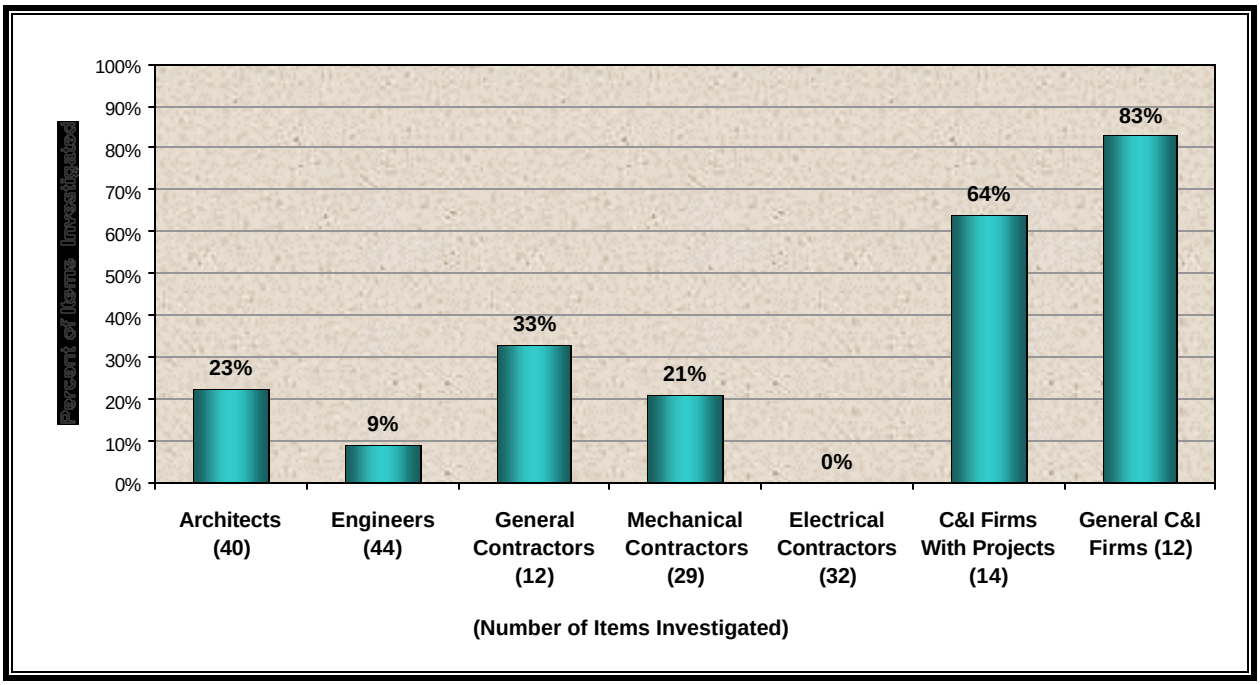
We examined the responses of each group to questions exploring their use of efficiency measures. The proportion of responses that vary by firm size compared to the total are shown in Figure 4.10 for each group.

Architects show some tendency toward large firms including more efficiency measures. In fact, for all five of the daylighting measures we asked about, large firms include the measures more than small firms. Only four of the remaining 35 measures (11%) asked of architects showed a size effect, and these measures were scattered throughout the different building systems (e.g., the

effect showed for only one of several measures asked about a system). Thus we conclude size of architectural firm is related to the inclusion of daylighting features, but is not related to the other practices.

Figure 4.10

DIFFERENCES BY FIRM SIZE IN ENERGY EFFICIENCY PRACTICES/MEASURES INSTALLED



The responses of engineers are not appreciably influenced by size. The responses of general contractors are similar to those of architects. Larger firms do more daylighting measures.

Six of 39 responses given by mechanical contractors about efficiency practices varied by size. However, the findings are hard to generalize. For two measures, smaller firms did more; for four measures, larger firms did more; for 23 measures, no size differences were found. We conclude from these findings that firm size is not an important influence on the mechanical contractor practices. The responses of electrical contractors do not show any size effect.

Among C&I firms—both those with construction projects and the general C&I sample—large firms have installed efficiency measures more frequently than small firms, and these differences are statistically significant.

The real estate developer sample was too small to examine response variation by size of firm.

DECISION MAKING PROCESS

Client Concern for Energy Efficiency and Its Marketing to Clients

About nine out of ten designers report their clients express a concern for facility energy costs (see Table 4.7). However, about two-thirds of designers believe their clients' concerns exceeded their clients' willingness to address energy costs. Only about 20 to 25% of designers are paid to conduct computer modeling and life cycle cost analyses in support of energy efficiency on at least half of their projects.

Table 4.7

CLIENT COMMITMENT TO ENERGY EFFICIENCY IN PROJECTS OF ARCHITECTS AND ENGINEERS

CLIENT COMMITMENT TO ENERGY EFFICIENCY	ARCHITECTS (N=30)		ENGINEERS (N=16)	
	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR	AT LEAST 50% OF PROJECTS	AT LEAST ONCE IN PAST YEAR
Client Expressed Concern for Facility Energy Costs	87%	93%	81%	88%
Professional Expressed More Concern for Facility Energy Costs than Client Expressed	63%	70%	63%	75%
Client Willing to Invest to Have Facility Be More Energy-Efficient than Similar Facilities in the State	53%	60%	31%	50%
Client Paid for Computer Modeling of Building or Lighting System Energy Use	27%	33%	19%	50%
Computer Modeling Resulted in a More Energy-Efficient Design Being Selected	23%	37%	6%	44%

Client Paid for Formal Life Cycle Cost Analysis of Efficiency Options	20%	37%	25%	31%

As Figure 4.11 shows, about 40% to 55% of designers' contractors report their clients are now more concerned about energy efficiency than they were in the past, figures that are comparable to, or a little higher than, those expressed by the clients themselves (C&I firms with construction projects and general C&I firms, see Figure 4.12). In contrast, only about 20% of developers described themselves as more concerned now than in the past (also in Figure 4.12). Engineers are the group most likely to promote their capability with energy efficient options, followed by architects and mechanical contractors (Figure 4.11).

Figure 4.11

CLIENT CONCERN FOR ENERGY EFFICIENCY AND ITS MARKETING TO CLIENTS—DESIGNERS AND CONTRACTORS

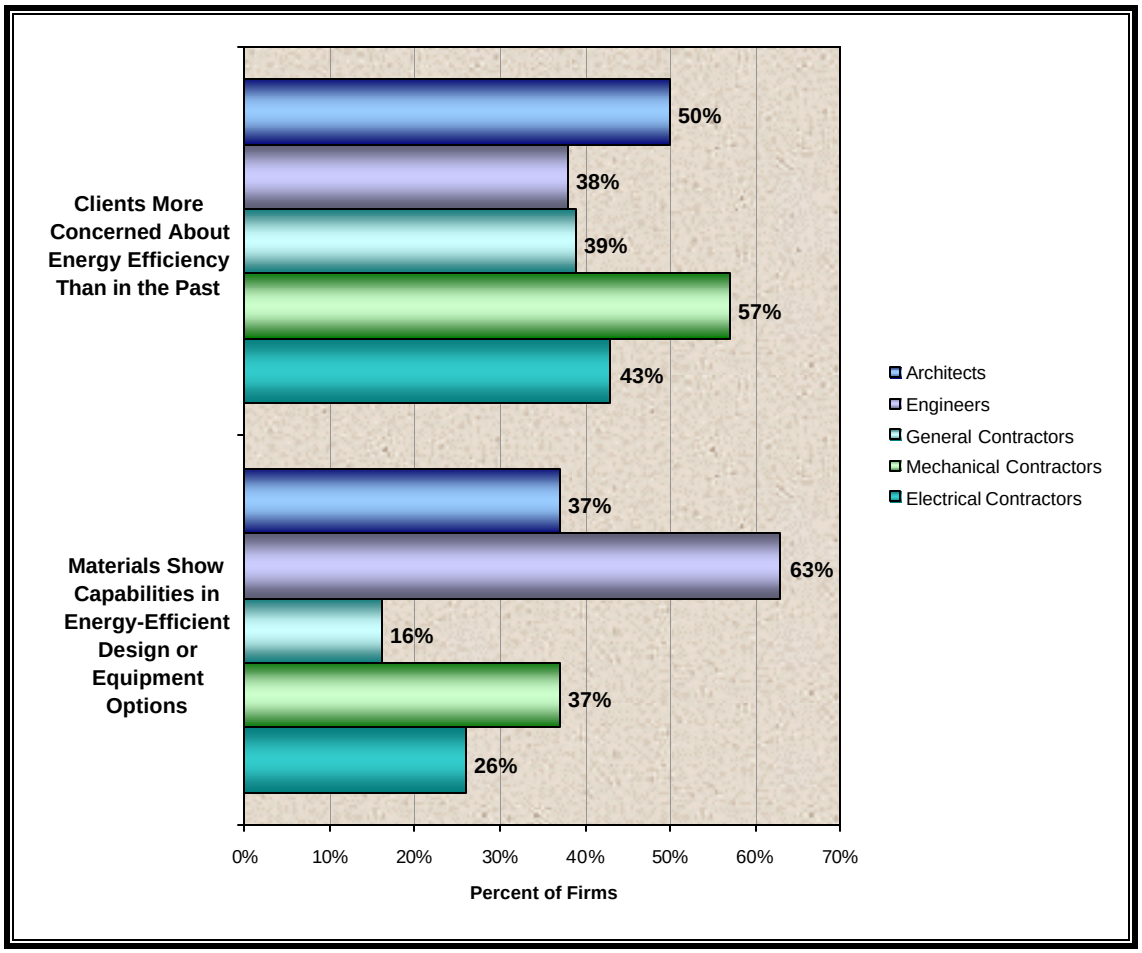
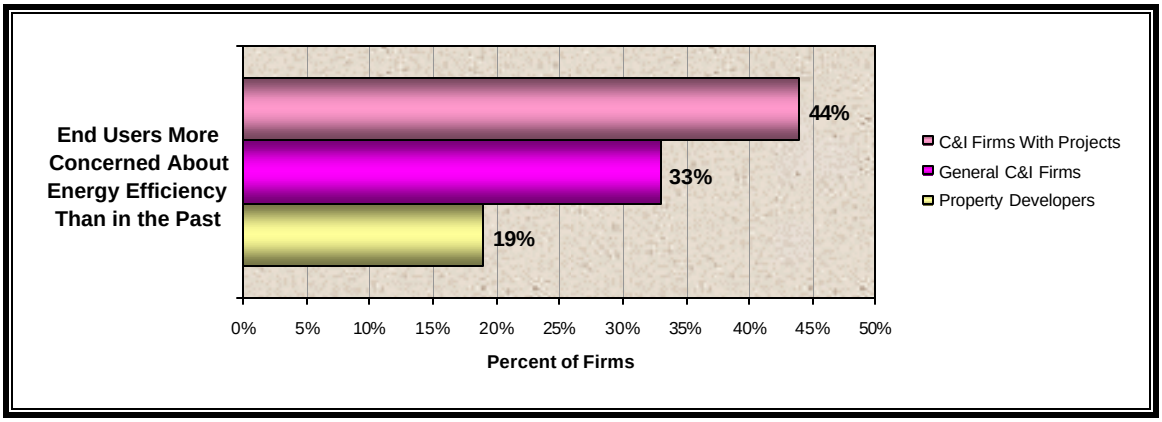


Figure 4.12

CONCERN FOR ENERGY EFFICIENCY—END USERS REAL ESTATE PROFESSIONALS



Differences in Concern for Energy Efficiency by Respondent Size

None of the responses to questions about concern for efficiency vary by size of respondent.

Decision Making Process for Market Actors

We asked designers and contractors who (what professional—or building owner) makes decisions about equipment. We explored decisions for lighting and HVAC decisions separately. The designers and general contractors were asked about both types of equipment; electrical contractors were asked about lighting, and mechanical contractors were asked about HVAC systems. There was little agreement among the market actors as to who are the key decision makers.

Engineers (electrical or mechanical) were reported by three groups as being among the top two decision-makers for equipment (lighting or HVAC) decisions. These groups are: architects, engineers, and contractors (electrical or mechanical).

Building owners were reported by two groups as being among the top two decision-makers for equipment decisions. These two groups are: general contractors and equipment (electrical or mechanical) contractors.

Equipment (lighting and HVAC) suppliers were mentioned by engineers as being among the top two decision-makers for equipment (lighting and HVAC) decisions. Two types of professionals included themselves among the top two decision- makers for equipment, yet the other types of respondents, on average, did not rank them as such. Architects reported themselves as among the top two decision-makers for lighting and HVAC equipment decisions and mechanical contractors included themselves among the top two decision-makers for HVAC equipment.

Decision Making Process for End Users

Table 4.8 shows the professionals C&I firms reported using on their permitted construction projects. The table shows two proportions for each professional, the proportion of permitted construction projects and the proportion of the total square footage constructed. The two proportions are the same for general contractors. The other professionals are somewhat more likely to be used on larger projects than on smaller projects, and so the proportion of total square footage for these professionals is somewhat larger than the proportion of total projects. The two proportions differed the most for engineers, who work on about one-third of the projects and about one-half of the total floorspace.

Table 4.8

PROFESSIONALS USED AS PROPORTION OF PROJECTS AND OF TOTAL CONSTRUCTED FLOORSPACE

PROFESSIONALS	PROPORTION OF PROJECTS USING PROFESSIONAL	PROPORTION OF TOTAL CONSTRUCTED FLOORSPACE USING PROFESSIONAL
Architect	48%	58%
Mechanical Engineer	33%	50%
Electrical Engineer	30%	46%
General Contractor	79%	79%
Mechanical Contractor	68%	79%
Electrical Contractor	85%	81%

Roughly speaking, about one-third of the C&I firms used five or six professionals on their projects, about one-third used three or four professionals, and about one-third used one or two professionals, as shown in Table 4.9. Larger projects used more professionals; thus, five or six professionals were used on 43% of the total constructed floorspace.

Table 4.9

NUMBER OF PROFESSIONALS USED ON A PROJECT AS A PROPORTION OF PROJECTS AND OF TOTAL CONSTRUCTED FLOORSPACE

NUMBER OF PROFESSIONALS	PROPORTION OF PROJECTS USING NUMBER OF PROFESSIONAL	PROPORTION OF TOTAL CONSTRUCTED FLOORSPACE USING NUMBER OF PROFESSIONAL
One or Two	32%	28%
Three or Four	39%	29%
Five or Six	29%	43%
Total	100%	100%

Among all firms with permitted projects, respondents most often cited general and mechanical contractors as influencing HVAC decisions.[31] Were all professionals involved in every project, the mechanical engineers and contractors would be the most influential for HVAC decisions.[32] Among all firms with permitted projects, respondents said lighting contractors most often influenced lighting decisions. When used on a project, electrical engineers are the most influential for lighting decisions.

[31] This finding reflects a combination of the influence of each market actor and the frequency with which that market actor is involved in projects.

[32] This finding reflects only the influence of market actors, under the assumption that all are used on projects with the same frequency.

We asked C&I firms with permitted projects to name the building professional with whom they discussed energy use in their project. Responses were roughly equally divided among those who had discussed energy use with each of the five building and construction market actors. Respondents named general contractors most frequently (20%) and mechanical engineers least frequently (9%). C&I firms discuss energy use most often with electrical engineers and next most frequently with architects, when those professionals are involved in projects.

Differences in Decision Making Process by Respondent Size

There were no overall differences by size of C&I firm in professionals used on projects (responses to 3 of 14 questions—21%—differed by size) and discussions of energy use with professionals (responses to 4 of 15 questions—27%—differed by size).

BARRIERS TO ENERGY EFFICIENCY

We asked the market actors to rate the degree to which various factors (depending on the group) posed a barrier to the incorporation of energy efficient options in their projects.[33] Figure 4.13 shows the proportion of designers and contractors rating the barriers on a five-point scale.[34] (See Chapters 5, 6, and 7 for the ratings of all the barriers discussed with each type of respondent.)

The barrier most frequently described as most challenging was "getting clients to spend money on analyzing energy efficiency options", endorsed by about 63% of both architects and engineers. The next most significant barriers, among all groups, were: getting reliable estimates of the costs and benefits of energy efficiency options, or just getting accurate information in general about the options. In addition, mechanical contractors reported difficulty in getting

[33] The barriers were as standardized as possible across groups to support a comparison of responses, yet by necessity, tailored to each trade.

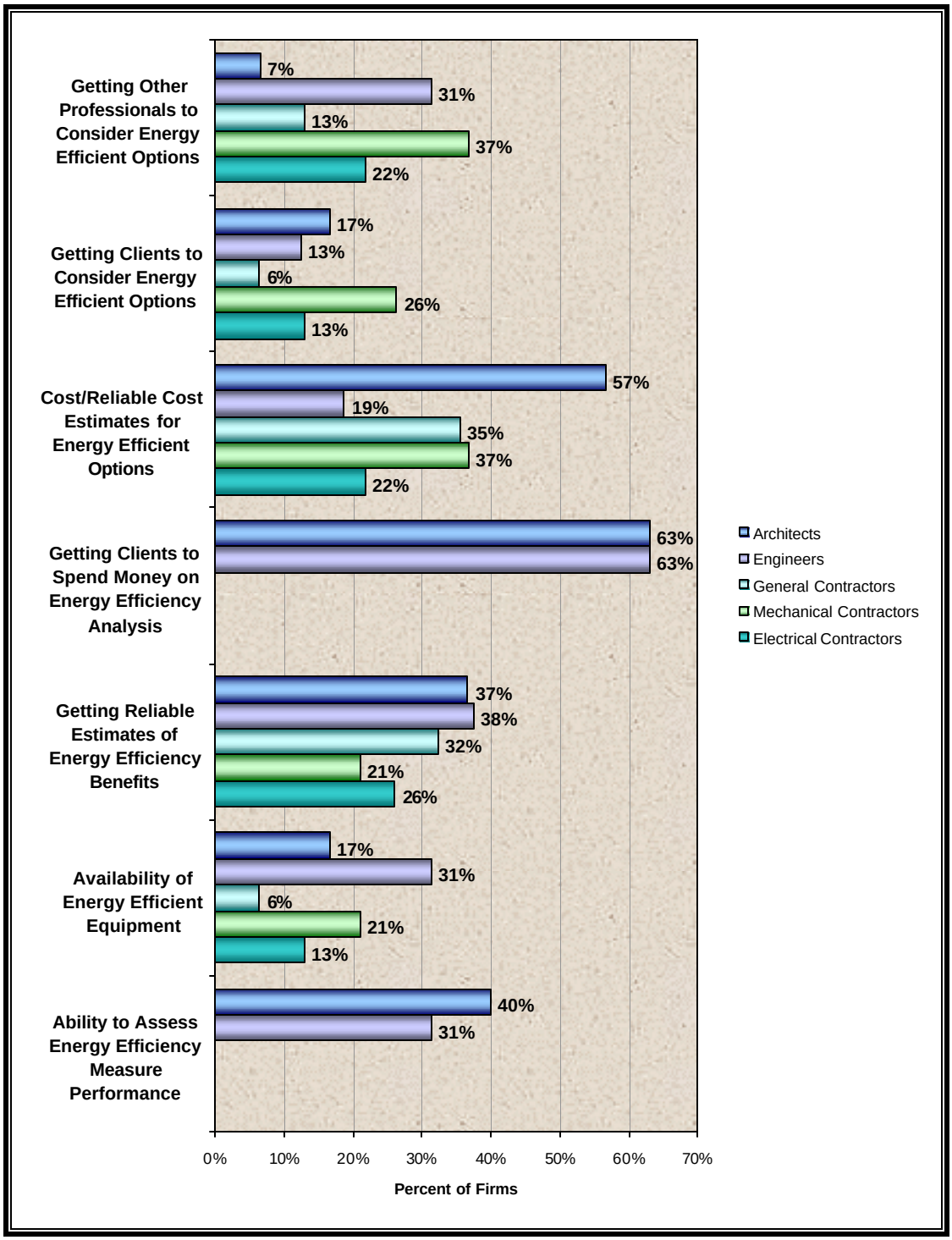
[34] As with the figures on experience and practices, if a market actor is not shown for a barrier, then that barrier was not ranked among the most problematic the market actor faces.

general contractors to consider efficiency options, and both mechanical and general contractors reported the higher cost of efficient products is a barrier.

For C&I firms and real estate professionals, we approached the issue of barriers to efficiency through a different line of questioning. We first asked C&I firms to rate the importance of lighting and HVAC equipment criteria. We then asked respondents what comes to mind when they think of energy efficient lighting or HVAC equipment. To determine which criteria or associations are barriers, we compared the list of associations and criteria for contradictions.

Figure 4.13

BARRIERS TO INCLUDING ENERGY EFFICIENCY IN PROJECTS (PERCENT OF MARKET ACTORS RATING BARRIER AS SUBSTANTIAL)



For energy efficient lighting, "quality of lighting" was rated as important or very important by 91% of C&I firms with permitted construction projects. The proportion of firms with construction projects that associate high-efficiency lighting with good quality light output is roughly the same as the proportion that associate high-efficiency lighting with poor quality light output. Attitudes about the quality of light output of high-efficiency lighting are therefore a barrier for some C&I firms with permitted projects. We determined attitudes about the quality of light output are also a barrier for C&I firms without permitted projects. A comparison of criteria and associations did not suggest any notable barriers for real estate professionals.

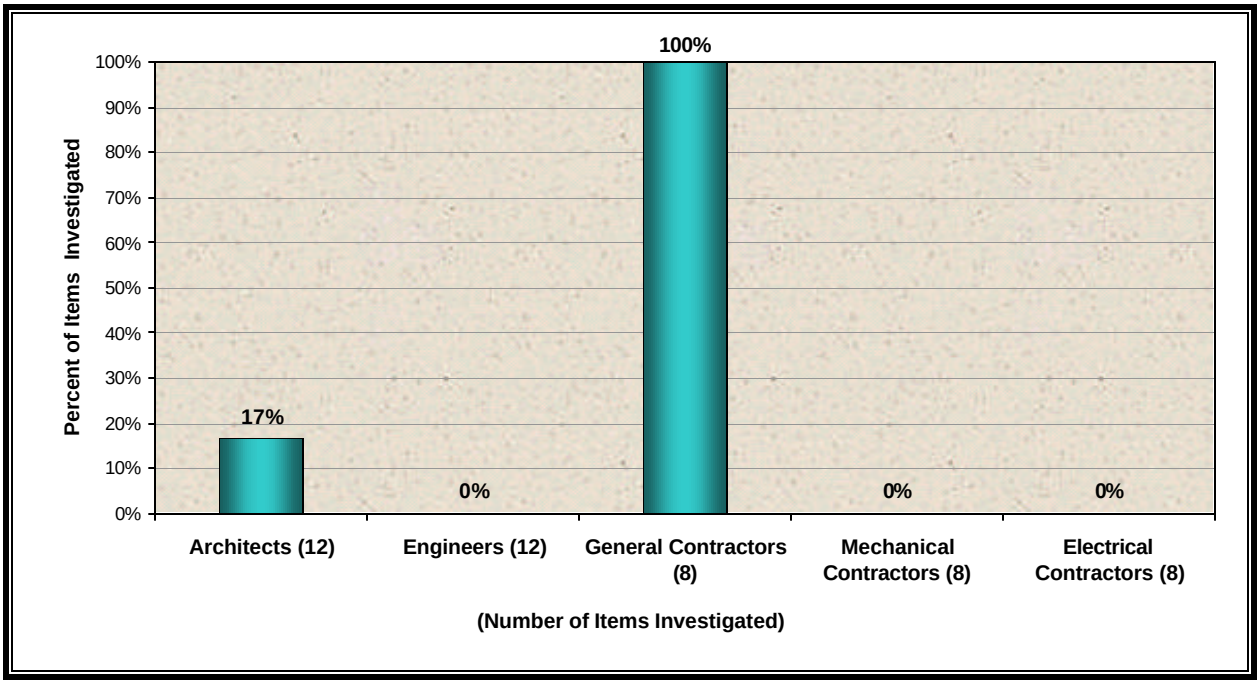
For all C&I firms and real estate professional groups, attitudes and associations regarding high-efficiency HVAC equipment were congruent. Thus, no notable barriers were identified.

Differences in Barriers by Respondent Size

Figure 4.14 shows, for each market actor, the proportion of response about barriers to energy efficiency that vary by firm size.

Figure 4.14

DIFFERENCES BY FIRM SIZE IN BARRIERS TO EE PRACTICES/MEASURES



All but one of the market participant groups shows virtually no differences between large and small firms in perception of barriers to energy efficiency (see Figure 4.13). General contractors provided the exception. For seven of the eight barriers explored, large general contractors described the barriers as more significant than small firms did; for one barrier, the opposite relationship prevailed. Getting accurate and objective information about high-efficiency options was stated as a barrier more often for small general contracting firms than for large firms.

PROGRAM PROCESS ASSESSMENT

ACT 250

Act 250 is Vermont's land-use planning and development law. It contains provisions for energy efficiency.

Three-fourths of the engineers and two-thirds of the architects had experience with Act 250 by the time of the interview (see Figure 4.15). Just over half of general contractors and developers had experience with Act 250. Only 43% of

C&I firms with construction permits had experience with Act 250. Electrical and mechanical contractors were least likely to have experience with Act 250.

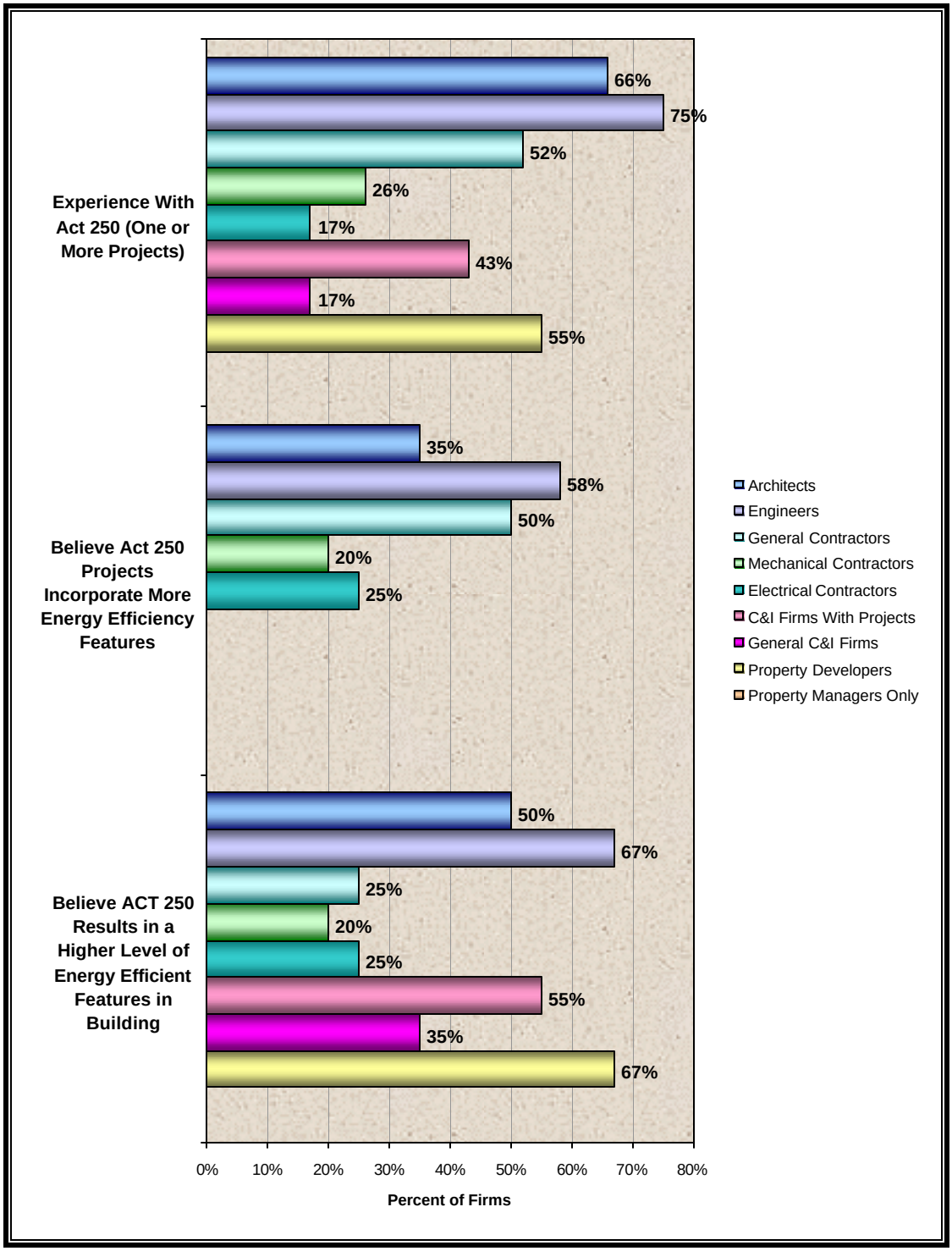
We asked two questions to probe—for those experienced with Act 250—respondents' opinion about the effect of Act 250 on energy efficiency. One, we asked if they believe Act 250 projects incorporate *more* energy efficiency features than non-Act 250 projects and two, we asked if they believe Act 250 results in a *higher level* of energy efficiency features in a building. A higher proportion of respondents were more likely to endorse the second metric—a higher level of features—than the first metric (more features).

At least 50% of architects, engineers, general contractors, C&I firms with permitted construction projects, and developers agreed Act 250 had a positive effect on efficiency—accomplishing more features and/or a higher level of features. Electrical and mechanical contractors were the least likely to believe Act 250 resulted in an increase in energy efficiency.[35]

[35] Note that any groups not shown in the figure for a given item were not asked the question it describes.

Figure 4.15

ACT 250: EXPERIENCE WITH, AND EFFECTS OF ACT 250



It is not possible within the existing study to probe differences between market actor respondents who thought Act 250 had a positive effect on efficiency and those who did not because insufficient information exists to distinguish between two opposite, plausible relationships. These relationships are illustrated in Table 4.10. Knowing the extent to which a designer or contractor reported engaging in energy efficiency practices does not suggest a particular response to Act 250.

Table 4.10

HYPOTHETICAL RELATIONSHIPS BETWEEN ENERGY EFFICIENCY PRACTICES OF DESIGNERS AND CONTRACTORS AND ASSESSMENT OF ACT 205'S INFLUENCE

STANDARD APPROACH ON NON-ACT 250 PROJECTS:	TAKES ACT 250 SERIOUSLY OR MAKES SPECIAL EFFORT TO COMPLY	DOES NOT MAKE SPECIAL EFFORT FOR ACT 250 PROJECTS
Energy Efficient	Describes Act as influential	Describes Act as not influential
Not Energy Efficient	Describes Act as influential	Describes Act as not influential

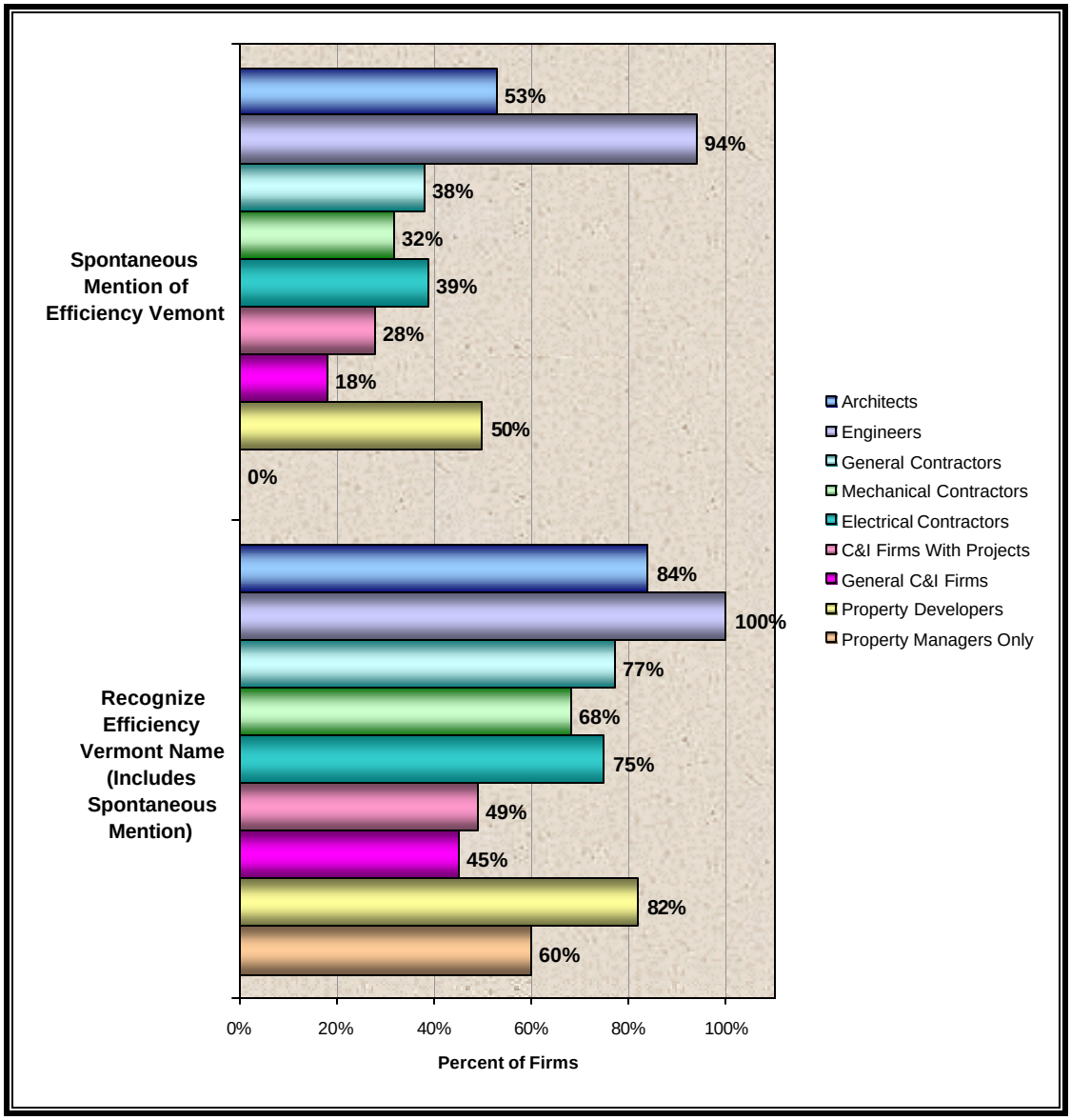
Fortunately, the study is able to assess the relationship between C&I end user experience with Act 250 and the outcomes of end user awareness and installation of efficiency measures. A multivariate regression analysis of the efficiency measures installed by C&I firms found firms that had experience with Act 250 were aware of more energy efficiency measures than firms that did not have experience with Act 250. This relationship was true for both C&I firms with permitted construction projects and those without current construction projects but who had installed building equipment systems such as heating or lighting. However, no difference was found between those with and without Act 250 experience in the number of efficiency measures C&I firms reported installing.

Efficiency Vermont

One hundred percent of the engineers and 84% of the architects recognized Efficiency Vermont or EVT by name, as had between 68% and 77% of the three contractor groups (see Figure 4.16). Over 75% of real estate professionals had heard of EVT, and 45% to 50% of C&I firms. The figure also shows the proportion of each group that was able to spontaneously mention Efficiency Vermont or EVT as the name of an organization that promotes energy efficiency statewide in Vermont, prior to the interviewer naming the organization. Almost all engineers (93%) spontaneously mentioned EVT. Architects and developers were next mostly likely to spontaneously mention EVT; about 50% did so.

Figure 4.16

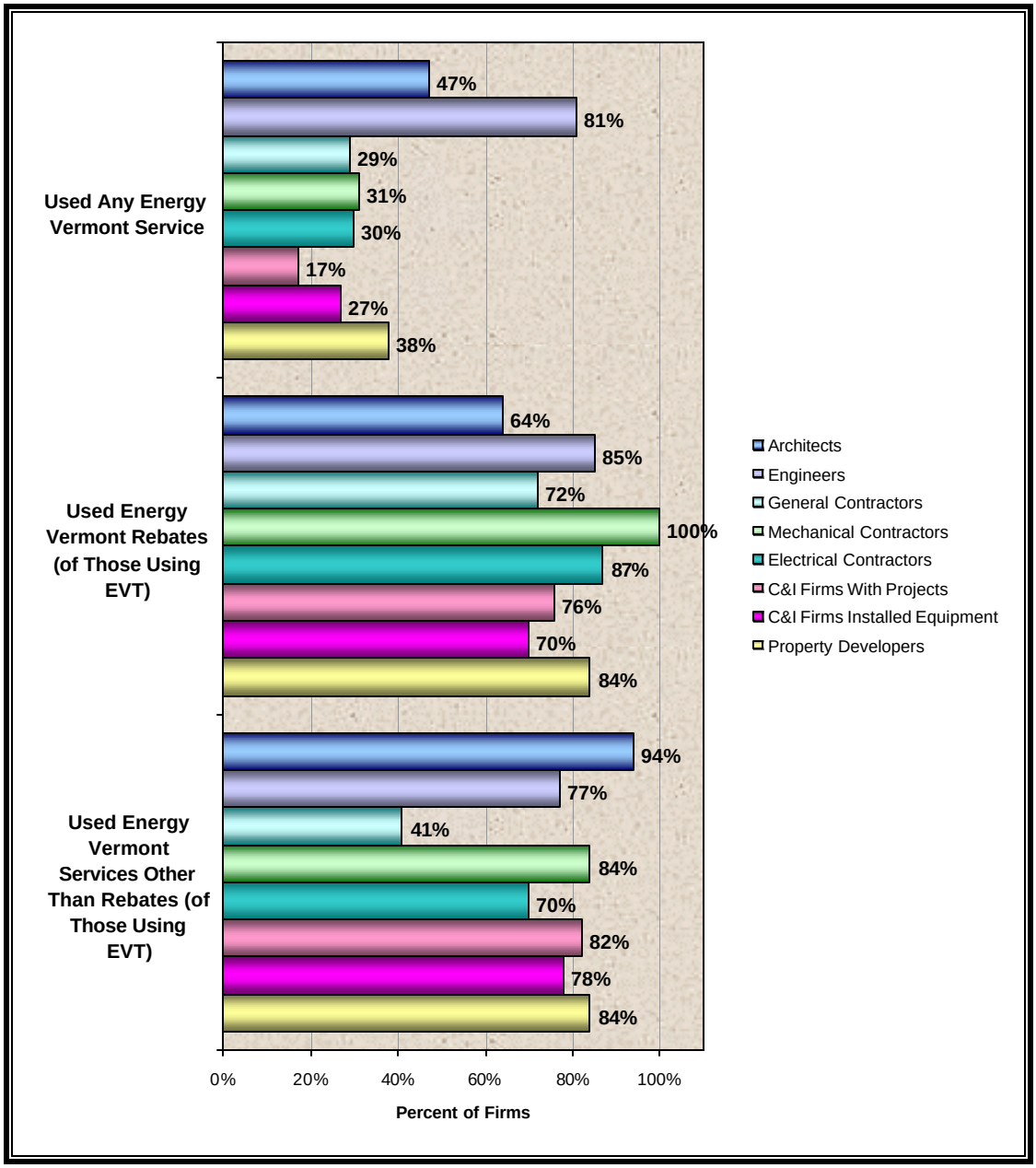
EFFICIENCY VERMONT: AWARENESS OF EVT



The ability to spontaneously name EVT reflects respondents' use of EVT services, shown in Figure 4.17.

Figure 4.17

EFFICIENCY VERMONT: USE OF EVT SERVICES



Eighty-one percent of engineers, about 45% of architects and developers, and about 30% of contractors reported using EVT services. C&I firms report using EVT services at a lower rate (18% among end users with permitted construction projects and 11% among those without).

The figure also shows the rate at which respondent groups that had received services from EVT used rebates or other services. For every group but architects, rebates were used with equal or greater frequency than all other EVT services combined. Even so, the other EVT services were commonly used. Taking a simple average across the market participant groups, about 75% of respondents using EVT services had used rebates, compared with about 60% of all respondents using EVT services, that had used one or more of the other, non-rebate EVT services.

One hundred percent of mechanical contractors using EVT services had used EVT rebates. Nearly nine out of ten architects (86%) had used EVT services other than rebates, and 50% had used non-rebate services. General contractors had received the fewest non-rebate services from EVT.

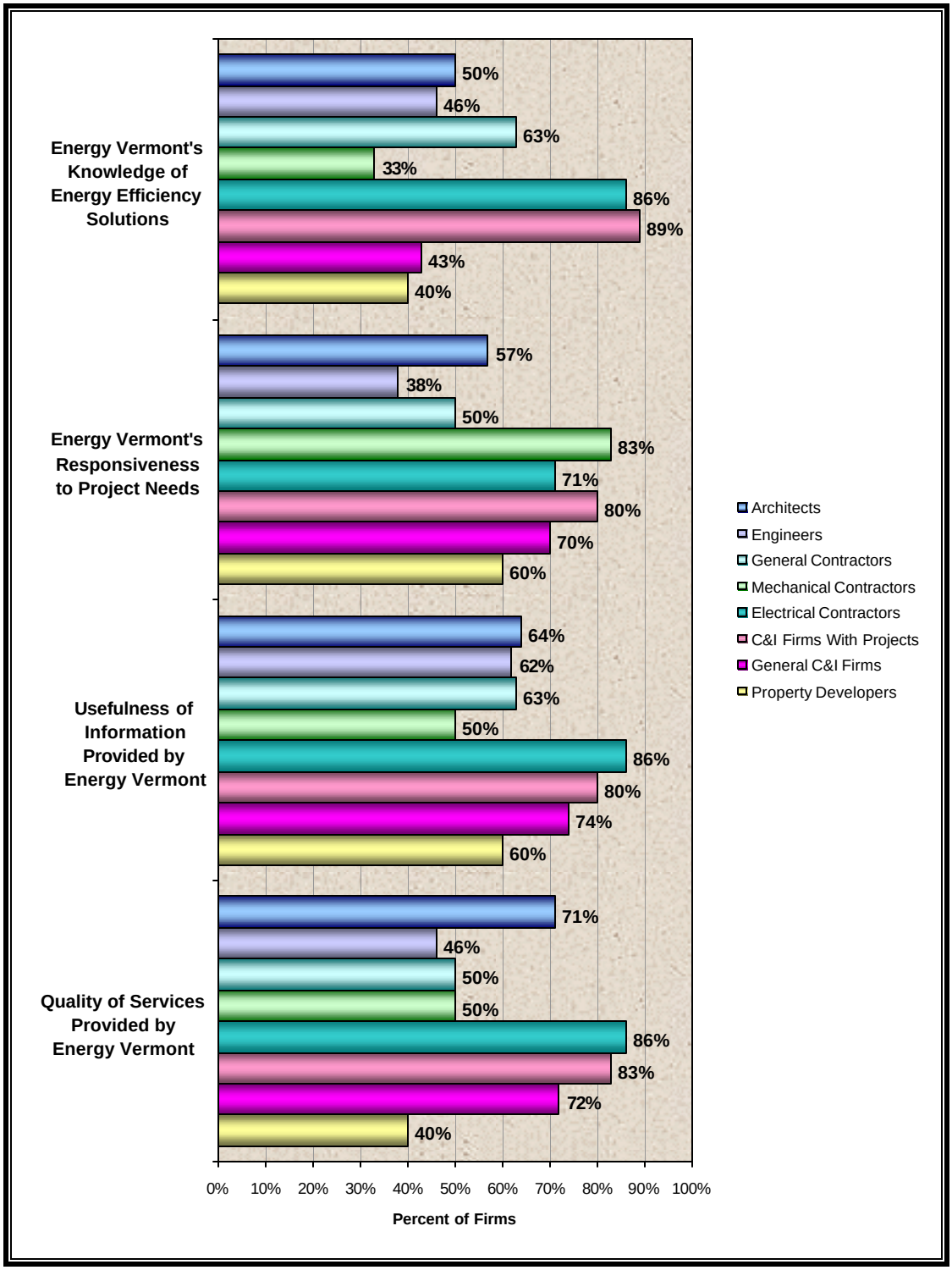
Figure 4.18 gives the proportion of respondents, among those using EVT services, who rated the services highly (a "4" or "5" on a five-point scale) with respect to four criteria. Taking a simple average across the market participant groups, between 67% and 56% of the market participants rated EVT highly on each of the four criteria. EVT was most frequently rated highly on usefulness of information provided, then on responsiveness to project needs. These criteria were followed by quality of services provided, then by knowledge of energy efficiency solutions.

Electrical contractors and C&I firms (both those with construction projects and general C&I firms) consistently had the highest proportion of respondents that rated EVT highly. Other groups that had a higher-than-average proportion who rated a criterion highly are general contractors with respect to EVT's knowledge of efficiency solutions, mechanical contractors with respect to EVT's responsiveness to project needs, and architects with respect to quality of services provided.

The lowest proportion of respondents who rated a criterion highly were mechanical contractors, of which only 33% rated EVT's knowledge of efficiency solutions highly. For two other criteria, mechanical contractors were also among the groups with the lowest proportion of respondents giving high ratings. But paradoxically, for responsiveness to project needs, more mechanical contractors gave a high rating than any other group.

Figure 4.18

ENERGY VERMONT: FAVORABLE ASSESSMENT OF EVT SERVICES RECEIVED



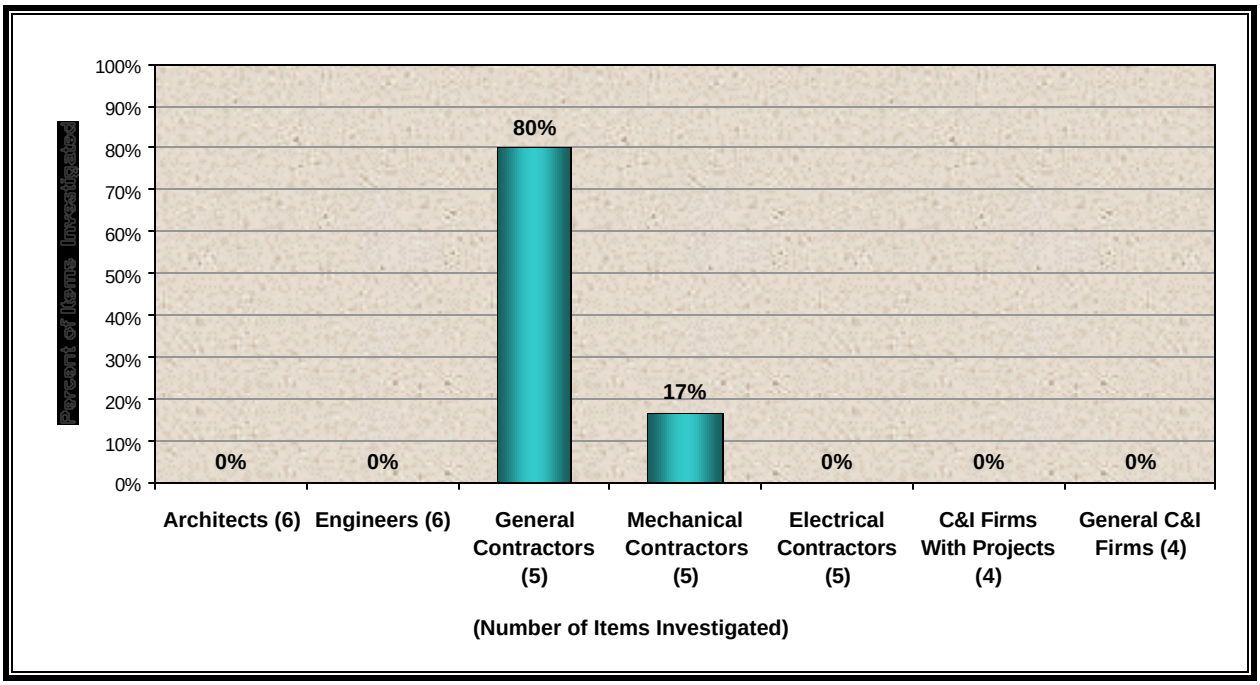
A multivariate regression analysis of the efficiency measures installed by C&I firms found firms that users who had used Efficiency Vermont's services installed more energy efficiency measures than those that did not. This relationship was true for both C&I firms with permitted construction projects and those without current construction projects but who had installed building equipment systems such as heating or lighting. In addition, awareness of EVT or contact with EVT was associated with higher awareness of energy efficiency options.

Differences in Program Process Assessment by Respondent Size

There was very little difference by size of respondent in responses to the Act 250 questions, as indicated in Figure 4.19 by the proportion of Act 250 responses that vary by firm size. Only general contractors showed a difference, with large general contractors more likely to have experience with Act 250 and believe it results in a higher level of energy efficiency.

Figure 4.19

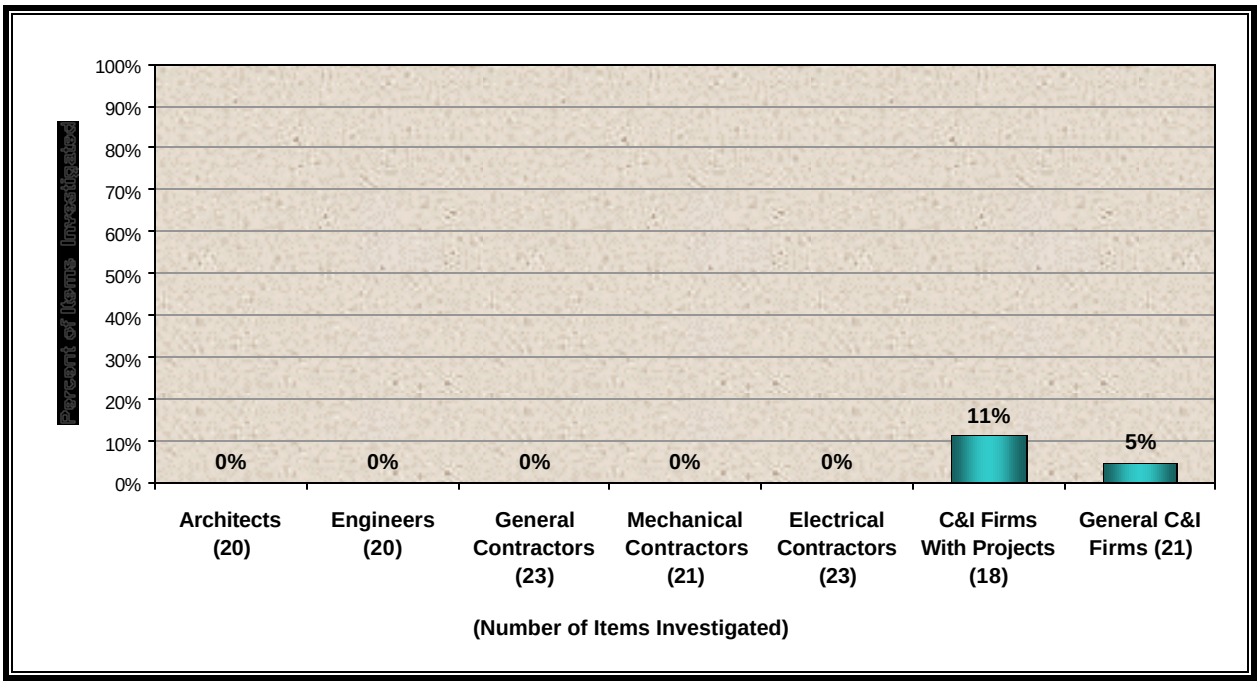
DIFFERENCES BY FIRM SIZE IN EXPERIENCE WITH AND RESPONSE TO ACT 250



There were no differences by firm size among responses to questions on the awareness of, use of, and assessment of EVT, as shown in the proportion of EVT responses that vary by firm size (see Figure 4.20).

Figure 4.20

DIFFERENCES BY FIRM SIZE IN AWARENESS, USE AND ASSESSMENT OF EVT



5. SUMMARY OF MARKET ACTOR RESULTS

The GDS team conducted interviews with designers (architects and engineers, both electrical and mechanical), contractors (general, mechanical, and electrical) and suppliers (lighting, HVAC, windows, and motors and drives) for commercial and industrial buildings in Vermont. Chapter 3 provided a discussion of the samples and the limits of the analysis.

This chapter looks within and across the market actor groups and presents key findings organized into four topic areas: (1) market characteristics; (2) market structure; (3) current energy efficiency practices; and (4) program process findings.

In an attempt to understand whether there are important sub-groups within the designer and contractor market actor groups, we looked at differences among responses by up to 11 factors, including:

- Total number of projects in Vermont in the past year
- Number of employees
- Total number of square feet of Vermont projects in the past year
- Annual revenues

All respondent groups were able to enumerate the number of employees at their firm and all but one (electrical contractors) provided the total number of projects completed in Vermont in the past year. Table 3.4 showed the complete list of factors explored and the data available for each group.

We found that distinguishing among firms by number of employees and by total number of projects completed in Vermont yielded similar subsets of respondents. A cut-off between small and larger firms was identified at five employees (fewer than five being "small"), and six projects in Vermont in the past year (fewer than six being "small"). All market actor groups were analyzed according to these two size variables. Throughout this chapter, any findings for a market actor group that differ by size of firm are clearly noted.

In addition to subsets based on size, we looked at market actors that serve commercial and industrial clients exclusively. Only general contractors had a sizeable proportion (29%) that conducted only C&I work. The two general contractors groups created by distinguishing those that conduct exclusively C&I work did not differ with respect to the topics explored in this study.

Unlike some regions of the country, where there are specialty firms for nonresidential buildings, most Vermont market actors who work on commercial and industrial buildings or who supply equipment to these buildings were found to also provide services to the residential sector. The few who exclusively serve the C&I sector do not differ from their counterparts that serve all sectors.

CHARACTERISTICS OF MARKET ACTORS

The issues of market characterization concern the size of businesses offering services for commercial and industrial buildings in Vermont, the volume of sales, the type of construction, and the types of clients these businesses have.

Designer and Contractor Markets

As discussed in the previous chapters, many small firms doing mainly relatively small projects dominate Vermont's nonresidential construction market. We typically were able to talk to owners, presidents and principals in the interviewed firms.

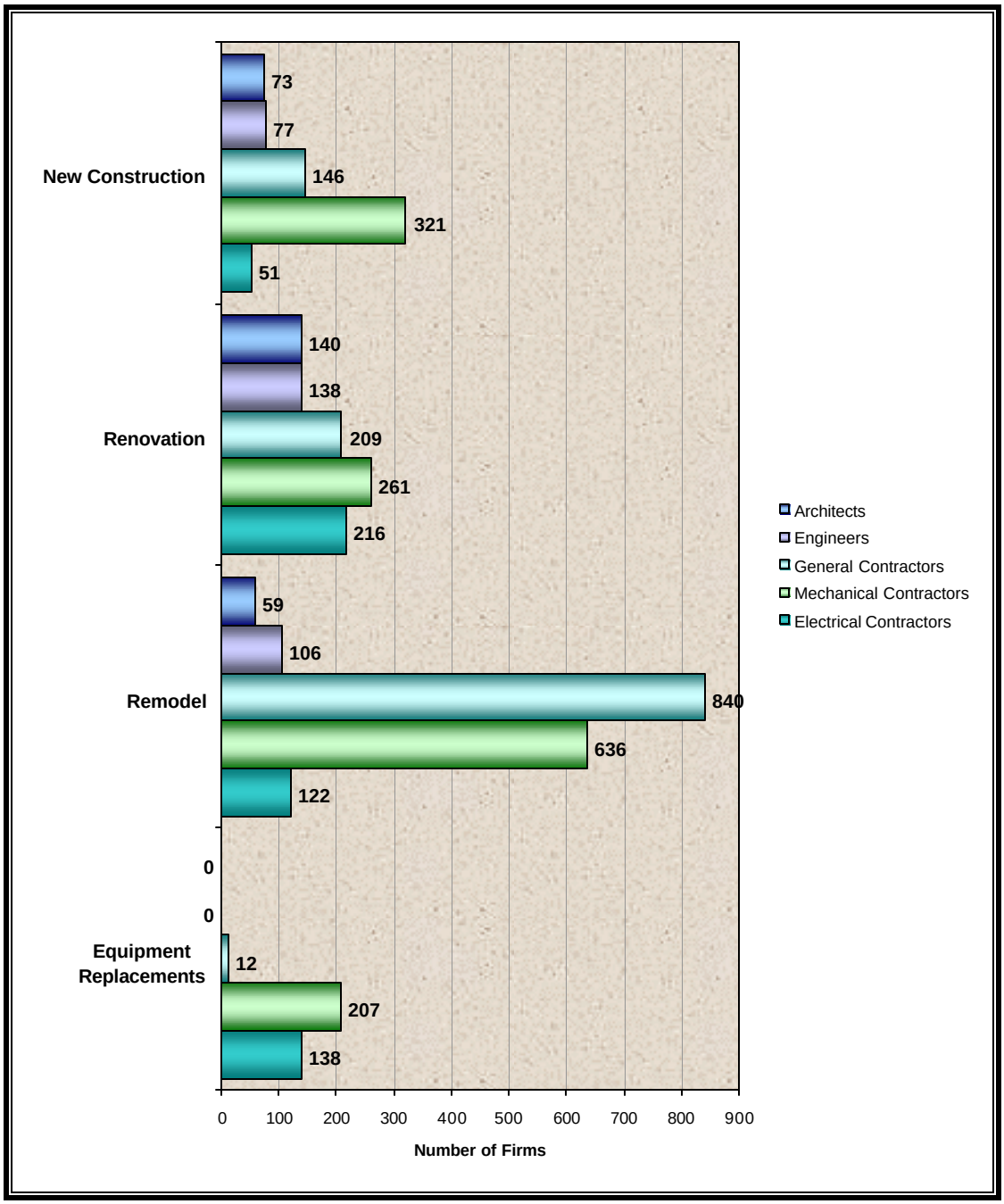
Figure 5.1 displays the total number of new construction, renovation, remodel and replacement projects completed in the past year as reported by the design and contracting firms we interviewed. These should be viewed in light of the total number of construction permits for 1998 and 1999 identified by the Department of Labor and Industry: 471 new construction permits and 368 remodel, renovation and addition permits.

The total number of projects for architects, engineers and electrical contractors are close to what one might expect based on the permit data reviewed. However, the numbers of remodeling projects reported by mechanical and general contractors are much higher than the number of permitted projects. We suspect two possible explanations. The most likely is that large volumes of

small-scale remodeling projects are occurring without any type of permit, since requirements for permits are based on size of project rather than the fact that a project is occurring at all. A second explanation is that our contacts were not accurate in their estimation of the number of projects. While that seems plausible, it is notable that the mechanical contractor with the largest volume of business provided the most detailed—hence the most seemingly accurate—numbers.

Figure 5.1

NUMBER OF PROJECTS COMPLETED BY DESIGNERS AND CONTRACTORS IN THE PAST YEAR



Note: The 207 equipment replacements for Mechanical Contractors excludes 900 projects reported by one large contractor. The responses of the 18 mechanical contractors depicted an

average 11.5 projects per contractor. Including the respondent that reported about 900 projects brings the total to 1,107 projects.

The designer and contractor groups we surveyed were found to have conducted different proportions of new construction, remodeling, and renovation work as well as different proportions of design-build work. For example, 70% to 80% of all contractor groups reported doing at least some design-build work while only 10% of the architects reported doing any design-build; engineers fell between these two figures. No differences were noted by size of firm.

Based on a definition for renovation as a "major remodel or gut rehab" , we found designers and general and electrical contractors reported conducting more renovation projects in the past year, while mechanical contractors reported more new construction and remodeling projects. Although over half of the mechanical and electrical contractors reported doing straight equipment replacement projects, most do very few. Size of firm did not have a bearing on the type of construction undertaken except for the one large mechanical contractor that reported roughly 900 replacement projects in the past year.

Designers and contractors all reported that the majority of their projects are for owner-occupied facilities in the private sector. A very small percentage of the work done by contractors or designers is for owners who plan to sell the building. Several contractors in each category and several designers reported they have done work for owners who plan to lease their building. These findings are consistent with the permit data reported in chapter 2. No differences were noted by size of firm.

We conclude the Vermont nonresidential construction market is characterized by the involvement of contractors—general contractors, electrical and mechanical—in the vast majority of projects.[36] Frequently these contractors take the role of design-builder. Architects and engineers are less frequently

[36] These conclusions are supported by the C&I end user findings, given in chapter 7. Between 68% and 85% of projects used one or more of the three types of contractors, while between 30% and 48% of projects used one or more of architects, mechanical engineers, or electrical engineers.

involved in projects, especially projects under 5,000 square feet.[37] Architects and engineers typically report involvement in about four or five projects a year. Seventy-five percent of the architects and all of the engineers report completing in excess of 20,000 square feet worth of projects in the past year. No differences by size of market actor firm were apparent.

Supplier Markets

The pictures we are able to draw of the supplier markets are less clear than those we can formulate for designers and contractors. This lack of clarity results from three factors: (1) our samples were quite small; (2) we experienced high refusal rates among the suppliers, which can result in a biased sample;[38] and (3) the suppliers had wider-than-anticipated variation in the equipment they sold and the markets they served.

Fortunately, the supplier interview process revealed fairly clear information about the population size. Less than 50 firms were identified supplying lighting, HVAC, and motors/drives for C&I construction in Vermont.[39] An estimated 154 firms supply windows. Only a few of the suppliers serving Vermont were found to be located outside the state, usually in New Hampshire or New York.

The supplier market place is similar to that of contractors: primarily small firms sell equipment for C&I projects in Vermont, plus a few moderately large firms. The supply firms are scattered throughout the state, with many small firms located in the rural areas. With just a few exceptions, the supply firms we spoke with sell equipment to all sectors, not just the C&I sector. This finding was true for motor suppliers as well as for suppliers of other types of equipment.[40]

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37 Table 4.8 shows the proportion of projects and the proportion of total constructed square footage involving each type of market actor, as reported by C&I firms with construction projects.

38 See Table 3.2.

39 See Table 3.1.

40 Given their few numbers and the findings on this issue among designers and contractors, we did not further explore the behavior of firms supplying the C&I market exclusively.

The firms we spoke with represented two different levels of suppliers: some were wholesalers and distributors and others were retailers and installers who also distribute. One mechanical and one motor supplier were found to have exclusive relationships with single manufacturers, but most suppliers sold products from various manufacturers.

Some confusion was found among suppliers regarding terminology. For example, one mechanical supplier did not recognize the term "packaged HVAC units" when asked about the categories of equipment sold, but in a subsequent discussion of specific equipment reported the firm sold packaged and split systems. Of the seven window suppliers interviewed, only two recognized the term "glazing" as meaning windows.[41] As these are terms used by EVT staff involved with this project, these findings suggest additional work is needed to identify the optimal terminology for energy efficient equipment in Vermont.

Although insufficient information was obtained from our supplier sample to support sales tracking, we believe the data provide an adequate cross section of the supplier markets. Should the DPS decide sales tracking is important, an approach could be developed from this initial effort that would achieve satisfactory results.

MARKET STRUCTURE

The issues of market structure include client concerns for energy efficiency, how equipment and efficiency are promoted, decision-making practices, and barriers to implementing energy efficiency.

Client Concerns for Energy Efficiency

Architects and engineers were asked detailed questions about their clients' commitment to energy efficiency. From this line of inquiry, we conclude client commitment to energy efficiency is moderate. It appears that clients talk about

[41] The sample size was too small to enable a mid-course correction and revision of the survey instrument. Unfortunately, this confusion led to a loss of data for the project.

energy efficiency much more often than they require it and are willing to pay for it.

Both architects and engineers report their clients asked about energy efficiency or expressed a commitment to energy efficiency at project outset about 90% of the time. Yet, only about two-thirds of the designers reported that the majority of their projects included *any* type of pre-design activities to address energy efficiency.[42] Similarly, only about half of the designers reported their clients were willing to invest to have their facilities be more energy efficient than similar facilities in the state. These opinions were corroborated by the extent to which clients are willing to pay for computer analysis of building or lighting energy use or lifecycle cost analysis of options. Only one-third of architects and one-half of engineers reported being paid to conduct computer analyses at least once in the past year, and 20% of architects and 25% of engineers reported being paid to conduct lifecycle cost analyses for at least half of their projects.[43]

One-third to a little over one-half of the designers, contractors and suppliers reported that their clients are more concerned about energy efficiency in the past year than in previous years. However, similar proportions of respondents reported their clients had the same level of concern as in previous years and about 10% to 15% of the contractors interviewed indicated their clients were less concerned. These findings are comparable to the reports of C&I end users about whether their concern for efficiency has changed. No differences by size of firm were noted.

Promotion of Energy Efficiency

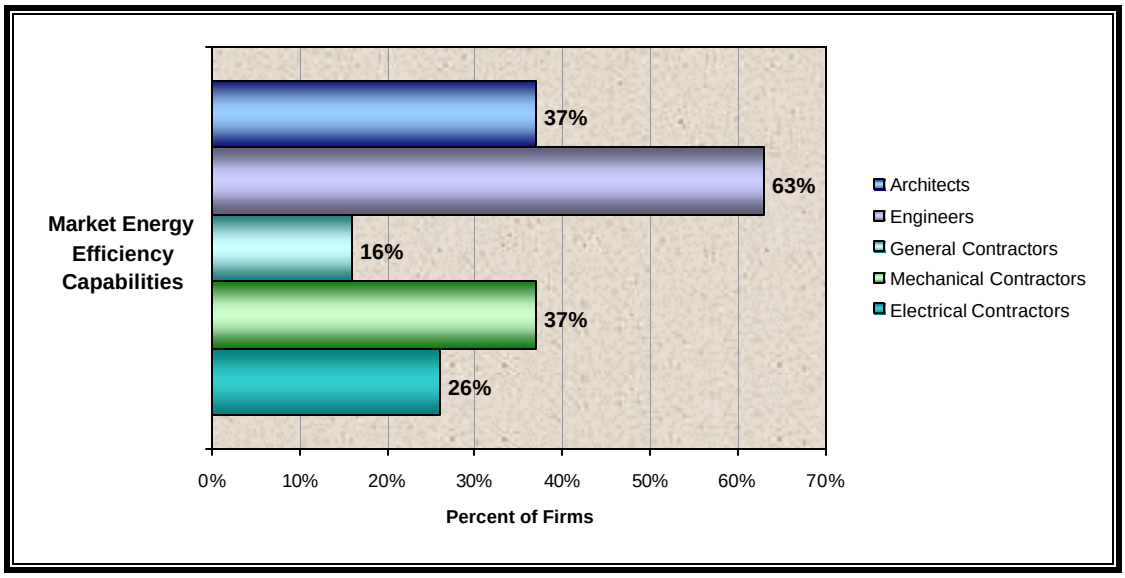
Figure 5.2 shows the degree to which various respondent groups market their energy efficiency capabilities.

[42] See Table 4.3.

[43] See Table 4.7.

Figure 5.2

PERCENT OF DESIGNERS AND CONTRACTORS THAT MARKET ENERGY EFFICIENCY CAPABILITIES



Engineers are more likely than architects to market their capability with energy efficiency. Among contractors, mechanical contractors are more likely to market their capability with energy efficiency than are electrical or general contractors. Size of firm does not have a bearing on which firms market their energy efficiency capabilities.

Suppliers also reported they discuss energy efficiency with their customers and promote energy efficient products. However, the practices described by each group vary. Within each group, we did not find that size of firm played an important role.

Window suppliers and lighting suppliers appear to be the strongest advocates of efficient products. All seven window suppliers and five of the seven lighting suppliers interviewed indicated they advocate energy-efficient equipment 100% of the time. The remaining two lighting suppliers indicated their recommendations varied by project according to the specific project requirements.

These findings from window and lighting suppliers are supported by findings from end users that had installed equipment. We asked C&I (end user) firms with construction and equipment projects and real estate developers who had purchased equipment about the frequency with which they had installed energy-efficient equipment. Of 12 measures explored, three lighting measures and low-e coatings on windows comprised four of the five most frequently installed measures. These measures had saturations of 40% to 70% for most of the groups of C&I and real estate firms.

HVAC suppliers reported a lower level of efficiency marketing practices. Only one supplier said his firm promotes energy efficiency nearly all the time. The other three HVAC suppliers interviewed said they promote efficiency 50% to 80% of the time, depending on the project, the size of the units, and the installation requirements. Among C&I and real estate firms that had installed equipment, programmable thermostats comprised one of the five most frequently installed measures, with a saturation of 30% to 80%, depending on the group.

Motor suppliers were similar to HVAC suppliers in their efficiency actions. Three of the four motor suppliers interviewed indicated they promote energy efficient motors at least half of the time. Motor suppliers noted energy efficiency was not always appropriate and that larger projects typically called for a greater focus on energy efficiency than smaller ones. Among C&I firms and real estate professionals that had installed motors, variable frequency drives were installed by 18% of C&I firms with motors in their permitted projects, 35% of C&I firms that had installed motors in the absence of a permitted project, and 66% of property developers.

Energy Efficiency Decision-Making

The different market actors had different perceptions about which party makes decisions about energy efficiency. Their perceptions tended to vary with their role in the design/construction process.

Electrical and general contractors say the primary decision-maker for equipment selection is the building owner, followed by the architect or engineer. These contractors rarely see themselves as the key decision-maker. The mechanical contractors interviewed perceived themselves as the primary

decision-maker for equipment selection on new construction and renovation projects, followed by the building owner. They perceived their influence on remodeling and equipment replacement projects to be somewhat lower. For these projects, mechanical contractors see themselves as making the decision at least half of the time. Interestingly, general contractors noted that for design-build projects no single party, including the owner, tends to lead the decision-making process; rather, the contractors describe it as highly collaborative.

Designers (architects and engineers) were asked somewhat different questions regarding efficiency decision-making than were asked of contractors. Architects and engineers were asked what professionals are typically involved in decision-making. Architects reported they (architects) usually took the lead for lighting and mechanical design, though for both systems they also described engineers as often taking the lead. Architects and engineers described mechanical contractors—but not electrical contractors—as sometimes taking the lead in decision-making. These findings provide some support to the self-perception of mechanical contractors. Engineers also mentioned equipment suppliers (both lighting and HVAC) as among the top two decision-makers for equipment decisions.

Suppliers were not asked their views on who are the key decision-makers.

The strong role that mechanical contractors see themselves as playing, as well as the strong role that all parties see for designers and owners suggests these parties are key players in the decision making process for equipment selection. C&I firms most frequently cited mechanical and general contractors as influencing HVAC decisions and lighting contractors as influencing lighting decisions. Among those C&I firms that used engineers, they frequently reported the engineers were influential along with the contractors. There were no differences by size of market actor firm among the responses.

Barriers to Implementing Energy Efficiency: Designers and Contractors

For purposes in this report, barriers have been identified as those factors that interviewees most frequently rated a “4” or “5” on a five-point scale, where “5” was defined as a “major problem”. We found the major barriers to energy

efficiency from the perspective of designers and contractors to be similar, although not identical.

Perceptions of barriers are shown in Figure 5.3. These perceptions are consistent with findings presented in the next section about the experience of market actors with energy efficiency.

Across all of the market actors, a significant barrier is their difficulty in providing clients with reliable estimates of the benefits of energy efficiency. This barrier ranked within the top two most problematic barriers for three of the five market actor groups.

Architects and engineers rated the *ability to assess the performance of equipment in a specific application* and the *willingness of the client to authorize research into performance and benefits* as very substantial barriers to energy efficiency in construction projects. These concerns are shared widely among the architects and engineers we interviewed. They are also consistent with the finding on barriers in other regions of the country.[44] Size of design firm was not found to have a bearing on the barriers mentioned by these designers.

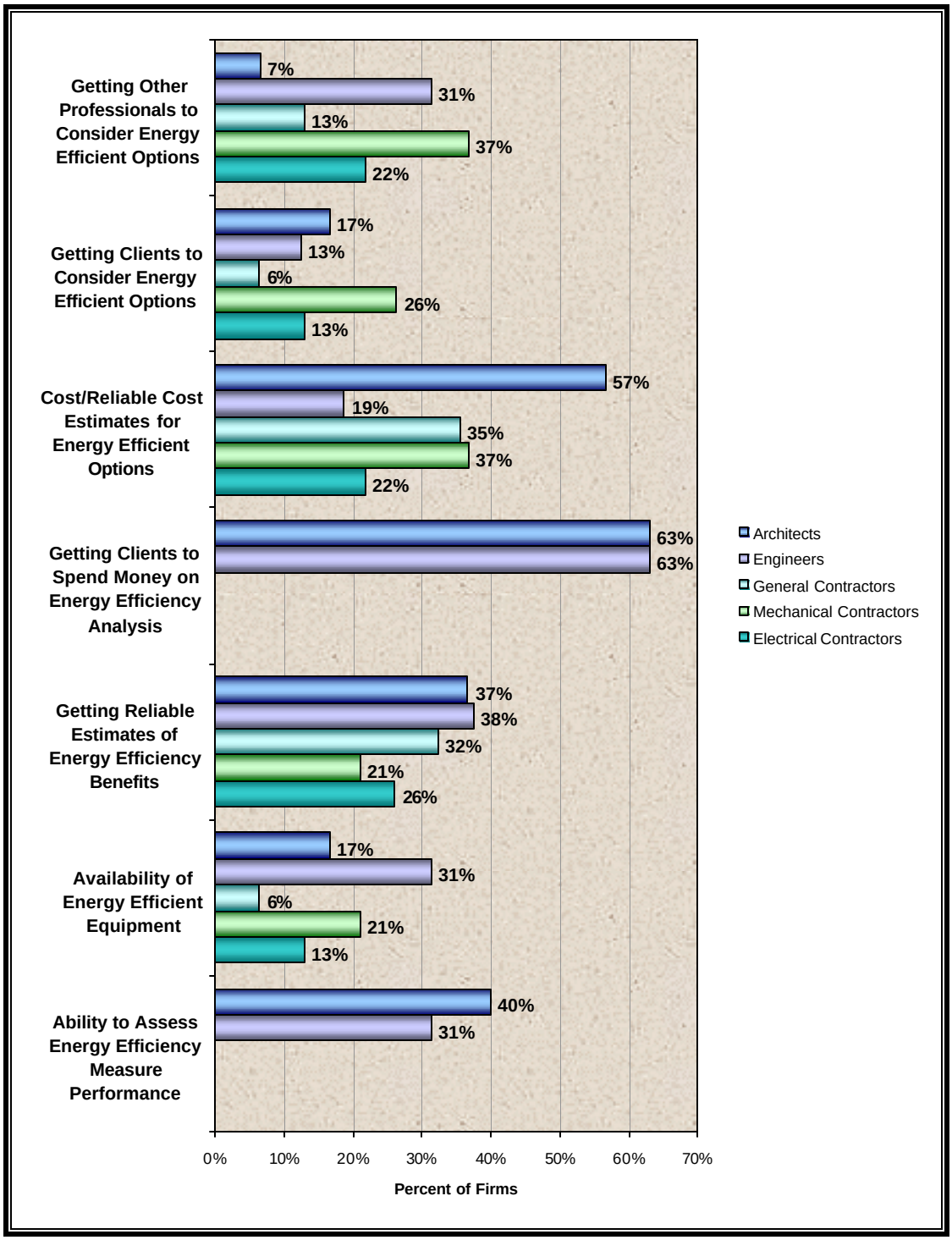
Contractors see the *cost of energy efficiency options* as a major barrier. Architects see as a major barrier the *ability to provide reliable estimate of the costs*, although most engineers do not share this concern.

Contractors see other contractors as major barriers to energy efficiency. Mechanical and electrical contractors point to general contractors as a barrier, while general contractors point to subcontractors as a barrier, though less of a barrier than the subcontractors see the general contractor. Engineers similarly see getting architects to consider options as a barrier; however, architects do not see engineers as a barrier.

[44] Work done by Research Into Action, Inc. for the Northwest Energy Efficiency's Alliance Architecture + Energy Program found that architects viewed the ability to develop reliable estimates of costs and benefits and getting the client to authorize research as major barriers to energy efficiency.

Figure 5.3

BARRIERS TO INCLUDING ENERGY EFFICIENCY IN PROJECTS (PERCENT OF MARKET ACTORS RATING BARRIER AS SUBSTANTIAL)



This issue of "finger pointing" among contractors was not explored in more detail during our telephone surveys due to the already lengthy survey instruments and time demands on interview respondents. However, we can turn to other survey findings to shed some light on this issue.

On the one hand, some support was found for the claims of mechanical and electrical contractors that general contractors are a barrier. Only 16% of general contractor respondents said their marketing materials show capabilities in energy-efficient design or equipment options, in contrast to 37% of the mechanical contractors and 26% of the electrical contractors.

On the other hand, some support was also found for the claims of general contractors that the mechanical and electrical contractors are the bottlenecks. Among C&I end users, discussing energy use with a general contractor, an architect, or a mechanical engineer led to higher rates of measure discussion and installation, as determined through statistical analysis. The results from statistical analysis are supported by C&I end users' reports that general contractors, architects, and mechanical engineers encouraged the consideration of energy efficiency more than other building and construction professionals.

These findings must be considered in light of the job responsibilities of general contractors. The general contractors are the ones responsible for bringing the project in on time and on budget, and bringing in a project that functions as expected. General contractors may feel the prices quoted by subcontractors for energy efficient options are too high, or that there is too much performance uncertainty, and so they reject the proposals. In this scenario, general contractors believe they would do more energy efficiency if the subcontractors could better meet their needs; subcontractors believe they would do more energy efficiency if the general contractors didn't reject it.

Further research is necessary to provide a deeper understanding of these issues of barriers and contractor interaction.

General contractors are the single market actor group for which size of firm made a difference in the barriers mentioned. A higher proportion of respondents from larger general contracting firms than from smaller firms rated each of the barriers as a substantial problem, with one exception. A higher proportion of smaller firms than larger firms rated "getting accurate and

objective information about options" as a substantial problem. The rating of barriers by all other market actor groups did not vary by size of firm.

Two opposing explanations for the general contractor size effect are possible: (1) larger firms try to do (and do) more energy efficiency than smaller firms, thus they are more acquainted with the barriers and assess them as more significant; and (2) smaller firms succeed at energy efficiency more than larger firms, and thus they rate the barriers as less significant. Perhaps both explanations are true among the group as a whole, with some larger firms rating the barriers as significant because they butt against them often, and other larger firms rating them as significant as an excuse for not taking action.

Barriers to Implementing Energy Efficiency: Suppliers

To explore supplier barriers, suppliers were asked first to tell us what features were most important to their customers and then to discuss the factors they considered as the selling features of energy-efficient products.

As shown in Figure 5.4, the features that suppliers said are most important to their customers varied across the four types of suppliers. For lighting and HVAC suppliers, energy savings or life cycle costs tied for highest place in importance, along with factors unique to each equipment type. Energy savings and life cycle cost were among customer's least important concerns in the view of window and motor suppliers.

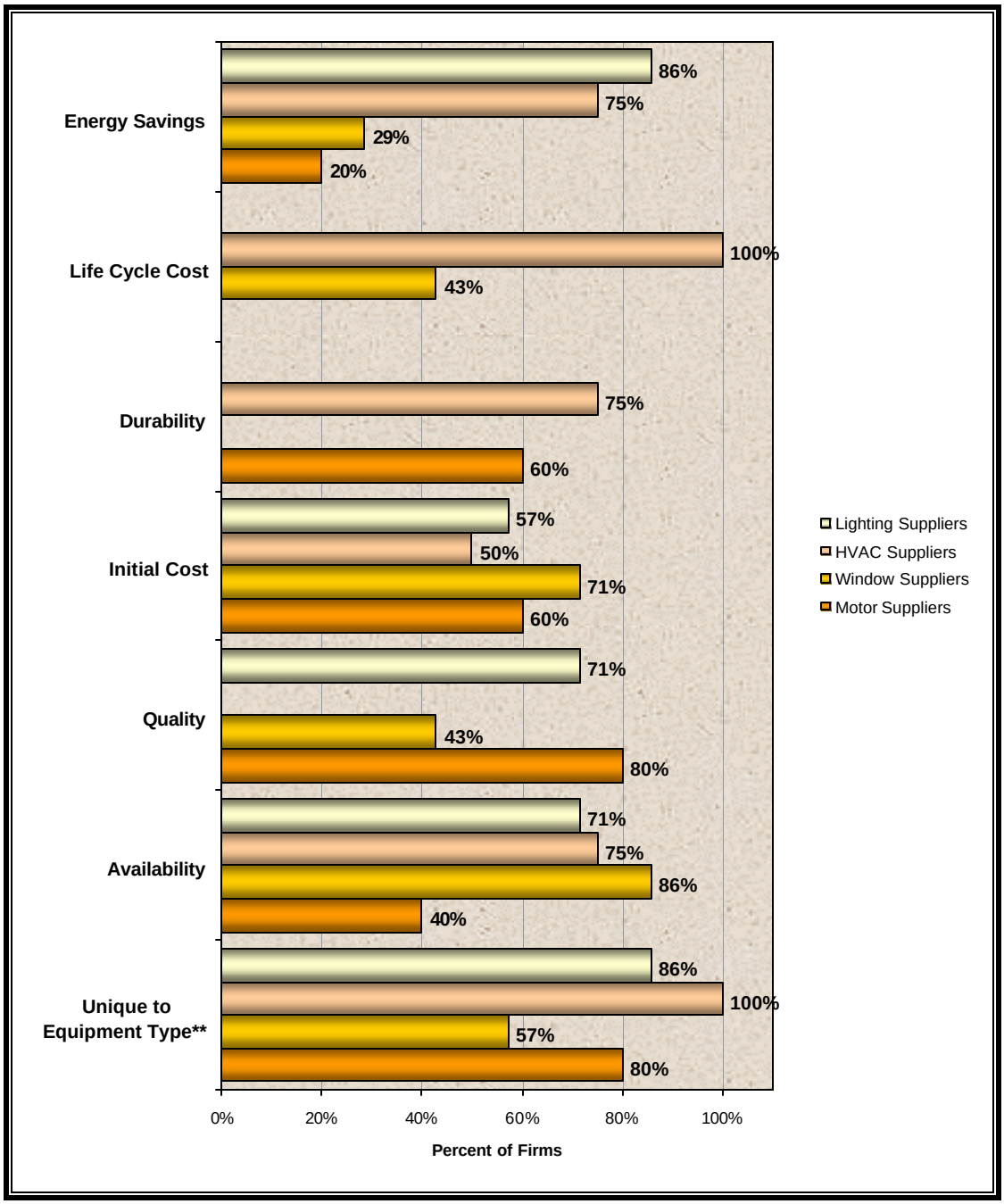
Suppliers identified the features of energy efficient equipment that they most often emphasize when talking with customers. Figure 5.5 shows energy savings or life cycle cost is the feature most suppliers report using to promote energy efficient equipment. Comfort and features unique to each equipment type are the next most common selling points.

Barriers to increasing the market share of energy efficiency products are evident when the features most important to customers are compared with the features suppliers emphasize when selling energy efficient equipment. Suppliers report customers consider availability, perceived quality/comfort, initial price and durability as important. Of these, only comfort and durability are also on the suppliers' lists of selling features for energy efficient equipment. Suppliers most frequently emphasize energy savings, yet energy savings is not the primary consideration in the customer's view for window and

motor purchases, and is equaled in importance by other factors for lighting and HVAC purchases.

Figure 5.4

EQUIPMENT FEATURES SUPPLIERS IDENTIFY AS MOST IMPORTANT TO CUSTOMERS (PERCENT* OF SUPPLIERS RATING FEATURE A "IMPORTANT" OR "VERY IMPORTANT")

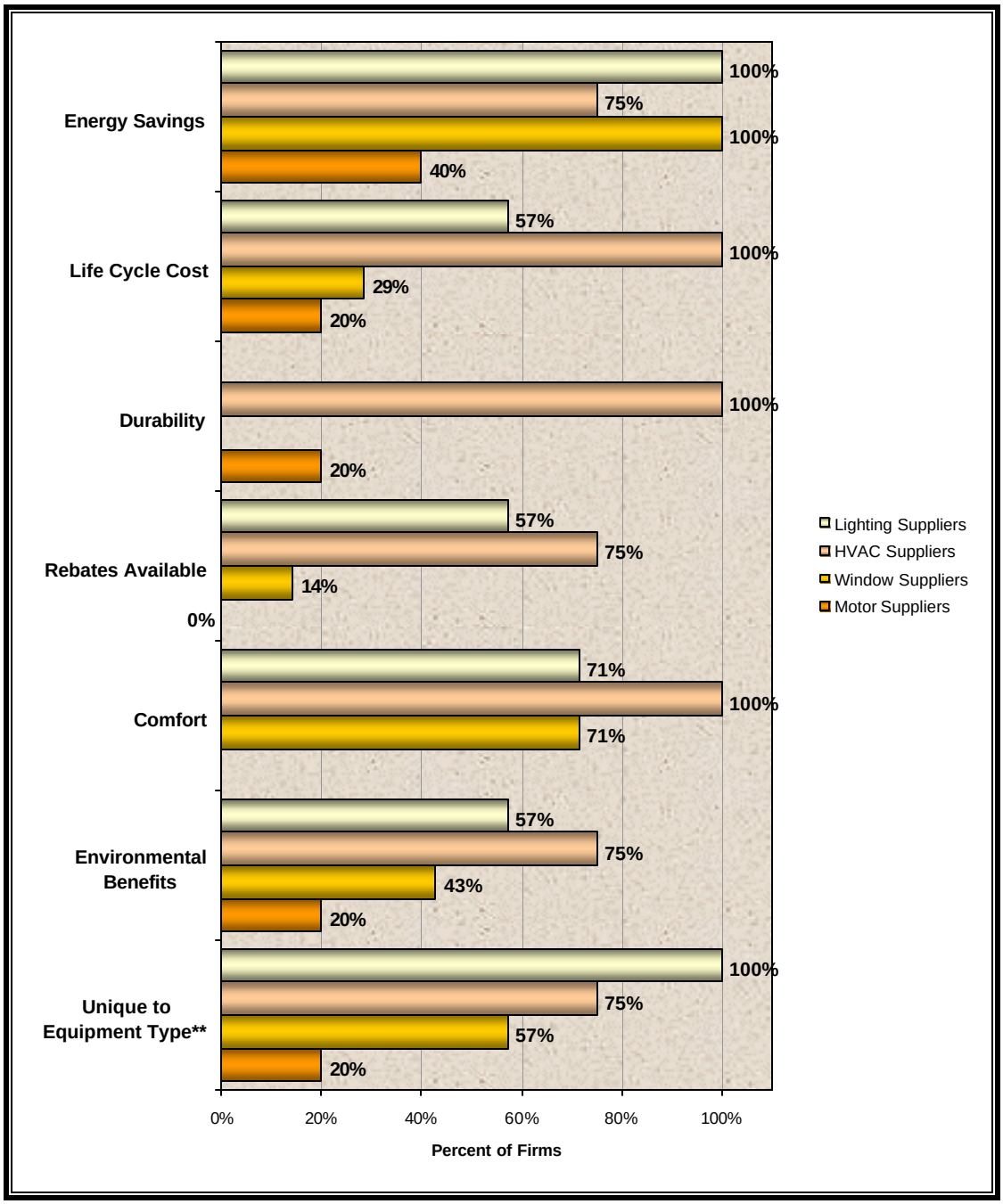


* *Percentages are based on very small sample sizes: Lighting – 7 suppliers; HVAC – 4 suppliers; Windows – 7 suppliers; Motors – 5 suppliers*

** *Lighting – pattern of light distribution; HVAC – comfort; Windows – delivery cost/time; Motors -- reliability*

Figure 5.5

FEATURES OF ENERGY EFFICIENT EQUIPMENT EMPHASIZED TO CUSTOMERS (PERCENT* OF SUPPLIERS RATING FEATURE "OFTEN" OR "ALWAYS" USED TO PROMOTE EQUIPMENT)



* *Percentages are based on very small sample sizes: Lighting – 7 suppliers; HVAC – 4 suppliers; Windows – 7 suppliers; Motors – 5 suppliers*

** *Lighting – color of light output; HVAC – availability; Windows – appearance; Motors -- maintenance*

These findings point to a barrier for suppliers selling energy efficient equipment. When buyers and sellers hold the perception that a product's primary selling feature is energy savings, sellers will be at a loss to promote the product to customers who are not particularly interested in this feature. In this situation, suppliers have little means of increasing their sales of energy efficient equipment. This situation will not change until energy-efficient equipment manufacturers and efficiency advocates, such as EVT, illuminate for suppliers (and buyers) the selling features that align with customer interests.

Barriers to energy efficiency from the view of designers, contractors, and suppliers remain quite challenging to address. Driven in part by the difficulty architects and engineers report in providing clients with reliable assessments of performance, benefits and costs, contractors and suppliers find little alignment between their customers' desires for equipment characteristics and the selling features they are familiar with for energy efficient equipment.

Were changes such as the following to occur, they would suggest that barriers to energy efficiency are being reduced:

- Suppliers begin to tout features other than energy savings for the energy-efficient equipment they sell.
- Architects and engineers are able to gain assistance and increased capability in assessing performance, benefits and costs.
- Contractors find system benefits easier to estimate and find each other more willing to discuss and consider energy efficiency options.

USE AND AWARENESS OF ENERGY EFFICIENCY MEASURES

This section discusses market actor experience with energy efficiency measures and practices and the types of measures sold or recommended. Because each group of market actors deals with different types of equipment, we asked the groups different questions and discuss each group separately.

Designers

Architects and engineers designing commercial and industrial buildings in Vermont have moderate familiarity with efficiency options. Firms with larger work volumes and more staff tend to have somewhat more familiarity with these measures and tend to specify them slightly more often. However, it is also true that some small firms are very knowledgeable about and experienced with energy-efficient design. Only one area of design was sensitive to size of firm: larger architectural firms used daylighting strategies and features more often than smaller firms.

To fully understand the extent to which firms' practices includes energy efficiency options, it is necessary to ask them to specifically describe the types of options they specify, rather than rely on general statements of knowledge or use of energy efficiency solutions. Therefore, architects and engineers were asked very detailed questions about their energy efficiency practices. The questions proceeded from pre-design practice through specific systems that have energy-efficient options. See Table 4.3 for a complete listing of measures and tally of responses; about 40 measures were explored.

Both architects and engineers reported that during the pre-design phase of projects they typically discuss energy efficiency with clients and with other design team members. More engineers (62%) however, reported they frequently set energy goals than did architects (33%). Engineers from smaller firms mentioned setting pre-design goals more often than those from larger firms. No other differences by size were noted for pre-design activities.

One-quarter of the engineers (4 out of 16) reported incorporating a variety of passive systems to reduce HVAC load and said they did this for about 20% of their projects. Three of the four engineers that reported incorporating passive systems were from large firms. In contrast, one-half of the architects (15 out of 30) reported doing designs that include a variety of passive system features that go beyond the use of operable windows and said they did so on over 50% of their projects. Ten of the fifteen architects were from large firms.

All of the architects and engineers who were involved in specifying glazing materials indicated they specified low-e coatings for windows. However, only one engineer (of the three who specify glazing) and three architects (of the 30 who specify glazing) were able to recall the solar heat gain factor (SHGF) they

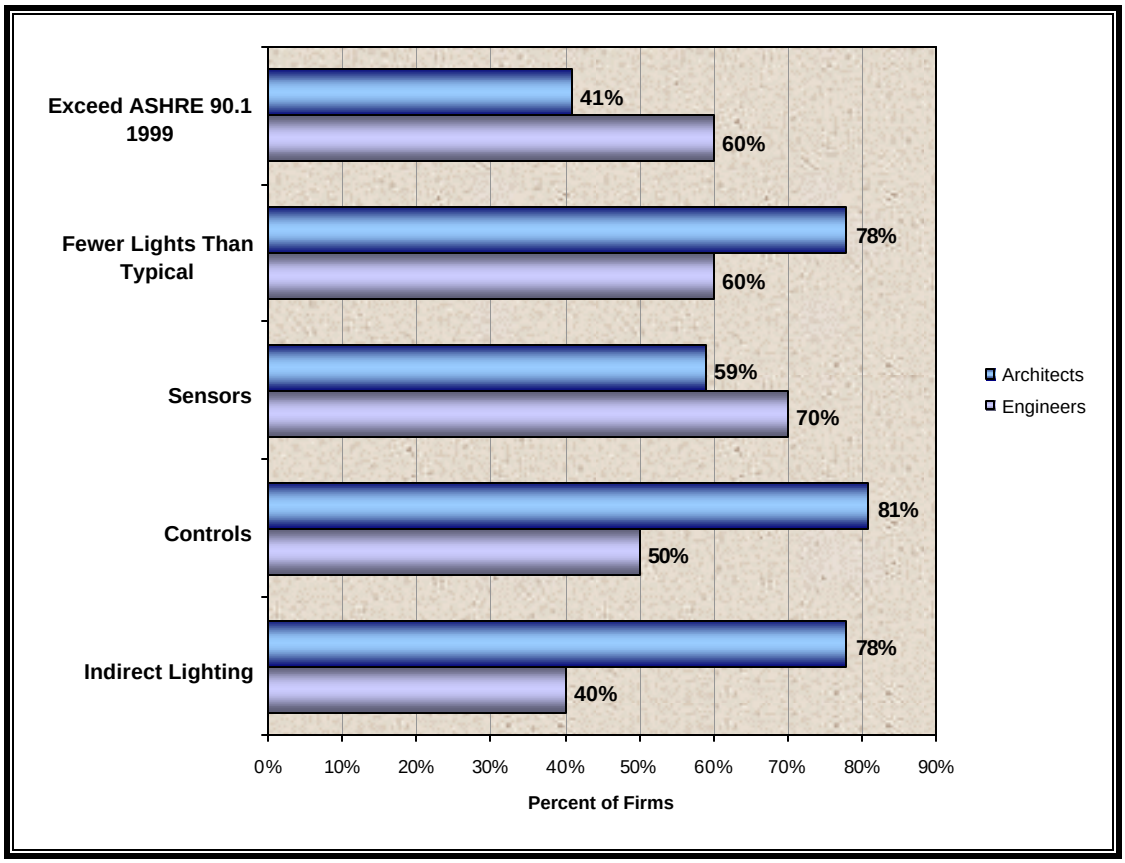
typically specified. The two designers from small firms said they specify SHGF less than 0.4 and the other two, from large firms, said they specify SHGF between 0.51 and 0.6.

Some use of day lighting was reported by 5 (31%) of the engineers and 23 (76%) of the architects interviewed. Because day lighting might imply to some respondents simply the use of extra windows, we asked about specific day lighting features and about the use of a day lighting strategy. The specific features were endorsed less frequently than was the general term day lighting. Designers from large firms more often reported using each specific day lighting measure. The use of day lighting strategies was reported by 3 (19%) of the engineers and 11 (36%) of the architects. Two of the engineers that reported using a day lighting strategy were from large firms. Seven of the eleven architects that employed a day lighting strategy were from large firms. Even fewer designers said they had used automatic dimming to maximize the benefits of day lighting (two, or 13%, of the engineers and ten, or 30%, of the architects). The designers doing day lighting reported the percent of their projects; percents ranged from less than 1% for one large firm (*i.e.*, one project) to about half for some of the smaller firms.

Figure 5.6 highlights the lighting design practices identified by the interviewed architects and engineers.

Figure 5.6

PROPORTION OF DESIGNERS USING LIGHTING EFFICIENCY PRACTICE AT LEAST ONCE IN PAST YEAR



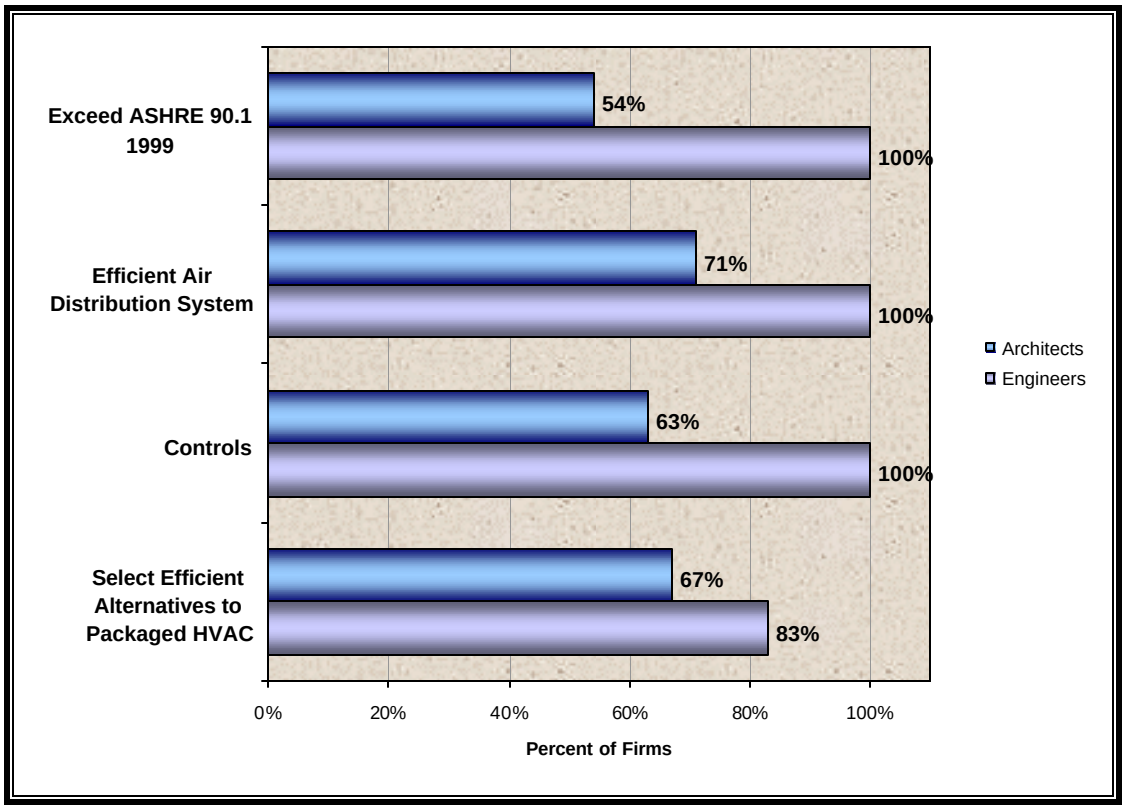
Note: Proportions of those architects and engineers involved in lighting design

Engineers who are involved in lighting design (10 were involved of the 16 we spoke with) were more likely to be familiar with ASHRAE standards, and to design project to exceed the ASHRAE 90.1 1999 standards, than were the architects that reported involvement in lighting design (27 of 30). Yet engineers were less likely than architects to specify each of a variety of lighting features that increase the efficiency of the lighting systems. No differences by size of firm were discernible for lighting design practices.

The findings for the role of ASHRAE standards in HVAC design are similar to those for lighting design, as shown in Figure 5.7.

Figure 5.7

PROPORTION OF DESIGNERS USING HVAC EFFICIENCY PRACTICE AT LEAST ONCE IN PAST YEAR



Note: Proportions of those architects and engineers involved in HVAC design

Engineers who design HVAC systems (12 design HVAC of the 16 engineers) were more familiar with and more frequently reported designing projects to exceed ASHRAE 90.1 1999 standards than did the architects that reported involvement in HVAC design (24 of 30). Yet unlike the lighting design practices, engineers also more frequently reported using one or more specific energy-efficient design practices than did architects. No differences were discernible by size of firm for architects and engineers.

We asked the 12 engineers who reported specifying HVAC equipment about the specific HVAC measures that they specify. These engineers reported a high level of familiarity with different HVAC measures. Seven engineers reported specifying variable air volume (VAV) systems—four of the seven specified VAV

systems for one-third or more of their projects. Ten engineers reported considering alternatives to packaged HVAC systems. Size of firm did not have a bearing on specification of VAV systems or alternatives to packaged HVAC systems.

Twelve engineers reported specifying economizers. Five of the twelve specified economizers for 80% of their projects. Dual and single enthalpy economizers were the most commonly specified. Three engineers said they specified a single enthalpy economizer in at least 80% of the projects they had worked on and two engineers said they had specified dual enthalpy economizers for 80% of their projects. Most reported they did not specify one type of economizer all of the time but varied the specification according to project needs. For measures other than economizers, VAVs, and alternatives to packaged HVAC systems, most of the engineers reported they specified these solutions in 20% or less of the projects they worked on.

Between 50% and 60% of architects and engineers reported they use modeling as a design tool. The most common application by engineers is to simulate cooling and heating for sizing HVAC equipment (used by 91% of engineers at least once in the past year); the most common application by architects is to simulate lighting (used by 43% of architects at least once in the past year). Modeling, however, appears to be used on only about 50% or less of the projects that most of these architects and engineers work on. Forty-three percent of architects said they used computer modeling of any type on at least half of their projects; 19% of engineers reported this. A minority—three engineers (19%) and three architects (10%)—reported using it on more than 75% of their projects.

Life cycle cost analysis was reported as being used by architects and engineers somewhat less frequently than they use modeling, and is used on a smaller proportion of projects. Architects from larger firms more frequently reported conducting life-cycle analyses without passing the cost on to the clients than did architects from smaller firms. No other differences by size of firm were apparent.

Forty percent of architects and 30% of engineers reported they had used commissioning, yet more detailed questioning revealed only 3% of architects and no engineers had used an independent third-party agent for commissioning. Comments from both architects and engineers clearly indicate

two common perceptions: (1) they perceive third party commissioning as no more valuable than commissioning (or, often, equipment balancing) done by their own staff; and (2) they perceive commissioning to be so poorly defined that it does not hold value for them. Size of firm was not a factor in the responses.

General Contractors

Large general contractors, defined by the number of projects conducted, were found somewhat more likely than small general contractors to rate themselves as experienced (a rating of "4" or "5" on a five-point scale with "5" being "very experienced") with energy efficiency measures (see Table 5.1). In this analysis, large general contractors are defined as those that conducted four or more projects during the past year. This influence of size on self-rating of experience was *not* found when size was defined based on number of employees.

Although large general contractors were somewhat more likely than small general contractors to rate themselves as experienced with efficiency practices, this perceived experience was not reflected in the extent to which they *used* most efficiency measures in the past year. Higher proportions of large[45] general contractors than small contractors reported using daylighting measures and building commissioning. No other differences were found between large and small general contractors in their use of the other categories of energy efficiency measures on projects during the past year.

General contractors appear to have more experience with day lighting than any other group of market actors we spoke with. Thirty-nine percent reported they worked on at least one project in the past year that included day lighting features. General contractors most commonly worked on projects using roof designs, such as skylights and clerestories, and shading devices.[46] Given that a full day lighting strategy takes into account heating and cooling loads, this

[45] Large defined either as five or more employees or four or more projects.

[46] Table 4.4 provides the proportion of contractors using each efficiency measure explored in their new construction and renovation projects.

finding suggests perhaps 15% of the general contractors are experienced with day lighting, a figure consistent with the other market actor groups.

Table 5.1

PROPORTION OF GENERAL CONTRACTORS RATING THEMSELVES AS EXPERIENCED WITH EFFICIENCY PRACTICES

EFFICIENCY PRACTICES	ALL GENERAL CONTRACTORS (N=31)	LARGE GENERAL CONTRACTORS* (N=16)
Third-Party Commissioning of Equipment Installation and Operation	43%	50%
High Efficiency HVAC	32%	44%
High Efficiency Lighting	29%	38%
Energy Management Systems	27%	27
Day Lighting	25%	25%
High-Efficiency HVAC Alternatives	23%	31%
Variable Speed Drives	21%	31%
Energy Analysis of Equipment Options	21%	31%
Life-Cycle Costing	16%	25%
Building-Wide Lighting Control System	13%	25%
On-Site Electricity Generation	6%	6%

* *Large general contractors are those that conducted four or more projects in the past year.*

One very large general contractor reported installing a micro-turbine; no other general contractors installed distributed generation systems. Eight large contractors (26%) reported using third party commissioning at least once in the past year. Only two of the eight contractors reported they employed a third party to perform commissioning for half or more of their projects during the past year. Of the 146 new construction projects, general contractors had

worked on in the past year, less than 5% (8 projects) had third party commissioning. This small proportion of projects is consistent with the reports of architects (3% reported using third-party commissioning on half or more of their projects) and engineers (0% reported third-party commissioning).

The most commonly used efficiency measures were insulation and low-e coatings on windows. More than 80% of general contractors reported wall insulation of R19 and more than half of general contractors reported roof insulation of R38. About two-thirds of general contractors reported using low-e glazing 100% of the time; 81% say they used it at least 50% of the time; and 96% say they used it at least once in the past year. However, only 39% (12) were familiar with the term SHGF rating, and only two general contractors knew the specifications for the windows they install. One of the two contractors was large and located in Chittenden County, and the other contractor was small and located in rural Vermont. As might be expected, general contractors report slightly higher use of these measures in new construction than in remodeling projects. No differences by size of firm were noted.

Other than low-e windows and insulation, low proportions of general contractors reported installing efficiency measures in their projects in the past year. There is room for an increase in the penetration of all measures, including low-e windows and insulation, especially in the remodeling market.

Mechanical Contractors and HVAC Suppliers

Similar to general contractors, large mechanical contractors were somewhat more likely than small mechanical contractors to describe themselves as more experienced with energy efficiency measures. Table 5.2 shows the proportion of mechanical contractors rating themselves a “4” or “5” on a five-point scale, with “5” indicating “very experienced.”

Again similar to general contractors, large mechanical contractors were no more likely than small mechanical contractors to report *installing* efficiency measures in their projects during the past year.

Mechanical contractors compared favorably to electrical contractors and general contractors in their use of efficiency measures. Greater proportions of mechanical contractors than electrical contractors used, at least once in the

past year, the energy efficiency measures we explored. Half or more of the mechanical contractors reported using each of 11 measures (out of 18 explored) on at least one new construction or renovation project in the past year.[47] In contrast, half or more of the electrical contractors reported using each of 7 measures (out of 19 explored) on at least one new construction or renovation project in the past year.

Table 5.2

PROPORTION OF MECHANICAL CONTRACTORS RATING THEMSELVES AS EXPERIENCED WITH EFFICIENCY PRACTICES

EFFICIENCY PRACTICES	ALL MECHANICAL CONTRACTORS (N=19)	LARGE MECHANICAL CONTRACTORS* (N=10)
High Efficiency HVAC	79%	90%
Energy Management Systems	67%	80%
Variable Speed Drives	61%	80%
High-Efficiency HVAC Alternatives	58%	60%
Energy Analysis of Equipment Options	53%	60%
Variable Air Volume Fans	39%	50%
Life-Cycle Costing	31%	30%
Third-Party Commissioning of Equipment Installation and Operation	29%	20%
On-Site Electricity Generation	21%	20%

* *Large mechanical contractors are those employing five or more people.*

[47] See Table 4.4.

We expect that just as mechanical contractors are more familiar with efficiency measures than electrical contractors, HVAC suppliers are more familiar with energy efficient solutions than the lighting suppliers, which are discussed below. Unfortunately, baseline measures for the mechanical equipment can only be provided for contractors. Because some suppliers did not understand the terminology, even awareness and availability measures cannot be estimated for them.

All but two mechanical contractors reported using at least some method for sizing HVAC systems. The most commonly used method is software modeling. Two-thirds of mechanical contractors (68%) reported using modeling for new construction and renovation projects at least once in the past year and 58% reported using it on half or more of their projects. Slightly fewer reported using modeling to size HVAC systems for remodeling and equipment replacement projects.

Those who do not use software to size HVAC systems are more likely to use manual calculations than rules of thumb. One large contractor with ten employees indicated that over 75% of the time he replaces equipment with the same sized equipment, thus not using any sizing techniques. The contractor said all but one of his projects were equipment replacement projects, rather than new construction or renovation.

Two-thirds of the mechanical contractors interviewed (68%) reported their HVAC systems exceed ASHRAE 90.1 1999 standards for heating on at least one new construction/ renovation project in the last year, and 32% reported they exceeded these standards on half or more of their projects. The proportion that reported they exceed the ASHRAE 1989 standards on at least half of their projects is 37%.

Of the various types of HVAC equipment that could be installed for efficiency, the most commonly installed measures are:

- Programmable thermostats (at least once in past year: 95% new construction, 63% remodeling);
- Single enthalpy economizers (at least once in past year: 63% new construction, 56% remodeling; on at least half of projects: 37% new construction, 26% remodeling);

- VAV systems (at least once in past year: 68% new construction, 53% remodeling);[48] and
- Energy management systems with controls for optimal start (at least once in past year: 63% new construction, 53% remodeling).

Not surprisingly, the suppliers we spoke with also carry these measures.

Only three of the mechanical contracting firms reported installing chillers in either new or remodeling projects. All three of these firms have large project volumes and large staff.

We also asked mechanical contractors a very general question about their practices for packaged systems. Most contractors responded they install high-efficiency packaged systems (at least once in past year: 74% new construction, 63% remodeling). Size of firm did not have a bearing on mechanical contractors' specification of high-efficiency packaged systems.

Suppliers were unable or unwilling to provide detail about the types of packaged systems they sell. As noted, some of the suppliers had difficulty with the terminology of packaged heating and cooling systems; this certainly contributed to the lack of response regarding efficiency data. Only one of the four suppliers indicated they sold any units in excess of SEER 13 for 5.4 ton systems (the smallest size) or SEER 11 for 5.4-11.25 ton systems.

Although the supplier data are extremely limited, they suggest mechanical contractors may have overstated the extent to which the packaged systems they installed were high efficiency.

Electrical Contractors and Lighting Suppliers

Similar to general and mechanical contractors, large electrical contractors were somewhat more likely than small electrical contractors to describe themselves as experienced with energy efficiency measures. Table 5.3 shows the

[48] For comparison, 58% of engineers reported use of VAVs in at least one project in the past year. See Table 4.3.

proportion of electrical contractors rating themselves a "4" or "5" on a five-point scale, with "5" indicating "very experienced."

As found for general and mechanical contractors, the efficiency measures *installed* in projects during the past year did not vary by size of contracting firm.

Electrical contractors reported lower installation rates of efficiency measures than mechanical contractors, but higher rates than general contractors reported. Of 19 efficiency measures and practices, only 7 were used by more than half of electrical contractors at least once in the past year. These include: compact fluorescent lamps (83%), T-8 fixtures (78%), high-intensity discharge lamps (70%), occupancy sensors (65%), and high-bay fluorescent lamps (52%).[49] Controls, automatic dimming ballasts and other solutions are used infrequently by electrical contractors and lack wide availability from lighting suppliers.

Table 5.3

PROPORTION OF ELECTRICAL CONTRACTORS RATING THEMSELVES AS EXPERIENCED WITH EFFICIENCY PRACTICES

EFFICIENCY PRACTICES	ALL ELECTRICAL CONTRACTORS (N=23)	LARGE ELECTRICAL CONTRACTORS* (N=12)
High Efficiency Lighting	65%	75%
LED and Low Voltage Lights	57%	25%
Occupancy Sensors	48%	58%
Building-Wide Lighting Control System	26%	42%
On-Site Electricity Generation	26%	25%

[49] The other two efficiency practices conducted by more than half of electrical contractors were discussions with owners and designers about energy use and conducting energy analyses of options discussed. See Table 4.4.

T-5 Fixtures	26%	33%
Energy Analysis of Equipment Options	22%	33%
Energy Management Systems	17%	33%
Automatic Day Light Dimming	17%	25%
Third-Party Commissioning of Equipment Installation and Operation	13%	25%
Life-Cycle Costing	13%	25%

** Large electrical contractors are those employing five or more people.*

Only 17% of the electrical contractors reported exceeding ASHRAE 90.1 1999 standards for lighting on at least one project in the past year; 26% reported exceeding ASHRAE 90.1 1989 standards. Another 26% stated they did not know what the ASHRAE standards were. As with the other efficiency measures, these findings did not vary by size of firm.

Compact fluorescent and T-8 fixtures for all types of construction and pulse start metal halide and high intensity discharge lamps for new construction are reportedly installed in over two-thirds of projects.

As was true for mechanical contractors, electrical contractors reported slightly more installation activity in new construction and renovation projects than in remodeling and equipment replacement projects.

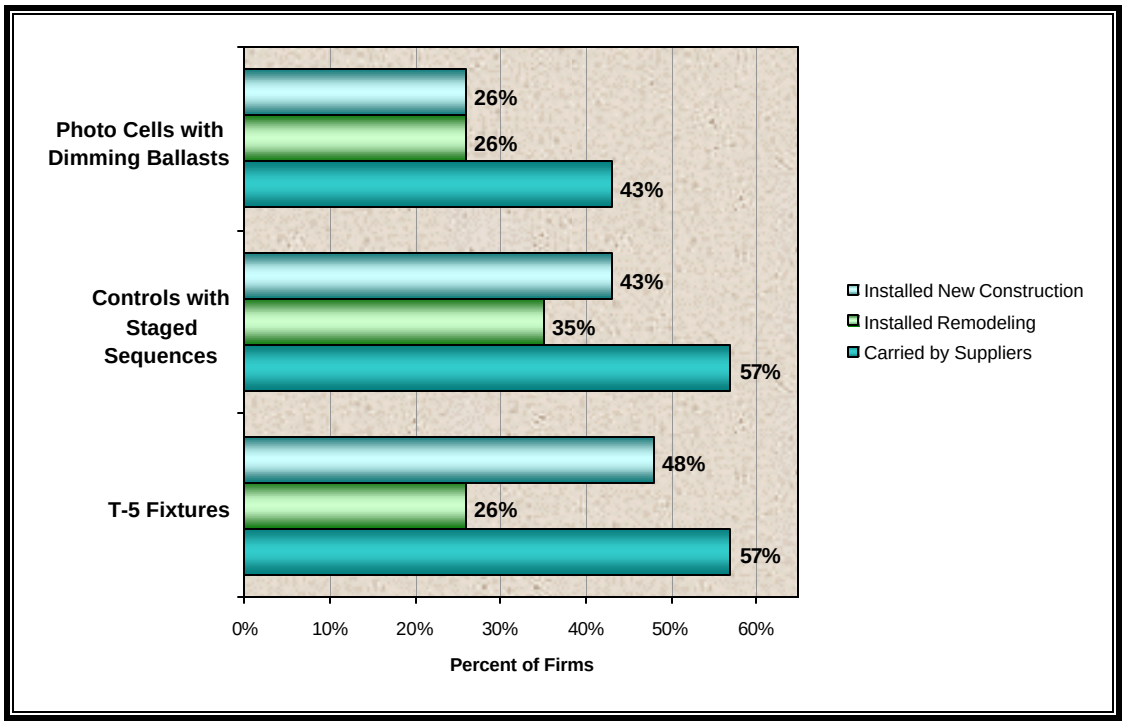
Most of the targeted products were carried by at least 40% of the lighting suppliers, with the following measures carried by 80% to 100% (measures that are of particular note for the evaluation are shown in Figure 5.8):

- Magnetic ballasts,
- LED exit signs,
- On-off occupancy sensors,
- Regular metal halide,

- Pulse start metal halide,
- T-8 and T-12 fixtures, and
- Compact florescent fixtures.

Figure 5.8

PERCENT* OF CONTRACTORS INSTALLING AND SUPPLIERS CARRYING KEY LIGHTING MEASURES



* *Supplier sample very small – 7 lighting suppliers*

Window Suppliers

Window suppliers claimed high levels of knowledge about energy efficient products. The seven window suppliers we spoke with overwhelming agreed

they were knowledgeable about energy efficient products and that they promoted energy efficient products to their customers.

Unfortunately, as noted, five of the seven window suppliers misunderstood some of the questions about products they sell, and the small sample size precluded us from making mid-stream adjustments to the survey instrument.[50] As a consequence, we did not obtain any information about the types of windows these five suppliers sell. For the two suppliers who understood the terminology we used (glazing as a term for windows), we obtained information on the types of windows they sell and the specialty windows they sell: custom storefronts and curtain walls.

The two suppliers who reported the types of glazing they use in their windows indicated they sell double or triple paned windows 70% to 100% of the time. One of the two suppliers did not know the SHGF for the windows he sold; the other estimated that 85% of his window sales have SHGF less than 0.49 and 15% have SHGF over 0.49. He reported all of his windows have low-e coatings.

The suppliers selling custom storefronts primarily sell double pane windows without low-e coatings. This product was sold for about half of the storefronts one supplier sold and about two-thirds of the storefronts for the other. However, for both suppliers custom storefronts make up only 10% to 15% of their total annual sales. The one firm also selling custom curtain walls reported these sales are 2% of its total annual sales, and 100% of the sales are for double pane windows with low-e coatings.

Motor Suppliers

Similar to other equipment suppliers, four of the five motor suppliers interviewed indicated they actively promote or recommend motors that exceed standard efficiency levels. However, we believe this may overstate the actual promotion activities. The MotorUp evaluation noted that motor suppliers across New England have shown “very spotty and inconsistent progress” in

[50] Note that the survey was pre-tested. The problem was not detected from the very small pre-test sample.

participation in the MotorsUp program.[51] Many suppliers participate in that program, but 50 of the 225 regional firms account for 75% of the incentives.

The efficiency product focus for the suppliers we interviewed was not motors but rather variable frequency drives (VFD), which are not addressed by MotorUp. For VFDs, one of the five motor suppliers rated himself as moderately knowledgeable (a "7" on a ten-point scale with "10" being very knowledgeable). The other four suppliers rated themselves as not knowledgeable (a rating of "3" or less). Three of the suppliers indicated they sell VFDs and that most of the applications were industrial, with a very small number of sales for HVAC applications.

PROGRAM PROCESS ASSESSMENT

This section describes the response of designers, contractors, and suppliers to questions relating to Act 250, Vermont's land-use planning and development law, and Efficiency Vermont.

Act 250

About two-thirds of the architects and three-quarters of the engineers interviewed have been involved in projects that faced Act 250 review. About half of the general contractors and around 20% of the electrical and mechanical contractors reported having similar exposure.

Respondents' assessment of Act 250 was gauged by asking whether they believe Act 250 results in *more* energy efficiency features being incorporated and if it results in a *higher level* of efficiency measures. Taking the higher of the two responses to this question gives the following: Two-thirds of engineers, one-half of architects and general contractors, and about one-quarter of electrical and mechanical contractors interviewed think Act 250 has resulted in more features or a higher level of efficiency measures than would have happened in the absence of Act 250.

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[51] *MotorUp Evaluation and Market Assessment*. Prepared by Xenergy for the Northeast Energy Efficiency Partnership. Boston, MA. November 2001.

Designers were asked to elaborate on their assessment. Some commented the process was useful in helping the designer leverage efficiency into a project. Others commented it was cumbersome or that requirements were arbitrary.

Large general contractors were more likely than small contractors to believe Act 250 resulted in more or higher levels of efficiency measures. For all other market actors, there was no difference in experience or assessment of Act 250 by firm size.

Almost all of the lighting, HVAC and windows suppliers were aware of Act 250. Lighting suppliers thought customers with Act 250 projects tended to buy more energy efficient equipment, but neither HVAC suppliers nor window suppliers concurred. Not surprisingly, given the role of motors in end user processes rather than in building equipment, motor suppliers had limited awareness of Act 250.

Act 250 has been in effect in Vermont for decades. As discussed in Chapter 4, within this evaluation, we were unable to tease out why market actors differ in their assessment of Act 250. Subsequent studies can explore market actors' responses to the 2001 Vermont Guidelines for Energy Efficient Commercial Construction (developed to assist people in meeting the energy requirements of Act 250), perhaps illuminating some of these questions.

Efficiency Vermont

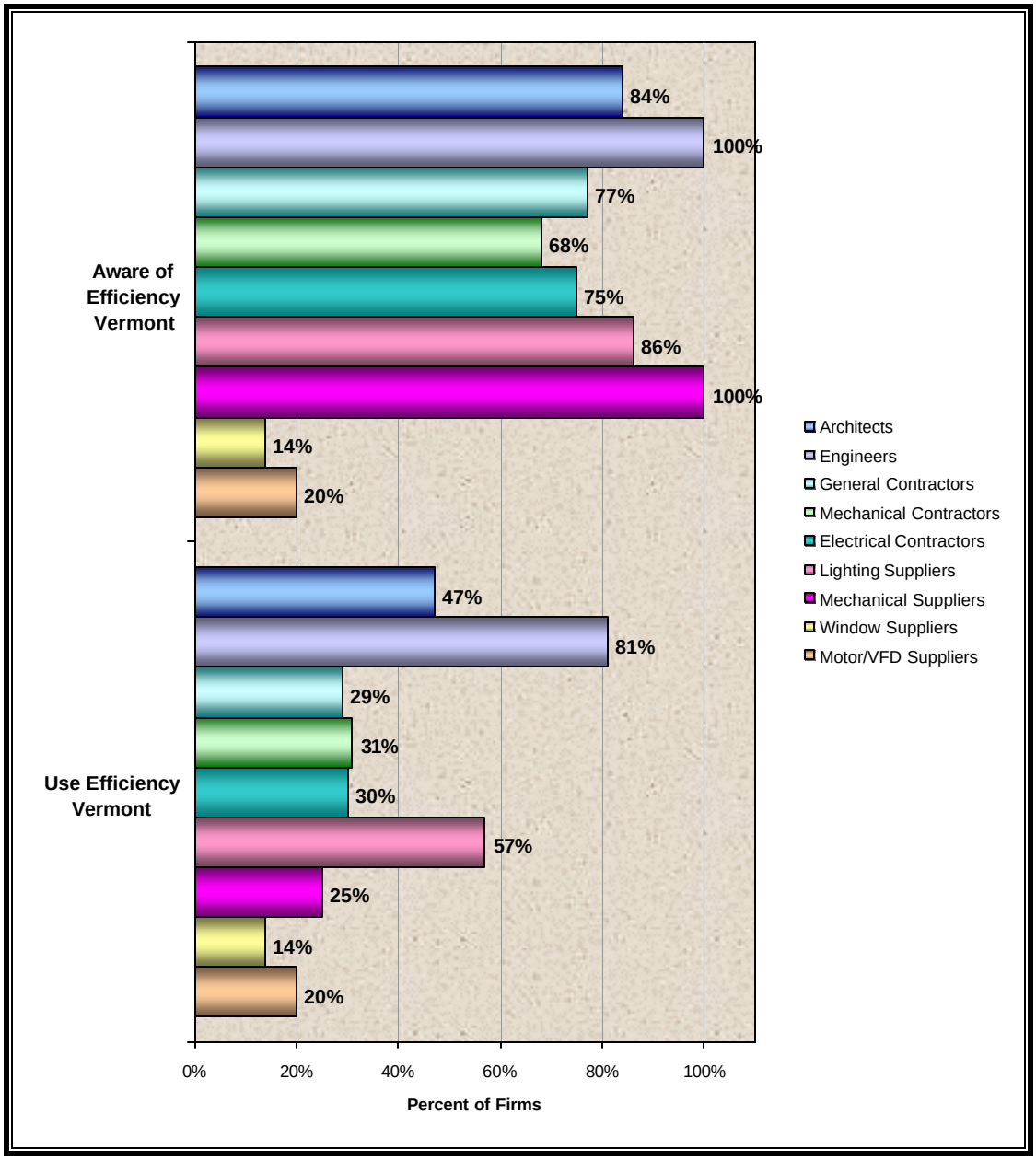
Most of the market actors reported high levels of awareness of EVT, as shown in Figure 5.9. Awareness and use of EVT is highest for engineers. Architects have the next highest awareness level, but unlike engineers—most of whom used EVT services—only about one-half of the aware architects had used EVT services. For contractors, awareness ranged between 68% and 77%; about 30% of all three contractor groups used EVT. The single window and motor suppliers we spoke with who noted awareness of EVT also reported using their services. Lighting suppliers reported the highest usage rate, following engineers. (A caveat to this finding is the very small sample size for lighting suppliers—7 respondents, and rather small sample size for engineers—16 respondents.)

Designers and contractors that used EVT services typically used both rebates and assistance/ information services (see Table 5.4). Less commonly,

respondents used just rebates alone or assistance alone. Perhaps not surprisingly, architects were unlikely to use rebates and mainly used EVT assistance and information services, including attending the February Building Solutions conference. Very few contractors and suppliers had attended the Building Solutions conference. Comparing rebates with other types of assistance, rebates were more frequently used than all other nonfinancial services combined.

Figure 5.9

AWARENESS AND USE OF EVT SERVICES*



* *Percentages for suppliers are based on a very small sample sizes: Lighting – 7 suppliers; HVAC – 4 suppliers; Windows – 7 suppliers; Motors –5 suppliers*

Table 5.4

PROPORTION OF MARKET ACTORS USING EVT SERVICES

MARKET ACTOR	USED ANY EVT SERVICE	USED ONLY FINANCIAL INCENTIVES	USED ONLY ASSISTANCE/ INFORMATION SERVICES	USED BOTH FINANCIAL AND ASSISTANCE SERVICES
Architects	47%	3%	17%	27%
Engineers	81%	19%	12%	50%
General Contractors	29%	15%	6%	6%
Mechanical Contractors	31%	5%	0%	26%
Electrical Contractors	30%	9%	4%	17%
Lighting Suppliers	57%	29%	0%	29%
HVAC Suppliers	25%	0%	0%	25%
Window Suppliers	14%	0%	14%	0%
Motor Suppliers	20%	0%	0%	20%

Overall, about 60% to 70% of the designers and contractors who reported using EVT rated the services highly in each of four areas explored, as shown in Table 5.5. The table provides the proportion of respondents rating EVT services a "4" or a "5" on a five-point scale with "5" being the highest rating.

A few respondents gave EVT low marks, suggesting EVT has opportunities to improve. One electrical contractor was dissatisfied with EVT's knowledge of efficient solutions and the usefulness of the information. One general contractor was dissatisfied with the quality of the services. One architect was dissatisfied with these same three aspects of the service, as was one engineer. Their opinions suggest EVT could expand its staff knowledge of practical issues contractors face, especially in the more rural areas of Vermont.

Yet most of the market actors' comments point to the benefits of EVT and the opportunity EVT has to increase the knowledge and awareness of contractors

and suppliers for energy efficient equipment throughout Vermont. As one respondent said: "Often contractors have never seen these options before. EVT has got to get the word out!"

Table 5.5

PROPORTION OF RESPONDENTS HIGHLY RATING THE EVT SERVICES THEY RECEIVED

MARKET PARTICIPANT*	USEFULNESS OF INFORMATION	RESPONSIVENESS TO PROJECT NEEDS	QUALITY OF SERVICES	KNOWLEDGE
Architects	64%	57%	71%	50%
Engineers	62%	38%	46%	46%
General Contractors	63%	50%	50%	63%
Mechanical Contractors	50%	83%	50%	33%
Electrical Contractors	86%	71%	86%	86%
Lighting Suppliers	100%	100%	100%	100%
HVAC Suppliers	100%	100%	100%	100%
Window Suppliers	0%	0%	100%	100%
Motor Suppliers	0%	100%	0%	0%

* *Sample sizes for suppliers using EVT services are very small: 4 lighting suppliers, one HVAC supplier, one window supplier, and one motor supplier.*

Finally, we examined the relationship between whether designers had used EVT services and their assessment of market barriers. Large proportions of architects and engineers had rated as significant barriers the difficulty in assessing the performance of, and obtaining reliable estimates of the benefits of, energy efficiency options. For architects, we found no difference between those who had used EVT's services and those who had not in their rating of the difficulty of these two barriers. Thus, even architects using EVT services perceive these barriers to be particularly problematic. This suggests these are difficult areas for architects, even with EVT assistance. No conclusions can be

drawn from these findings about the value of the information EVT provides on efficiency measure performance and benefits.

For engineers, only three respondents had not used EVT services. For both barriers, two who had not used EVT services rated the barrier as particularly problematic, compared with one who had used EVT services. The other 13 engineers had used EVT services and did not rate the barrier as particularly problematic. This finding provides weak support for the notion that engineers who use EVT are less troubled by these barriers than those who do not use EVT.

No differences were found in awareness, use, or assessment of EVT by size of market actor.

5. Summary of Market Actor Results

6. REAL ESTATE PROFESSIONALS FINDINGS

This chapter presents the survey findings from discussions with developers and real estate managers. Real estate professionals act in the construction market both as entities that supply end users with buildings and equipment and as end users themselves, receiving building and equipment services from market actors (designers, contractors, and suppliers).

The chapter organizes our findings into four topic areas: (1) market characteristics; (2) market structure; (3) current energy efficiency practices; and (4) program process findings.

The GDS team interviewed 16 real estate professionals, exceeding our target of 15 completed interviews.[52] Eleven of the sixteen interviewees reported their firm both developed and managed commercial/industrial properties; five of the managers reported their firms are property managers only and do not develop properties. Throughout the chapter, we distinguish between the real estate firms on the basis of whether or not they report developing properties.[53]

Analyses were conducted by firm size and by location. The size and location groupings were each created to produce subsets of approximately equal size. Firms managing properties totaling less than 75,000 square feet are grouped together as "small" (5 firms), in contrast to "large" firms managing more 75,000 square feet or more (8 firms). Firms in Chittenden County and small urban areas are grouped together (7 firms), in contrast to rural areas (9 firms). Table 6.1 shows the distribution of firms according to total square footage of properties managed and location.

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52 The developer and real estate manager populations were assembled from purchased lists of developers and real estate managers and from a list of developers maintained by the Department of Public Service.

53 Respondents self-report of development activities often differed from what we expected based on the list from which the contact was obtained. We conclude that the lists did not provide the expected differentiation of roles, but did enable us to reach broadly into the real estate developer and management community.

Table 6.1

SIZE AND LOCATION CHARACTERISTICS OF REAL ESTATE FIRMS

CHARACTERISTICS	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
TOTAL SQUARE FOOTAGE OF PROPERTIES MANAGED			
Under 75,000 (Small)	4 (36%)	1 (20%)	5 (31%)
75,000 and Over (Large)	6 (55%)	2 (40%)	8 (50%)
Don't Recall	1 (9%)	2 (40%)	3 (19%)
LOCATION			
Chittenden County and Small Urban	6 (55%)	1 (20%)	7 (44%)
Rural	5 (45%)	4 (80%)	9 (66%)

Table 6.2 shows how the size and location of firms varies together. Most of the firms in the Chittenden County/ Small Urban group are large, and the majority of the rural firms are small. One developer and two nondevelopers—all located in rural areas—did not provide estimates of their sizes. Given the patterns evident in the data (most large firms are in Chittenden County or small urban areas and most small firms are in rural areas), it is likely these respondents are small size.

Table 6.2

SIZE OF PROFESSIONAL BY LOCATION

LOCATION	LARGE	SMALL	TOTAL
Chittenden County/ Small Urban	6 (5 developers)	1 (1 developer)	7
Rural	2 (1 developer)	4 (3 developers)	6

Total	8	5	13

Because the overall sample size is small (16 real estate firms), the findings do not represent precise estimates of the total population of real estate firms in Vermont. Due to the very small sizes of the subsamples, the subsamples of developer and nondeveloper, large and small, and Chittenden County/ small urban and rural cannot be definitively compared. Thus, conclusions about firm type, size, and location are described using such phrases as "there is a tendency" and "somewhat more" or "somewhat less". Although the sample is small, we have no indication that it is skewed or nonrepresentative of the population.

We examined every variable in the survey instrument by type of firm, firm size, and location. The text mentions all findings of interest. No mention of the influence of firm type, size or location means no apparent differences were found between subgroups.

We compare key findings from the real estate firms with findings obtained from commercial and industrial firms (end users), which are discussed in detail in Chapter 7.

CHARACTERISTICS OF REAL ESTATE PROFESSIONALS

To describe salient characteristics of Vermont's real estate professionals, the following areas were assessed: building ownership and energy bill responsibilities; building stock – types and sizes; and plans to change space.

Building Ownership and Energy Bill Responsibilities

Five of the 16 real estate respondents with whom we spoke report their companies manage buildings but do not engage in any development. They may or may not own the buildings they manage. In fact, Table 6.3 shows one firm owns the buildings they manage, two firms manage property owned by others,

and two firms manage both buildings they own and buildings owned by others. None of these characteristics varied by the size or location of the firm.

Eleven of the 16 real estate respondents report that, in addition to managing properties, their company develops properties and constructs buildings for commercial or industrial use. Nine of these 11 (82%) retain ownership of some or all of the properties they develop and lease them to tenants; one respondent firm does not retain ownership of the properties and one respondent was not sure. As shown in Table 6.3, more than half of the developers (7 out of 11) own all of the properties they manage. No differences by size or location were discernible.

Table 6.3

OWNERSHIP OF PROPERTIES MANAGED

PERCENT OF PROPERTIES OWNED AND MANAGED + PERCENT OF PROPERTIES MANAGED FOR OWNER	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
100% + 0%	7 (64%)	1 (20%)	8 (50%)
75% + 25%	1 (9%)	0	1 (6%)
50% + 50%	0	2 (40%)	2 (13%)
40% + 60%	1 (9%)	0	1 (6%)
0% + 100%	1 (9%)	2 (40%)	3 (19%)
Not Sure	1 (9%)	0	1 (6%)

No respondent reported managing property for a real estate investment trust (REIT).

All respondents indicated the owner pays for energy use in the common areas of the buildings and the tenants pay for energy use in the spaces they occupy. This finding describes a barrier to energy efficiency termed “split incentives”.

The developer pays the cost of constructing an efficient building yet the tenant reaps most of the benefit of lower energy bills. Unless the developer can recoup the cost of efficiency measures through the building's sale or lease price, the developer does not have sufficient incentive to build energy-efficient structures.

Building Stock: Types and Sizes

Office and retail spaces were the most common development types reported, followed by industrial and warehouse space (Table 6.4), and most of these building types are managed by the firms that develop them. Firms that do not develop properties manage a similarly diverse set of building types.

Table 6.4

BUILDING TYPES DEVELOPED AND MANAGED (MULTIPLE RESPONSES)

BUILDING TYPE	PROPERTIES DEVELOPED	PROPERTIES MANAGED		
	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Office	7 (64%)	7 (64%)	3 (60%)	10 (63%)
Retail	5 (45%)	5 (45%)	3 (60%)	8 (50%)
Warehouse	3 (27%)	5 (45%)	1 (20%)	6 (38%)
Industrial	3 (27%)	3 (27%)	2 (40%)	5 (31%)
Multi-family, 1-3 Stories	1 (9%)	2 (18%)	3 (60%)	5 (31%)
Multi-family, 4+ Stories	1 (9%)	0	1 (20%)	1 (6%)
Public Buildings, Health Care, College, Church, or Other Institutions	1 (9%)	1 (9%)	0	1 (6%)
School (Non-College)	0	0	0	0

Seven of the 11 developers were able to give an estimate of the total square footage of all the property their firms developed in Vermont over the 12 months prior to the survey. Three of the seven had developed less than 10,000 square feet and all seven had developed less than 75,000 square feet (Table 6.5). The developers managed more square footage than they developed; six of the eleven developers managed over 75,000 square feet of property. Only three of the five firms that do not develop properties were able to estimate the total square footage managed, and two of these respondents reported their firms managed over 75,000 square feet in the preceding year.

Table 6.5

TOTAL SQUARE FOOTAGE OF PROPERTY DEVELOPED AND MANAGED

BUILDING TYPE	PROPERTIES DEVELOPED	PROPERTIES MANAGED		
	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Under 5,000	2 (18%)	0	0	0
5,000 to Under 10,000	1 (9%)	1 (9%)	1 (20%)	2 (13%)
10,000 to Under 25,000	2 (18%)	1 (9%)	0	1 (6%)
25,000 to Under 75,000	2 (18%)	1 (9%)	0	1 (6%)
75,000 and Over	0	6 (55%)	2 (40%)	8 (50%)
Don't Know	4 (36%)	2 (18%)	2 (40%)	4 (25%)

Plans to Change Space

Nine of the 11 developers have plans to change the space they manage; six of these nine have plans to construct a new building (Table 6.6). One of the five firms that manage but do not develop properties plans to construct a new building and remodel part of an existing building. This firm owns about half of

the properties it manages. One other firm that does not develop properties plans to remodel part of an existing building; this firm does not own any of the properties it manages.

This high proportion planning to construct a new building suggests that real estate professionals constitute a large opportunity for energy efficiency.

The total number of real estate professionals with plans to change the space they develop or manage was 11—or 69% of the professionals interviewed. Most firms were planning on making more than one type of change to their properties. Only two firms planned to undertake a single activity—remodeling. Two firms had plans to remodel and undertake new construction or an addition to an existing building. The remaining firms either reported plans to conduct all three activities, or reported plans to conduct two of the activities and reported "don't know" to one of the activities. Thus, in the analyses that follow, we are unable to compare subsets of respondents based on the type of change they planned to make to their facilities.

Table 6.6

TYPE OF CONSTRUCTION PROJECTS PLANNED FOR PROPERTIES MANAGED (MULTIPLE MENTIONS)

TYPE OF CONSTRUCTION PROJECT	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Construction of a New Building	6 (55%)	1 (20%)	7 (44%)
An addition to an Existing building	4 (36%)	0	4 (25%)
A remodel of Part of an Existing Building	6 (55%)	2 (40%)	8 (50%)
No Plans	2 (18%)	3 (60%)	5 (31%)

Real estate firms in Chittenden County and small urban areas were much more likely to have plans to construct a new building (six of seven firms) than

were firms in rural areas (one of seven firms; two respondents from rural firms did not know if their firm had plans).

MARKET STRUCTURE

This section explores the patterns of energy efficiency activities and attitudes (that is, the market structure) among Vermont's real estate professionals. We discuss the activities of having shopped for or discussed purchasing new equipment and installing end use equipment. We present awareness and attitudes: awareness of ENERGY STAR®; awareness of efficiency measures; concern for energy efficiency; and barriers to implementing energy efficiency.

Shopped for, or Discussed Purchasing, New Equipment

During the past two years, real estate respondents reported having shopped for roof or insulation levels more frequently than any other equipment type (Table 6.7). (Note: Among C&I firms who did not purchase any equipment, more respondents also had shopped for roof or insulation levels than any other equipment type.) As expected, respondents from firms that develop properties were more likely to report market forays for all types of equipment than those that do not develop properties. Smaller and rural firms more often reported shopping for elements of the building structure: roofing, insulation, and windows. Recall that 11 of the 16 firms have plans to change their facilities, of which only 2 firms are planning solely remodeling projects.

Table 6.7

MARKET FORAYS BY REAL ESTATE FIRMS DURING THE LAST TWO YEARS (MULTIPLE RESPONSES)

SHOPPED FOR OR DISCUSSED WITH DESIGNER OR CONTRACTOR REGARDING:	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Changes to Roof or Insulation Levels	9 (82%)	2 (40%)	11 (69%)
Lighting Systems*	8 (73%)	1 (20%)	9 (56%)

Controls for Lighting Systems*	7 (64%)	0	7 (44%)
Changes to Windows	5 (45%)	2 (40%)	7 (44%)
Changes to Ventilation Systems	5 (45%)	1 (20%)	6 (38%)
Changes to Heating or Cooling Equipment	5 (45%)	2 (40%)	7 (44%)
Changes to Building Structure	4 (36%)	1 (20%)	5 (31%)
Changes in Motors or Variable Frequency Drives	4 (36%)	0	4 (25%)
Changes to Any Other Major Electrical Equipment, Such As Pumps, Industrial Equipment, or Snow-Making Equipment	3 (27%)	1 (20%)	4 (25%)
Changes to Refrigeration Systems	2 (18%)	0	2 (13%)
No Equipment	0	2 (40%)	2 (13%)

** Respondents were asked whether they had "purchased, contracted for, or shopped for" these systems. For all other measures, respondents were asked whether they had "shopped for or talked to a designer or contractor" about the action*

Installed Windows, Heating, or Lighting Equipment

Eight of the 11 developers and two of the five firms that do not develop properties reported having installed windows, lighting, or heating equipment during the past two years, or had made changes to these systems (Table 6.8). All eight of the developers installed lighting, all in combination with windows or heating systems or both. None of the firms that do not develop properties reported installing lighting during the past two years.

Table 6.8

EQUIPMENT INSTALLED BY REAL ESTATE FIRMS

EQUIPMENT INSTALLED	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Windows	5 (45%)	1 (20%)	6 (38%)
Lighting	8 (73%)	0	8 (50%)
Heating	5 (45%)	2 (40%)	7 (44%)
COMBINATIONS OF SYSTEMS INSTALLED			
Windows, Heating, and Lighting	2 (18%)	0	2 (13%)
Windows and Lighting	3 (27%)	0	3 (19%)
Windows and Heating	0	1 (20%)	1 (6%)
Heating and Lighting	3 (27%)	0	3 (19%)
Heating Alone	0	1 (20%)	1 (6%)
No building systems	3 (27%)	3 (60%)	6 (38%)

All of the developers who shopped for windows, lighting, or heating systems during the past two years had gone on to buy and install them, as did one of the two nondevelopers who shopped for these systems.

Awareness of ENERGY STAR®

Thirteen real estate respondents said they had seen or heard of a label or logo about energy on business equipment or building materials (Table 6.9). Of those 13 respondents, three spontaneously mention ENERGY STAR® as the name label or logo they had heard of having to do with the energy use of business equipment or building materials. Respondents from firms that develop properties and those from firms that do not develop were similar in their rates of recognizing and understanding the ENERGY STAR® logo.

Table 6.9

AWARENESS OF ENERGY STAR® LABEL BY REAL ESTATE FIRMS

AWARENESS OF ENERGY STAR®	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
Heard of Label or Logo About Energy	10 (91%) (n=11)	3 (60%) (n=5)	13 (81%) (n=16)
Spontaneous Mention of ENERGY STAR®	3 (30%) (n=10)	0 (n=3)	3 (23%) (n=13)
Recognized ENERGY STAR® Name	6 (75%) (n=8)	3 (60%) (n=5)	9 (69%) (n=13)
Recognized ENERGY STAR® Description	2 (100%) (n=2)	1 (50%) (n=2)	3 (75%) (n=4)
Total Reported Awareness of ENERGY STAR®	11 (100%) (n=11)	4 (80%) (n=5)	15 (94%) (n=16)
Accurate Understanding of ENERGY STAR® Meaning Among Those with Reported Awareness	9 (82%) (n=11)	4 (100%) (n=4)	13 (87%) (n=15)
Accurate Understanding of ENERGY STAR® Meaning Among Sample	9 (82%) (n=11)	4 (80%) (n=5)	13 (81%) (n=16)
No Knowledge of ENERGY STAR® or Inaccurate Understanding Among Sample	2 (18%) (n=11)	1 (20%) (n=5)	3 (19%) (n=16)

The real estate professionals have a higher level of accurate awareness of ENERGY STAR® than do the C&I firms with whom we spoke, both those with permitted construction projects and those without. Among the C&I firms, about two-thirds of respondents had an accurate awareness of ENERGY STAR®, compared with about 80% of the real estate respondents.

The respondents who recognized the ENERGY STAR® logo described the ideas they associate with the logo. Table 6.10 shows that only two of the 16 respondents lacked an accurate understanding of the logo.

Table 6.10

MEANING OF ENERGY STAR® TO REAL ESTATE FIRMS (MULTIPLE MENTIONS)

MEANING OF ENERGY STAR®	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=4)	TOTAL REAL ESTATE FIRMS (N=16)
Conserves Energy, Energy Efficient	7 (64%)	2 (50%)	9 (56%)
Savings on Energy Bill	3 (27%)	2 (50%)	5 (31%)
Good for the Environment	1 (9%)	0	1 (6%)
Certified as Energy Efficient, Standard of Energy	1 (9%)	1 (25%)	2 (13%)
Inaccurate Understanding	2 (18%)	0	2 (13%)

Concern for Energy Efficiency

Three of the 11 respondents (27%) who work for firms that develop properties reported that the energy efficiency of the building is important to their company as a developer (Table 6.11). Recall that these companies also manage many of the properties they develop. We asked the five firms that only manage properties and engage in no development work for their view of the importance of energy efficiency as a manager. Two of these five respondents rate energy efficiency as important. Three real estate firms said they were more concerned about energy use now than in previous years; all of these firms are developers. Respondents from large firms of all types more often reported concern for energy efficiency.

Table 6.11

CONCERN FOR ENERGY EFFICIENCY AMONG REAL ESTATE FIRMS (TOP TWO BOXES)

MEASURES OF CONCERN FOR ENERGY EFFICIENCY	TOTAL
Building's Energy Efficiency Is Important to Developer*	3 (27%) (n=11)
Building's Energy Efficiency Is Important to Manager*	2 (40%) (n=5)
More Concerned About Energy Use Than In Previous Years	3 (19%) (n=16)

* *Respondents rating the importance of energy efficiency with a "9" or "10" on a ten-point scale with 1 as "not at all important," and 10 as "very important."*

As shown in Table 6.11, nineteen percent of real estate professionals described themselves as more concerned about energy use than in previous years. This compares with 44% of C&I firms with permitted projects and 33% of C&I firms with no permitted projects who said they were more concerned about energy use this year than in previous years. However, we do not have a way to assess how the groups compare in their current level of concern about energy use.

Barriers to Implementing Energy Efficiency

The lighting characteristics reported as most important to the real estate firms are operating costs, initial cost, and energy savings potential (Table 6.12). The differences in attitudes between the firms that develop properties and those that do not are not significant for most characteristics. The one exception is "compatibility with existing lighting fixtures," which was important to all five of

the firms that do not develop properties and to two-thirds (7 out of 11) of the firms that develop properties.[54]

Table 6.12

PROPORTION ASSIGNING HIGH IMPORTANCE TO LIGHTING EQUIPMENT CRITERIA (TOP TWO BOXES)*

LIGHTING CHARACTERISTIC	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Operating Costs	10 (91%)	5 (100%)	15 (94%)
Initial Cost	10 (91%)	5 (100%)	15 (94%)
Energy Savings Potential	10 (91%)	4 (80%)	14 (88%)
Quality	10 (91%)	3 (60%)	13 (81%)
Maintenance Effort or Cost	9 (82%)	4 (80%)	13 (81%)
Availability	9 (82%)	4 (80%)	13 (81%)
Pattern of Light Distribution	9 (82%)	3 (60%)	12 (75%)
Compatibility with Existing Fixtures	7 (64%)	5 (100%)	12 (75%)
Style	4 (36%)	2 (40%)	6 (38%)

* *Respondents who rated criterion with a "4" or "5" on a 1 to 5 scale in which 1 is "not at all satisfied," and 5 is "very satisfied.*

The opinions of real estate professionals regarding the importance of various lighting criteria are similar to those found for C&I firms, with one exception. For real estate professionals, initial cost rated tied for first place (rated highly

[54] The high proportion of respondents who rate lighting operating costs and energy saving potential as important to them appears at odds to the rather low proportion of respondents shown in Table 14 to be concerned with energy efficiency. The data do not provide any insights into this apparent contradiction.

by all but one of the 16 respondents) whereas for C&I firms, initial cost ranked seventh on the list of nine criteria, (rated highly by about 70% of respondents). The initial cost of efficient lighting equipment appears to be a barrier.

Respondents were asked to identify the characteristics that come to mind when they think of energy efficient lighting. Table 6.13 shows "low operating cost/saves money" is the association most often reported by the respondents with whom we spoke (7 out of 16). Three of these respondents also said "saves energy", and another one said solely "saves energy". Thus, 50% of respondents associated high-efficiency lighting with cost and energy savings. Given that "low operating costs" was rated important by 91% of respondents (see Table 6.13), this suggests there may be room for improvement in the awareness of steps one can take to lower operating costs. Thirty-one percent of respondents provided an association that is ambiguous as to positive or negative connotations or is neutral. This finding also suggests awareness of the benefits of efficient lighting could be improved.

Table 6.13

ASSOCIATIONS WITH ENERGY EFFICIENT LIGHTING EQUIPMENT (MULTIPLE RESPONSES)

ASSOCIATIONS	TOTAL REAL ESTATE FIRMS (N=16)
Low Operating Cost, Saves Money	7 (44%)
Saves Energy	4 (25%)
As Much Lighting As Needed, Not More, Functionality	3 (19%)
Quality, Prefer Efficient Lighting	2 (13%)
High Output Fluorescent	1 (6%)
Cost, Installation Cost, Color, Fluorescent, No Comment	5 (31%)

Regarding heating and cooling equipment, durability is the characteristic real estate firms most often identified as important (15 out of 16). Table 6.14 shows

comfort, maintenance effort or cost, and energy savings are also characteristics important to nearly all of the respondents (14 out of 16). Initial cost and life cycle cost of the heating and cooling equipment were rated as important by all but one of the firms that develop properties, a higher proportion than those not developing properties rated important. The initial cost of efficient HVAC equipment appears to be a barrier.

Respondents from firms in Chittenden County and small urban areas rated the life cycle cost of heating and cooling equipment as important more often than firms in rural areas.

Real estate professionals do not differ appreciably from C&I firms in the importance with which they rated the various characteristics of heating and cooling equipment.

Table 6.14

PROPORTION ASSIGNING HIGH IMPORTANCE TO HEATING AND COOLING EQUIPMENT CRITERIA (TOP TWO BOXES)*

HEATING AND COOLING CHARACTERISTIC	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
Durability	11 (100%)	4 (80%)	15 (94%)
Comfort	11 (100%)	3 (60%)	14 (88%)
Maintenance Effort or Cost	11 (100%)	3 (60%)	14 (88%)
Energy Savings	10 (91%)	4 (80%)	14 (88%)
Initial Cost	10 (91%)	3 (60%)	13 (81%)
Availability	9 (82%)	4 (80%)	13 (81%)
Life Cycle Cost	10 (91%)	2 (40%)	12 (75%)

* *Respondents who rated criterion with a "4" or "5" on a 1 to 5 scale in which 1 is "not at all satisfied," and 5 is "very satisfied."*

Respondents from all firms most often associate "operating costs savings" with energy efficient heating and cooling equipment (Table 6.15). Unfortunately, an equal proportion either gave no comment when asked for an association (five respondents) or made a neutral, ambiguous comment ("fuel type", one respondent). While 62% provided a positive association, the high proportion of "no comment" suggests real estate professionals may lack awareness of the benefits of energy-efficient HVAC equipment.

In a previous section of this chapter we found that tenants pay their energy bills and so the natural incentive that real estate professionals might have for energy efficiency—that is, building operating cost savings—is diminished. This finding, coupled with the finding that higher first costs are barriers to the purchase of efficient lighting and heating equipment, suggests an important role for rebates in the real estate market.

Table 6.15

ASSOCIATIONS WITH ENERGY EFFICIENT HEATING AND COOLING EQUIPMENT

ASSOCIATIONS	TOTAL REAL ESTATE FIRMS (N=16)
Operating Costs Savings	6 (38%)
Ease and Efficiency of Operations, How Well It Works	3 (19%)
Reliability, Maintenance	3 (19%)
Programmable, Good Environmental Control, Comfort	3 (19%)
BTU Output	1 (6%)
Type of Fuel, No Comment	6 (38%)

USE AND AWARENESS OF ENERGY EFFICIENCY MEASURES

This section presents results from analyses to identify current practices among Vermont's real estate firms regarding the efficiency measures discussed with building and construction professionals and the efficiency measures installed in their projects.

Awareness of Efficiency Measures

We asked respondents to identify efficiency measures they had heard of from a list of 13 measures. Awareness is highest for programmable thermostats (94% aware), electronic ballasts and energy management systems (both with 88% awareness, see Table 6.16). Since firms that develop properties are more likely to have had forays into the market in the last two years than firms that do not develop properties (as shown in Table 6.7), it is not surprising developers report higher awareness of each measure.

Table 6.16

AWARENESS OF EFFICIENCY MEASURES AMONG REAL ESTATE FIRMS

EFFICIENCY MEASURES	FIRMS THAT DEVELOP PROPERTIES (N=11)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=5)	TOTAL REAL ESTATE FIRMS (N=16)
WINDOWS			
Low-E Glass	10 (91%)	3 (60%)	13 (81%)
LIGHTING EQUIPMENT			
Electronic Ballasts	11 (100%)	3 (60%)	14 (88%)
Compact Fluorescent Lamps (CFLs)	11 (100%)	3 (60%)	14 (88%)
LED Exit Signs	10 (91%)	4 (80%)	14 (88%)
Occupancy Sensors for Lights	10 (91%)	1 (20%)	11 (69%)
Multi-Level Switching Controls for Lighting	8 (73%)	1 (20%)	9 (56%)

Features to Bring Daylight In	6 (55%)	2 (40%)	8 (50%)
T-8 Lights	6 (55%)	1 (20%)	7 (44%)
HEATING AND COOLING EQUIPMENT			
Programmable Thermostat	11 (100%)	4 (80%)	15 (94%)
Energy Management System	10 (91%)	4 (80%)	14 (88%)
Economizer	10 (91%)	1 (20%)	11 (69%)
Condensing Furnace or Boiler	8 (73%)	2 (40%)	10 (63%)
OTHER EQUIPMENT			
Distributed Generation	3 (27%)	0	3 (19%)

Table 6.17 show there is some tendency for awareness to vary by size of firm. Large firms tend more frequently to be aware of measures than small firms. Location of firm does not, in itself, seem to be associated with differences in awareness levels.

Table 6.17

AWARENESS OF EFFICIENCY MEASURES BY SIZE AND LOCATION OF REAL ESTATE FIRMS

NUMBER OF MEASURES AWARE OF	SIZE		LOCATION	
	SMALL (N=5)	LARGE (N=8)	RURAL (N=9)	CHITTENDEN COUNTY AND SMALL URBAN (N=7)
10 to 12 Measures	3 (60%)	5 (63%)	5 (56%)	4 (57%)
7 to 9 Measures	0	3 (37%)	2 (22%)	2 (29%)
4 to 6 Measures	2 (40%)	0	1 (11%)	1 (14%)
1 to 3 Measures	0	0	1 (11%)	0

No Measures	0	0	0	0

In our end user telephone interviews C&I firms were asked about their awareness of the same set of measures. Table 6.18 compares the awareness of the 11 real estate firms that develop properties with 200 C&I firms who constructed a permitted project and 158 C&I firms who did not construct a permitted project yet nonetheless had installed windows, lighting, or heating systems. Note that the sample size of the firms that develop properties is too small to yield as precise an estimate of awareness levels as we have for the C&I firms. Even so, we can conclude awareness of efficiency measures is greater among developers than among C&I firms, even those C&I firms with permitted projects.

Table 6.18

COMPARISON OF AWARENESS OF EFFICIENCY MEASURES: REAL ESTATE DEVELOPERS AND COMMERCIAL/INDUSTRIAL FIRMS

EFFICIENCY MEASURES	REAL ESTATE DEVELOPERS (N=11)	COMMERCIAL AND INDUSTRIAL FIRMS	
		WITH PERMITTED PROJECTS (N=200)	WITH NO PERMITTED PROJECTS YET INSTALLED EQUIPMENT (N=158)
WINDOWS			
Low-E Glass	10 (91%)	83%	85%
LIGHTING			
Electronic Ballasts	11 (100%)	84%	84%
CFLs	11 (100%)	82%	72%
LED Exit Signs	10 (91%)	78%	66%
Occupancy Sensors for Lights	10 (91%)	58%	53%
Multi-Level Switching Controls for	8 (73%)	58%	45%

Lighting			
T-8 Lights	6 (55%)	47%	35%
Features to Bring Daylighting In	6 (55%)	43%	49%
HEATING			
Programmable Thermostat	11 (100%)	90%	92%
Energy Management System	10 (91%)	59%	58%
Condensing Furnace or Boiler	10 (91%)	52%	40%
Economizer	8 (73%)	48%	44%
OTHER MEASURES			
Distributed Generation	3 (27%)	17%	12%

Efficiency Measures Discussed with Professionals

Respondents who reported installing lighting systems, heating and cooling systems, or windows in the past two years whether they had discussed specific energy efficiency measures applicable to those systems. Note that only firms that develop properties installed lighting systems; therefore, no firms that do not develop properties were asked about any lighting measures.

Electronic ballasts and CFLs are the lighting efficiency measures real estate respondents most often say they discussed with professionals (Table 6.19).

Table 6.19

DISCUSSED USING EFFICIENCY MEASURES WITH BUILDING PROFESSIONALS

EFFICIENCY MEASURES	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS INSTALLING THE END USE
WINDOW EQUIPMENT			
Low-E Glass	3 (60%) (n=5)	0 (n=1)	3 (50%) (n=6)

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EFFICIENCY MEASURES	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS INSTALLING THE END USE
LIGHTING EQUIPMENT			
Electronic Ballasts	7 (88%) (n=8)	NA*	7 (88%) (n=8)
CFLs	6 (75%) (n=8)	NA*	6 (75%) (n=8)
LED Exit Signs	5 (63%) (n=8)	NA*	5 (63%) (n=8)
Occupancy Sensors for Lights	3 (38%) (n=8)	NA*	3 (38%) (n=8)
Multi-Level Switching Controls for Lighting	3 (38%) (n=8)	NA*	3 (38%) (n=8)
T-8 Lights	3 (38%) (n=8)	NA*	3 (38%) (n=8)
			Continued
HEATING AND COOLING EQUIPMENT			
Energy Management System	4 (80%) (n=5)	0 (n=2)	4 (57%) (n=7)
Programmable Thermostat	4 (80%) (n=5)	0 (n=2)	4 (57%) (n=7)
Economizer	3 (60%) (n=5)	0 (n=2)	3 (43%) (n=7)
Condensing Furnace or Boiler	1 (20%) (n=5)	0 (n=2)	1 (14%) (n=7)
OTHER EQUIPMENT			
Variable Frequency Drives**	2 (67%) (n=3)	0 (n=2)	2 (40%) (n=5)

** None of the firms who do not develop properties reported installing lighting equipment.*

*** Asked of respondents responsible for industrial facilities.*

For heating and cooling equipment, respondents most often report discussing energy management systems and programmable thermostats with professionals. Respondents from firms that do not develop properties did not engage in discussions with professionals about any of the efficiency measures. Discussion of efficiency measures did not vary by size or location of firm.

Although Table 6.13 suggests developers may be somewhat more aware of efficiency measures than C&I firms involved in permitted construction projects, Table 6.20 shows developers discuss efficiency measures with professionals at about the same rate as C&I firms do.[55]

Table 6.20

COMPARISON OF DISCUSSED AS PERCENT OF AWARE OF MEASURE: REAL ESTATE DEVELOPERS AND COMMERCIAL/INDUSTRIAL FIRMS

EFFICIENCY MEASURES	DISCUSSED AS PERCENT OF AWARE		
	REAL ESTATE DEVELOPERS	C & I FIRMS WITH PERMITTED PROJECTS	C&I FIRMS WITH NO PERMITTED PROJECTS YET INSTALLED EQUIPMENT
WINDOWS			
Low-E Glass	60% (n=5)	74% (n=129)	61% (n=56)
LIGHTING EQUIPMENT			
Electronic Ballasts	87% (n=8)	81% (n=152)	71% (n=77)

[55] The table shows a higher percentage for developers than C&I customers with construction projects for eight of the measures, an equal proportion for one measure, and a lower proportion for two measures. However, note the very small sample sizes for the developer measures. A change in the response of a single developer from "discussed" to "not discussed" would more than wipe out the apparent differential between developers and C&I customers, and would give C&I customers a higher proportion for six of the eight measures for which developers now lead. Such a change would leave only the measures of CFLs and energy management systems showing a higher proportion of discussion by developers. Thus, we conclude that the current data cannot refute the null hypothesis that the two groups discuss the measures at the same rate.

CFLs	75% (n=8)	55% (n=150)	56% (n=70)
LED Exit Signs	71% (n=7)	64% (n=143)	47% (n=64)
Occupancy Sensors for Lights	43% (n=7)	36% (n=108)	35% (n=51)
Multi-Level Switching Controls for Lighting	50% (n=6)	43% (n=108)	25% (n=48)
T-8 Lights	100% (n=3)	78% (n=76)	64% (n=39)
HEATING AND COOLING EQUIPMENT			
Energy Management System	57% (n=7)	21% (n=95)	23% (n=52)
Programmable Thermostat	57% (n=7)	59% (n=153)	36% (n=78)
Economizer	75% (n=4)	57% (n=74)	15% (n=40)
Condensing Furnace or Boiler	25% (n=4)	51% (n=82)	23% (n=40)

** None of the firms who do not develop properties reported installing lighting equipment.*

*** Asked of respondents responsible for industrial facilities.*

Efficiency Measures Purchased or Installed

Table 6.21 shows the number of efficiency measures respondents say they had incorporated into any windows, lighting, or heating systems installed in the past two years. All of the developers installed lighting systems and 88% installed efficient ballasts and 63% installed CFLs. Programmable thermostats are the heating and cooling measure installed most (by 80% of the four developers installing HVAC). Only real estate firms that develop properties had installed any measures, as can be inferred from the data presented on

measures discussed with professionals. The table shows considerable room for improvement in the efficiency choices of real estate developers.

Table 6.21

EFFICIENCY MEASURES INSTALLED BY REAL ESTATE FIRMS

EFFICIENCY MEASURES	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
WINDOWS			
Low-E Glass	2 (40%) (n=5)	0 (n=1)	2 (40%) (n=5)
LIGHTING EQUIPMENT			
Electronic Ballasts	7 (88%) (n=8)	NA	7 (88%) (n=8)
CFLs	5 (63%) (n=8)	NA	5 (63%) (n=8)
LED Exit Signs	4 (50%) (n=8)	NA	4 (50%) (n=8)
Multi-Level Switching Controls for Lighting	3 (38%) (n=8)	NA	3 (38%) (n=8)
T-8 Lights	2 (25%) (n=8)	NA	2 (25%) (n=8)
Occupancy Sensors for Lights	2 (25%) (n=8)	NA	2 (25%) (n=8)
			Continued
HEATING AND COOLING EQUIPMENT			
Programmable Thermostat	4 (80%) (n=5)	0 (n=2)	4 (57%) (n=7)
Energy Management System	2 (20%) (n=5)	0 (n=2)	2 (29%) (n=7)
Economizer	1 (20%)	0	1 (14%)

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EFFICIENCY MEASURES	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
	(n=5)	(n=2)	(n=7)
Condensing Furnace or Boiler	1 (20%) (n=5)	0 (n=2)	1 (14%) (n=7)
OTHER EQUIPMENT			
Variable Frequency Drives	2 (66%) (n=3)	0 (n=2)	2 (40%) (n=5)

The number of opportunities to install efficiency measures was identified per size group (equal to the number of measures applicable to the end uses each firm installed—e.g., lighting—totaled across the firms in each group). Of the 25 opportunities to install efficiency measures faced by small firms, respondents report installing 9 measures, or 36%. Those from large firms had a total of 41 opportunities to install measures, and respondents reported installations of 20 measures, or 49%. Large firms, therefore, show some tendency to install more efficiency measures than small firms, although both groups show considerable room for improvement. We found no difference in measure installation rates by location. These findings echo those found for C&I firms, among whom large firms installed more efficiency measures than smaller firms, but for whom no differences in location were judged important.

Table 6.22 compares the real estate firms with firms with respect to the rate at which those who discussed an efficiency measure with a professional go on to install it. The rates for the two groups are similar: most people who discuss a measure install it.

Table 6.22

COMPARISON OF INSTALLED AS PERCENT OF DISCUSSED MEASURE: REAL ESTATE DEVELOPERS AND COMMERCIAL/INDUSTRIAL FIRMS

EFFICIENCY MEASURES	INSTALLED AS PERCENT OF DISCUSSED		
	REAL ESTATE DEVELOPERS	C&I FIRMS WITH PERMITTED PROJECT	C&I FIRMS WITH NO PERMITTED PROJECTS YET INSTALLED EQUIPMENT
Low-E Glass	2 (66%) (n=3)	93% (n=101)	81% (n=36)
Electronic Ballasts	7 (100%) (n=7)	98% (n=131)	92% (n=57)
CFLs	5 (83%) (n=6)	93% (n=88)	89% (n=41)
LED Exit Signs	4 (80%) (n=5)	93% (n=97)	87% (n=30)
Multi-Level Switching Controls for Lighting	3 (100%) (n=3)	82% (n=57)	77% (n=13)
T-8 Lights	2 (66%) (n=3)	84% (n=83)	93% (n=30)
Occupancy Sensors for Lights	2 (66%) (n=3)	77% (n=44)	65% (n=20)
Programmable Thermostat	4 (100%) (n=4)	92% (n=93)	93% (n=28)
Energy Management System	2 (50%) (n=4)	86% (n=49)	69% (n=16)
Economizer	1 (33%) (n=3)	80% (n=51)	70% (n=10)
Condensing Furnace or Boiler	1 (100%) (n=1)	76% (n=50)	83% (n=12)
Variable Frequency Drives	2 (100%) (n=2)	86% (n=7)	69% (n=13)

Each respondent reporting installing an efficiency measure was asked the proportion of installed systems that used the efficiency measure. For example, "What percent of the heating and cooling systems that you installed in the last two years that could use an energy management system included an energy management system?" Table 6.23 shows the proportion of installed systems that incorporate the efficiency measure. Among lighting measures, respondents report incorporating T-8 lights, electronic ballasts and LED exit signs in more than half of the systems. All four HVAC efficiency measures were used in the majority of heating and cooling equipment installations, although the number of respondents installing these measures is small (a single respondent for two of the measures).

Table 6.23

PROPORTION OF EFFICIENCY MEASURES INSTALLED BY REAL ESTATE FIRMS

EFFICIENCY MEASURES	LESS THAN HALF OF INSTALLED SYSTEMS INCORPORATE EFFICIENCY MEASURE	HALF OR MORE OF INSTALLED SYSTEMS INCORPORATE EFFICIENCY MEASURE
WINDOWS		
Low-E Glass (n=2)	0	2 (100%)
LIGHTING EQUIPMENT		
Electronic Ballasts (n=7)	1 (14%)	6 (86%)
CFLs (n=5)	4 (80%)	1 (20%)
LED Exit Signs (n=4)	0	4 (100%)
Multi-Level Switching Controls for Lighting (n=3)	2 (66%)	1 (33%)
T-8 Lights (n=2)	0	2 (100%)
Occupancy Sensors for Lights (n=2)	2 (100%)	0
HEATING AND COOLING EQUIPMENT		
Programmable Thermostat (n=4)	1 (25%)	3 (75%)
Energy Management System (n=2)	0	2 (100%)

Economizer (n=1)	0	1 (100%)
Condensing Furnace or Boiler (n=1)	0	1 (100%)
OTHER EQUIPMENT		
Variable Frequency Drives (n=1)	1 (100%)	0

PROGRAM PROCESS ASSESSMENT

In this section, we discuss the involvement Vermont's real estate professionals have had with Act 250 and with Efficiency Vermont.

Act 250: Involvement and Results

Half of all respondents report they are experienced with Act 250 (Table 6.24). The finding that real estate firms that develop properties have been involved with Act 250 is not surprising. What is perhaps surprising is that two of the firms experienced with Act 250 do not develop properties but only manage them.

Table 6.24

INVOLVEMENT WITH ACT 250 BY REAL ESTATE FIRMS

INVOLVEMENT WITH ACT 250	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
Has Been Involved with Act 250	6 (55%) (n=11)	2 (40%) (n=5)	8 (50%) (n=16)
PROJECTS IN THE PAST			
One	1 (9%) n=6)	0 (n=2)	1 (13%) (n=8)
Two to Five	1 (9%) (n=6)	1 (50%) (n=2)	2 (25%) (n=8)

More Than Five	2 (33%) (n=6)	1 (50%) (n=2)	3 (38%) (n=8)
Don't Recall	2 (33%) (n=6)	0 (n=2)	2 (25%) (n=8)

Large real estate firms were more likely to have had involvement with Act 250 (5 out of 8 large firms, compared to 1 out of 5 small firms). We also found firms in Chittenden County and small urban areas were more likely than those in rural areas to have had involvement with Act 250. This relationship may be an artifact of the location of the larger firms who had Act 250 involvement. There was no difference by size or location of C&I firms in involvement with Act 250.

Five of the eight respondents who had experience with Act 250 believe the Act 250 process results in a higher level of energy efficiency being incorporated into the project (Table 6.25). Two of the eight respondents offered no opinion. Note, though the samples are small, the percent of the sample reporting that Act 250 results in higher level of energy efficiency is higher than for any other group of market actors or end users we have surveyed. This may reflect the role of the developer as the person who deals most directly with the Act 250 review process. It may also indicate Act 250 has a more evident influence on speculative property, which the developers build, than on property for owner-occupants who may on average want somewhat energy-efficient buildings regardless of the requirements of the Act.

Table 6.25

RESULTS OF ACT 250 ACCORDING TO REAL ESTATE FIRMS

RESULTS OF ACT 250 PROJECTS COMPARED TO NON-ACT 250 PROJECTS	FIRMS THAT DEVELOP PROPERTIES (N=6)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=2)	TOTAL REAL ESTATE FIRMS (N=8)
Believe Act 250 Results in a Higher Level of Energy Efficiency	4 (67%)	1 (50%)	5 (63%)
Believe Act 250 Results in the Same	0	1 (50%)	1 (13%)

Level of Energy Efficiency			
Believe Act 250 Results in a Lower Level of Energy Efficiency in Projects	0	0	0
Don't Know/Refused	2 (33%)	0	2 (25%)

Of the eight respondents with Act 250 experience, three (38%) report they develop projects differently for those requiring Act 250 review than for non-Act 250 projects. Two of the three respondents who note a difference are from large firms that develop properties.

Efficiency Vermont: Awareness, Experience, Satisfaction

Most of the respondents (14 out of 16) had heard of an organization "that promotes energy efficiency in Vermont" (Table 6.26). A total of twelve (out of 16) respondents are able either to spontaneously name EVT as the organization that promotes energy efficiency in Vermont or to recognize EVT by name. Respondents from firms that develop properties tend to have higher rates of spontaneous recall and recognition of EVT's name than those that do not develop properties.

Table 6.26

AWARENESS OR RECOGNITION OF EFFICIENCY VERMONT AMONG REAL ESTATE FIRMS

AWARENESS, RECOGNITION OF EFFICIENCY VERMONT	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL
Heard of Organization That Promotes Energy Efficiency in Vermont	10 (91%) (n=11)	4 (80%) (n=5)	14 (88%) (n=16)
Spontaneous Mention of "Efficiency Vermont," "Vermont Efficiency, or "EVT"	5 (50%) (n=10)	0 (n=4)	5 (36%) (n=14)
Recognized "Efficiency Vermont," "Vermont Efficiency, or "EVT"	4 (67%) (n=6)	3 (60%) (n=5)	7 (64%) (n=11)

Total Aware of Efficiency Vermont*	9 (82%) (n=11)	3 (60%) (n=5)	12 (75%) (n=16)

* *Total of respondents who either spontaneously mentioned EVT name or recognized EVT from prompt.*

Just over half of the respondents (9 out of 16) report having had contact with Efficiency Vermont and/or Burlington Electric Department – BED (Table 6.27). Respondents from real estate firms that develop properties more often report contact with EVT than those from firms that do not develop properties. Contact with EVT did not vary by size or location.

Table 6.27

CONTACT WITH EFFICIENCY VERMONT AND BED BY REAL ESTATE FIRMS

CONTACT WITH EFFICIENCY VERMONT AND BED	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
Had Contact with Efficiency Vermont and BED	7 (64%) (n=11)	2 (40%) (n=5)	9 (56%) (n=16)
NAME OF AGENCY RESPONDENT CONTACTED			
"Efficiency Vermont"	5	1	6
"Burlington Electric Department"	0	0	0
Both "Efficiency Vermont" and "Burlington Electric Department"	2	1	3

Of the nine respondents who say they have had contact with Efficiency Vermont and BED, four report they initiated the contact and an equal number report communication between their firm and EVT flowed in both directions (Table 6.28). Firms in rural areas were more likely to report they initiated contacted EVT (3 out of 5 rural firms) than were firms in other areas (1 out of 4). This finding of difference in receiving services by location of firm was not found for C&I firms.

Table 6.28

DIRECTION OF CONTACT WITH EFFICIENCY VERMONT OR BURLINGTON ELECTRIC DEPARTMENT

DIRECTION OF CONTACT	FIRMS THAT DEVELOP PROPERTIES (N=7)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=2)	TOTAL REAL ESTATE FIRMS (N=9)
Respondent Contacted EVT or BED	3 (43%)	1 (50%)	4 (44%)
EVT or BED Contacted Respondent	1 (14%)	0	1 (11%)
Mutual Contact	3 (43%)	1 (50%)	4 (44%)

One respondent whose firm developed properties said the project's general contractor had recommended he use EVT; three named "other," unspecified sources as recommending Efficiency Vermont's services; and two could not recall who recommended Efficiency Vermont. These uninformative responses for who recommended EVT are very similar to those given by the C&I end user firms.

Of the nine respondents who had had contact with EVT or BED, six had received services. No differences were apparent among those who received services from EVT by size or location. Among C&I firms, large firms were more likely to have received services than smaller ones.

Rebates for lighting and technical assistance for remodeling or equipment replacement are the services respondents most often mention receiving from Efficiency Vermont (4 out of 6, see Table 6.29).

Table 6.29

EFFICIENCY VERMONT EVENTS AND SERVICES USED BY REAL ESTATE FIRMS (MULTIPLE MENTIONS)

SERVICE OR EVENT	FIRMS THAT DEVELOP PROPERTIES	FIRMS THAT DO NOT DEVELOP PROPERTIES	TOTAL REAL ESTATE FIRMS
Received Services from EVT/BED	5 (45%) (n=11)	1 20%) (n=5)	6 (38%) (n=16)
TYPE OF SERVICES RECEIVED			
	(N=5)	(N=1)	(N=6)
Lighting Rebates	3 (60%)	1 (100%)	4 (67%)
Technical Assistance for Remodeling or Equipment Replacement	3 (60%)	1 (100%)	4 (67%)
HVAC Rebates	3 (60%)	0	3 (50%)
Technical Assistance for Act 250 Project	3 (60%)	0	3 (50%)
Technical Assistance for Non-Act 250 Project	3 (60%)	0	3 (50%)
Motor Rebates	1 (20%)	0	1 (16%)
Building Solutions Conference	0	0	0

Three of the six respondents also mention receiving rebates for heating and cooling equipment, and technical assistance for other projects. None of the respondents had attended the Building Solutions Conference.

An influence of location on services received seemed possible for one service. Rural real estate firms were more likely to have received technical assistance for remodeling and equipment replacement than were firms located elsewhere. Likely, remodeling constitutes a higher proportion of the rural firms' total construction activity than it does for nonrural firms, as suggested by the discussion of planned construction projects (Table 6.6).

We analyzed whether real estate firms that had received services from EVT reported installing more efficiency measures than those that did not receive services. From Table 6.21, we tallied across the measures the number respondents who had installed the associated equipment and thus were a candidate for the measure.[56] The tally indicates real estate professionals had a total of 76 opportunities to install efficiency measures. For 36 of these opportunities, the respondent reported receiving services from EVT. Efficient measures were installed in 19 of these 36 cases, or in 53% of the opportunities for efficiency. For 40 of the total opportunities, the respondent had not received EVT services. Efficient measures were installed by these non-users of EVT service in 16 of the 40 cases, or in 40% of the opportunities for efficiency. We conclude that real estate professionals who received services from EVT installed efficiency measures at a higher rate—perhaps about 25% higher—than those who did not receive services.[57]

Of those respondents reporting satisfaction with EVT (top two boxes), four out of four respondents say they were "satisfied" or "very satisfied" with the usefulness of the information provided by EVT and three out of four respondents similarly rated the responsiveness of EVT staff to their projects' needs (Table 6.30). Satisfaction with EVT's knowledge of energy efficiency solutions received the fewest endorsements (2 out of 4).

56 This tally is the sum of the sample sizes reported for each measure.

57 With the caveat that these findings are from very small samples, those who received EVT services captured approximately 50% of the opportunities, compared with a 40% capture rate from those who did not receive services. That's a 10% differential on a base of 40%, i.e., a rate that is 25% higher for users of EVT services.

Table 6.30

SATISFACTION WITH EFFICIENCY VERMONT'S SERVICES AMONG REAL ESTATE FIRMS (TOP TWO BOXES)

CRITERIA	FIRMS THAT DEVELOP PROPERTIES (N=VARIES)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=1)	TOTAL REAL ESTATE FIRMS (N=VARIES)
Usefulness of Information Provided	3 of 3	1	4 of 4
Quality of Services	2 of 3	1	3 of 4
Responsiveness to Project Needs	2 of 4	1	3 of 5
Knowledge of Energy Efficiency Solutions	2 of 4	0	2 of 4

* *Respondents who rated criterion with a "4" or "5" on a 1 to 5 scale in which 1 is "not at all satisfied," and 5 is "very satisfied." Sample size varies due to "don't know" responses.*

Nearly all of those who had done a project with EVT (5 out of 6) spontaneously mentioned they found EVT staff to be helpful and constructive, and the information to be useful (Table 6.31). One respondent whose firm develops properties reported the EVT staff was *"good …They were extremely helpful, but not timely."*

Table 6.31

ASSESSMENT OF EFFICIENCY VERMONT AMONG REAL ESTATE FIRMS

ASSESSMENT	TOTAL REAL ESTATE FIRMS (N=6)
Helpful, Constructive, Useful	5 (83%)
Not Timely	1 (17%)

Three-quarters of all respondents (8 out of 12 who are aware of EVT) report they are "very likely" or "somewhat likely" to use the services of Efficiency Vermont in the future (Table 6.32). Large firms reported a greater likeliness than small firms to use EVT in the future. The differences in opinion between respondents from firms that manage and develop properties and those that manage properties but do not develop them are small.

Table 6.32

LIKELIHOOD OF USING EFFICIENCY VERMONT IN THE FUTURE

LIKELIHOOD	FIRMS THAT DEVELOP PROPERTIES (N=9)	FIRMS THAT DO NOT DEVELOP PROPERTIES (N=3)	TOTAL REAL ESTATE FIRMS (N=12)
Very Likely	3 (33%)	1 (33%)	4 (33%)
Somewhat Likely	3 (33%)	1 (33%)	4 (33%)
Not at All Likely	2 (22%)	1 (33%)	3 (25%)
Not Sure/Refused	1 (11%)	0	1 (8%)

The reasons respondents gave for using EVT's services in the future vary among all of the respondents:

- *"They were informative and helpful."*
- *"EVT staff was knowledgeable."*
- *"EVT's assistance is mandated in the permit structure."*
- *"We will use them to make our new properties efficient."*
- *"We are committed to using them."*
- *"If our contractors want us to use EVT again, we will."*

Respondents who are not likely to use EVT services on future projects elaborate:

6. Real Estate Professionals Findings

- *"We offer the same type of expertise as EVT."*
- *"It's too much work."*
- *"Green Mountain Power is not a part of the Efficiency Vermont group."*

7. C&I END USER FINDINGS

This chapter presents the survey findings from discussions with owners and managers of commercial and industrial establishments in Vermont. Findings are organized into four topic areas: (1) market characteristics; (2) market structure; (3) current energy efficiency practices; and (4) program process findings.

In total, a sample of 596 establishments were surveyed. This sample is comprised of two groups:

- **Firms with construction projects**: A sample (n=200) of commercial establishments from a list of 839 construction permits for a Vermont location during the period 1998 through 1999;[58]
- **General C&I sample**: A random sample (n=396) of C&I establishments (out of the approximately 20,000 Vermont C&I firms), drawn from a list of all Vermont C&I enterprises purchased from a business listing service.[59]

Both sample sizes are sufficient to provide estimates of their respective populations with a 95 confidence level +/-5%. Data from firms with construction projects were analyzed by type of construction activity. Firms in the general C&I sample were analyzed by whether they had engaged in equipment retrofit or replacement. Finally, all the responses were analyzed by

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58 Of the 839 construction permits, 471 were for new construction (92 of which were interviewed) and 368 were for renovations, additions, remodeling (108 of which were interviewed). All 839 firms were contacted at least once in the process of completing the sample of 200 interviews. Thus, the sample would be termed a convenience sample rather than a random sample. We believe the sample to be representative of the population.

59 The estimate of 20,000 firms is based on data from 1997 Economic Census, U.S. Census Bureau (19,717 establishments with payrolls). A published business list for 2002 reported 32,262 firms, including sole proprietorships without payroll. Statewide, there are 42,303 commercial and 413 industrial electricity accounts.

size and location of establishment. We report any significant differences in responses among the subgroups analyzed.

Firms with construction projects have engaged in one or more of four types of activities:

- Constructing a **new building** (also termed new construction)
- Constructing an **addition** to an existing building
- Conducting a gut rehab or major **renovation** of an existing building
- Conducting a **remodel** of part of an existing building

Most analyses found that responses did not vary by type of construction project. Those responses that did are called out in the text.

The general C&I sample are firms that were not issued construction permits during 1998-1999. It comprises two main subgroups:

- Firms with **equipment projects**: have installed new equipment or made changes to one or more systems (windows, heating, or lighting) in the two years prior to the survey period of spring 2002. This group includes retrofits and end-of-life equipment replacements.
- Firms **without equipment projects**: have *not* installed new windows or heating or lighting equipment nor made changes to these systems in the two years prior to spring 2002

Within the equipment replacement group are those who made changes to *one* system (windows, heating, or lighting) and those who made changes to *two or three* systems. In most cases, the distinction between one building system installed and two or three building systems was not significant. Any significant differences are noted in the text.

The activities of firms with construction projects are compared to those of firms with equipment projects to explore some issues in more detail. Construction projects with permits issued in 1998 and 1999 were completed during the period 1998 through 2001. Thus, the time frames for construction and equipment projects overlap, but are not identical. Some of the construction

projects were completed prior to Efficiency Vermont's inception, while all of the equipment projects occurred during the Efficiency Vermont's tenure.

For location of establishment, we distinguish among those:

- Within Chittenden County
- In moderate sized cities and towns outside of Chittenden County
- In rural areas outside of Chittenden County.

For size of establishment, we distinguish the following groups:

- Small: under 5,000 square feet
- Medium: 5,000 square feet to under 25,000 square feet
- Large: over 25,000 square feet.

CHARACTERISTICS OF C&I END USER FIRMS

To describe salient characteristics of Vermont's C&I end-use firms, the following areas were assessed: building stock – types, locations, sizes, ages; building ownership – occupancy status and energy bill responsibility; and building tenure and plans to change space.

Building Stock: Types, Locations, Sizes, Ages

Nearly one-half (46%) of firms with construction projects were constructing a new building and almost as many (43%) were constructing an addition to an existing building (Table 7.1).[60] The types of construction projects do not differ significantly by location or size of establishment.

[60] As discussed in chapter 3, the number of firms with construction permits suggests that most firms required to get permits do, in fact, get them. Nonetheless, there may be additional small remodeling activity occurring in Vermont beyond that reflected in Table 7.1.

Table 7.1

TYPE OF C&I PERMITTED CONSTRUCTION PROJECT

TYPE OF CONSTRUCTION PROJECT	FIRMS WITH CONSTRUCTION PROJECTS (N=200)*
Construction of a New Building	46%
An Addition to an Existing Building	43%
Gut Rehab or Major Renovation of an Existing Building	11%
A Remodel of Part of an Existing Building	6%

* *Totals 106%. 4% of respondents undertook multiple construction projects. Their specific activities are incorporated into the percentages for new building, addition, etc.*

Just over one-half (53%) of the buildings for firms with construction projects are office, retail, or industrial (see Table 7.2). Nearly two-thirds (61%) of the buildings for the general C&I sample are office or retail. Considered collectively, building types do not differ significantly by location or size of building. Nonetheless, warehouses and public buildings comprise a larger proportion of facilities with construction projects than they do of the general C&I sample.

Table 7.2

C&I FACILITIES TYPE

BUILDING TYPE	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Office	18%	29%
Retail	18%	32%
Industrial	17%	14%

School (Non-College)	5%	5%
Warehouse	13%	4%
Public Buildings, Health Care, College, Church, or Other Institutions	23%	10%
Multi-family, 1-3 Stories	—	0%
Multi-family, 4+ Stories	—	0.3%
Other	6%	6%

The general C&I sample is distributed evenly across the three geographic areas, with roughly one-third of the firms in Chittenden County, one-third in small urban areas outside of Chittenden County, and one-third in rural areas (Table 7.3). Firms with construction projects are much more likely to be located in rural areas and much less likely to be in Chittenden County than are firms in the general C&I sample.

Table 7.3

LOCATION OF C&I FACILITIES

LOCATION	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Chittenden County	15%	30%
Small Urban (excluding Chittenden County)	25%	35%
Rural	60%	35%

Roughly half of all firms occupy facilities smaller than 5,000 square feet (see Table 7.4). Firms with construction projects and firms with equipment projects were more likely to occupy larger facilities than were firms in the general C&I sample who had installed no building systems in the past two years.

Table 7.4

SIZE OF C&I FACILITIES

SIZE IN SQUARE FEET	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=364)*
Under 5,000	41%	54%
5,000 to Under 10,000	16%	16%
10,000 to Under 25,000	19%	11%
25,000 to Under 75,000	11%	8%
75,000 and Over	8%	4%
Don't Know	5%	7%

Note: Firms with construction projects were asked for the total square footage of the building. General C&I firms were asked for the total square footage their establishment occupies.

* *Thirty-two respondents in the general C&I sample were not asked the question: 30 did not occupy the space and 2 were affiliated with campuses of multiple buildings.*

Among firms with construction projects, larger facilities were significantly more likely to be located in Chittenden County than in other areas. Together with the findings from Table 7.3, we conclude that although construction projects overall are less likely to be in Chittenden County than in rural areas, the large construction projects are more likely to be in Chittenden County; small projects are predominate in the rural areas. No differences in facility size by location were found for general C&I firms.

Table 7.5 provides a look at the ages of the facilities. Not surprisingly, the newest buildings are owned by the firms with construction projects that constructed a new building. Of the remaining firms with construction projects, about two-thirds (63%) had buildings that are at least twenty years old. Three-quarters (74%) of the general C&I firms reported owning buildings that are at least twenty years old. Building ages do not differ significantly by location or size of building, nor by type of construction project (excluding new buildings) or equipment acquisition.

Table 7.5

C&I FACILITIES AGE

BUILDING AGE	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Newly Constructed Building (1998-2000)	46%	NA
Less Than 5 Years Old	4%	3%
Between 5 and 20 Years Old	15%	20%
Older Than 20 Years	35%	74%
Don't Know	0%	3%

Firms with construction projects reported the project size. Table 7.6 shows one-half (51%) of the construction projects were under 5,000 square feet and three-fourths (74%) were under 10,000 square feet. Not surprisingly, the size of the project is correlated with the size of the establishment undertaking the construction. The sizes of the construction projects do not differ significantly by location, although there is a tendency for the larger projects to be in Chittenden County, given that larger establishments generally tend to be located in Chittenden County.

Table 7.6

SIZE OF CONSTRUCTION PROJECT AREA OF C&I FIRMS

SIZE IN SQUARE FEET	FIRMS WITH CONSTRUCTION PROJECTS (N=200)
Under 5,000	51%
5,000 to Under 10,000	23%
10,000 to Under 25,000	9%

25,000 to Under 75,000	8%
75,000 Square Feet and Over	5%
Don't Know	4%

Building Ownership: Occupancy Status and Energy Bill Responsibility

Nine out of ten firms with construction projects own and occupy their facility, compared with just over one-half of general C&I firms (Table 7.7).

Table 7.7

FACILITY OWNERSHIP AND OCCUPANCY STATUS AMONG C&I FIRMS

OWNERSHIP AND OCCUPANCY	FIRMS WITH CONSTRUCTION PROJECTS (N=200)*	GENERAL C&I SAMPLE (N=396)
Own and Occupy	89%	55%
Own & Lease to Tenant	7%	5%
Occupies Leased Space	4%	38%
Manages Space	1%	2%

** Percents do not add up to 100% due to rounding.*

Among the latter group, firms who had installed building systems were more likely to own and occupy their space than were firms who had not installed any building systems in the last two years. Ownership and occupancy status do not differ significantly by location or size of facility.

Nearly all (89%) of firms with construction projects pay the utility bills for the buildings they own and occupy (Table 7.8). There were too few of these respondents who leased to explore variations in responses by location or size.

For two-thirds (67%) of the general C&I firms, the building owner pays for the utilities, either because the owner also occupies the building, or through the leasing arrangement. The party responsible for the utility bills for these firms does not differ significantly by location or size of facility.

Table 7.8

PARTY RESPONSIBLE FOR ELECTRIC AND GAS BILLS AMONG C&I FIRMS

PARTY THAT PAYS FOR ELECTRICITY AND GAS	FIRMS WITH CONSTRUCTION PROJECTS (N=200)*	GENERAL C&I SAMPLE (N=396)
Respondent's Organization Owns and Occupies Building, Pays For Self	89%	55%
Leasing Occurs, Owner Pays	3%	12%
Leasing Occurs, Tenant Pays	8%	29%
Leasing Occurs, Owner Pays for Common Areas, Tenant Pays for Unit	1%	2%
Don't Know, Refused	0%	2%

** Percents do not add to 100% due to rounding.*

Building Tenure and Plans to Change Space

Not surprisingly, the majority of the firms who constructed new buildings (87%) have occupied their building for less than five years (Table 7.9). (We infer the other firms were adding a building to an existing facility.) In contrast, nearly half (46%) of the firms with construction projects other than new buildings and those in the general C&I sample have occupied their buildings for more than ten years. Length of time the establishment has occupied the building does not differ significantly by location or size of facility, nor by type of construction project (excluding new buildings) or acquisition of equipment.

Table 7.9

C&I FIRMS' TENURE IN BUILDING

YEARS IN BUILDING	FIRMS WITH CONSTRUCTION PROJECTS (N=200)		GENERAL C&I SAMPLE (N=396)
	NEW BUILDING (N=90)	PROJECTS OTHER THAN NEW BUILDING (N=110)	
One to Three	63%	13%	15%
Four to Five	24%	17%	9%
Six to Ten	3%	14%	21%
Eleven to Twenty	3%	19%	23%
Over Twenty	0%	27%	23%
Don't Know/Refused	7%	10%	9%

Table 7.10 gives the proportion of general C&I firms that are planning to undertake construction activities in the next two years.[61] Remodeling was most frequently mentioned. Large companies were significantly more likely than other companies to have plans to construct an addition to their space in the next two years. Smaller establishments were more likely than others to have plans to construct a new building, and this difference approached significance. There were no differences in plans to remodel by size of facility.

[61] See Chapter 3, Sampling of C&I Firms with Construction Projects, for a discussion of how these stated plans for construction activity compare with the number of permitted construction projects in 1998-1999.

Table 7.10

TYPE OF CONSTRUCTION PROJECTS PLANNED BY C&I FIRMS

TYPE OF CONSTRUCTION PROJECT	GENERAL C&I SAMPLE (N=396)
Construction of a New Building	9%
An Addition to an Existing Building	7%
A Remodel of Part of an Existing Building	18%

MARKET STRUCTURE

This section explores the patterns of energy efficiency activities, relationships, and attitudes (that is, the market structure) among Vermont's C&I end-use firms. We discuss the activities of installing end use equipment and shopped for or discussed purchasing new equipment. We report on the relationships of professionals used in construction projects. And we present awareness and attitudes: awareness of ENERGY STAR®; concern for energy efficiency; and barriers to implementing energy efficiency.

Installed Windows, Heating, or Lighting Equipment

Nearly three-quarters (72%) of firms with construction projects installed windows, heating, *and* lighting in their projects (Table 7.11). Nearly every firm (96%) installed lighting, either in combination with other equipment or alone. Eighty-seven percent installed heating (alone or in combination with other equipment) and 79% installed windows.

Among firms with equipment projects, lighting installations were much less common than for firms with construction projects. Among those with equipment projects, about one-fifth of the firms responding had installed lighting (22%) and heating (23%) systems in the last two years, or had made changes to these systems. Fifteen percent had installed windows or made changes to windows. Twelve percent of the firms had installed all three building systems and about 30% of firms had installed two of the three systems.

Table 7.11

EQUIPMENT INSTALLED BY C&I FIRMS

EQUIPMENT INSTALLED	FIRMS WITH CONSTRUCTION PROJECTS (N=137)	FIRMS WITH EQUIPMENT PROJECTS (N=158)
Windows, Heating, and Lighting	72%	12%
Heating and Lighting	13%	13%
Lighting Only	7%	22%
Windows and Lighting	4%	9%
Windows Only	2%	15%
Heating Only	1%	23%
Windows and Heating	1%	6%
TOTAL: Windows	79%	42%
TOTAL: Heating	87%	54%
TOTAL: Lighting	96%	57%

Installation of equipment varied by construction activity among firms with construction projects. Those who had undertaken major renovation projects were significantly more likely to have installed new heating equipment, windows, and lighting equipment than firms with other types of construction projects. Installation of equipment did not vary by location or size among firms with either construction or equipment projects.

Shopped for, or Discussed Purchasing, New Equipment

General C&I firms were asked whether they had shopped for building systems equipment in the last two years (Table 7.12). "Shopped for" was defined as "purchased, contracted for, shopped for, or discussed with a designer or contractor." About 5% of firms who installed no equipment in the past two years nonetheless reported having made inquiries into each type of equipment

the survey explored. Overall, firms were most likely to have shopped for heating/cooling or lighting systems (28% for each). Next in frequency, firms shopped for changes to their windows (21%) or roofs or insulation levels (19%).

Table 7.12

MARKET FORAYS DURING THE LAST TWO YEARS AMONG GENERAL C&I FIRMS

SHOPPED FOR OR DISCUSSED WITH DESIGNER OR CONTRACTOR REGARDING:	NO EQUIPMENT INSTALLED (N=238)	INSTALLED WINDOWS (N=66)	INSTALLED HEATING OR COOLING (N=85)	INSTALLED LIGHTING (N=90)	TOTAL: GENERAL C&I SAMPLE (N=396)
Changes to Heating or Cooling Equipment	6%	48%	100%	58%	28%
Lighting Systems*	5%	53%	49%	100%	28%
Changes to Windows	3%	100%	38%	44%	21%
Changes to Roof or Insulation Levels	15%	32%	32%	29%	19%
Changes to Building Structure	5%	24%	21%	23%	10%
Controls for Lighting Systems*	3%	15%	15%	28%	9%
Changes to Ventilation Systems	4%	19%	25%	23%	9%
Changes to Refrigeration Systems	5%	18%	19%	19%	8%
Changes to Any Other Major Electrical Equipment, Such As Pumps, Industrial Equipment, or Snow-Making Equipment	3%	18%	17%	17%	7%
Changes In Motors or Variable Frequency Drives	3%	11%	11%	16%	7%
Changes to Air Compressors	4%	13%	13%	16%	7%

*Note: Firms may have installed more than one type of building system. Thus, the samples in the middle three columns (installed windows, heating/cooling, lighting) are overlapping. *Respondents were asked whether they had "purchased, contracted for, or shopped for" these systems. For all other measures, respondents were asked whether they had "shopped for or talked to a designer or contractor" about the action.*

It is interesting to note that, among those firms who had installed one or more building systems, the frequency with which they shopped for the different equipment did not vary appreciably by what they had installed. For example, about 30% of firms had shopped for changes to the roof or insulation levels, regardless of whether they had gone on to install windows, heating/ cooling, or lighting (or two or three of these systems).

The frequency that establishments engaged in market forays did not differ by location and, for most measures, did not vary by size of facility. However, large facilities—commercial as well as industrial—were significantly more likely than other firms to have shopped for or discussed motors/ variable frequency drives, major industrial equipment, and ventilation systems.

Professionals Used

Firms with construction projects reported they were most likely to use an electrical contractor (85%) or a general contractor (79%) on their projects (Table 7.13). Firms occupying large facilities are significantly more likely than other firms to use an architect, mechanical engineer, or electrical engineer for their projects and firms in medium-sized facilities are significantly more likely than others to use a general contractor. These differences are captured in the proportion of total constructed floorspace on which the professional was used, which is also shown in the table.

Table 7.13

PROFESSIONALS USED AS PROPORTION OF PROJECTS AND OF TOTAL CONSTRUCTED FLOORSPACE (MULTIPLE RESPONSES)

PROFESSIONALS	PROPORTION OF PROJECTS USING PROFESSIONAL	PROPORTION OF TOTAL CONSTRUCTED FLOORSPACE USING PROFESSIONAL
Architect	48%	60%
Mechanical Engineer	33%	52%
Electrical Engineer	30%	50%

General Contractor	79%	81%
Mechanical Contractor	68%	82%
Electrical Contractor	85%	89%

Firms in Chittenden County are more likely to use a lighting or electrical contractor than are firms in other locations. Note that engineers often work as consultants to architects on project design. It is possible, therefore, that the end users (the firms with construction projects) underreported the extent to which their projects involved engineers.

Nearly all firms (98%) with construction projects used at least one professional for their project (Table 7.14) and about half (48%) used four or more professionals. Firms occupying larger buildings were significantly more likely to report using all six building professionals than those occupying smaller facilities. Over two-thirds of firms undertaking a major renovation (gut rehab) used four to six professionals, compared with about 50% of firms constructing a new building and 38% of firms constructing an addition. These differences approached statistical significance.

Table 7.14

NUMBER OF PROFESSIONALS USED ON C&I PERMITTED CONSTRUCTION PROJECTS

NUMBER OF PROFESSIONALS USED	FIRMS WITH CONSTRUCTION PROJECTS (N=200)
Did Not Use a Professional	2%
One	10%
Two	20%
Three	20%
Four	20%

Five	15%
Six	13%

Respondents were asked to rate the influence of building professionals on their decisions about the type of heating and cooling equipment to install in their building (see Table 7.15). Firms using mechanical engineers were more likely to say the mechanical engineer highly influenced the HVAC decisions than firms using other professionals said about those professionals.[62] However, fewer firms used mechanical engineers than used the other professionals. Considering firms with construction projects as a whole, therefore, mechanical engineers had among the least influence.[63] Heating and cooling contractors and general contractors were used by most firms and strongly influenced many of them. Thus, these two contractors are the professionals most likely to be rated high by the sample as a whole, with about one-third of the sample rating each of them as strongly influencing the HVAC decisions. The influence of building professionals on heating and cooling decisions did not vary significantly by location, facility size, or construction activity.

Table 7.15

PROFESSIONALS STRONGLY INFLUENCING HVAC DECISIONS OF C&I FIRMS (TOP TWO BOXES)*

PROFESSIONALS INFLUENCING HVAC DECISIONS	FIRMS USING THE GIVEN CONTRACTOR	FIRMS WITH CONSTRUCTION PROJECTS (N=200)
Heating & Cooling Contractor	50%	33%

62 Of those who did use a mechanical engineer, that professional strongly influenced the HVAC equipment design for 57% of the respondents. Thus, from mechanical engineers' perspective, they might experience themselves as highly influential on 57% of the projects they work on.

63 Recall, however, that the use of engineers on construction projects may be understated by the respondents. These data reflect respondent understanding of the influence of the various professionals.

	(n=136)	
General Contractor	41% (n=157)	30%
Architect	40% (n=95)	18%
Mechanical Engineer	57% (n=66)	18%

* *Respondents rated each contractor a "4" or "5" on a 0 to 5 scale, in which "0" indicates the professional had no influence, and "5" indicates the professional made the final project decision for or with the respondent.*

For lighting equipment, lighting/electrical contractors were most often mentioned as strongly influencing the equipment decisions (see Table 7.16). Only 30% of firms used an electrical engineer. However, among those who did, the electrical engineer was reported by 58% of the firms to be strongly influential. Firms in Chittenden County were significantly more likely to rate the general contractor as influential in their lighting decisions than firms from other geographical areas. Respondent rating of the influence of the various professionals did not vary across firms according to the types of construction projects, nor did the size of the firm's facility have a bearing on the response regarding professional influence.[64]

[64] Construction types examined include new building construction, an addition, a gut rehab, or a remodel of an existing building. Facility sizes examined are: small facilities (under 5,000 square feet), medium-sized facilities (5,000 square feet to 25,000 square feet), and large facilities (over 25,000 square feet).

Table 7.16

PROFESSIONALS STRONGLY INFLUENCING LIGHTING DECISIONS OF C&I FIRMS (TOP TWO BOXES)

PROFESSIONALS INFLUENCING LIGHTING DECISIONS	FIRMS USING THE GIVEN CONTRACTOR	FIRMS WITH CONSTRUCTION PROJECTS (N=200)*
Lighting or Electrical Contractor	47% (n=170)	39%
General Contractor	31% (n=157)	24%
Architect	49% (n=95)	22%
Electrical Engineer	58% (n=60)	17%

* *Respondents rated each contractor a "4" or "5" on a 0 to 5 scale, in which "0" indicates the professional had no influence, and "5" indicates the professional made the final project decision for or with the respondent.*

Awareness of ENERGY STAR®

Awareness of the ENERGY STAR® label is high among both firms with construction projects and in the general C&I sample. Table 7.17 shows about four-fifths of both groups recognized ENERGY STAR®. Recognition was indicated in one of two ways. One way was the spontaneous mention of ENERGY STAR® as "a label or logo about energy on business equipment or building materials" (21% of firms with construction projects and 26% of the general C&I sample). Other respondents recognized the ENERGY STAR® label from either its description or name (49% of firms with construction projects and 47% of the general C&I sample). Of those able to mention or recognize ENERGY STAR®, over 80% of both groups were also able to accurately define the ENERGY STAR® message. Awareness of the ENERGY STAR® label did not vary by firm location, size of facility, construction activity, or equipment acquisition.

Table 7.17

AWARENESS OF ENERGY STAR® LABEL AMONG C&I FIRMS

AWARENESS OF ENERGY STAR®	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Spontaneous Mention of ENERGY STAR®	21%	26%
Recognized ENERGY STAR® Name	49%	47%
Recognized ENERGY STAR® Description (asked of those neither spontaneously mentioning or recognizing name)	10%	6%
Total Reported Awareness of ENERGY STAR®	*80%*	*79%*
Accurate Understanding of ENERGY STAR® Meaning Among Those with Reported Awareness	86%*	84%*
Accurate Understanding of ENERGY STAR® Meaning Among Sample	69%	66%
No Knowledge of ENERGY STAR® or Inaccurate Understanding Among Sample	31%	34%

* *Base (denominator) for percentage is 159 for firms with construction projects and 311 for general C&I firms.*

Of the respondents who were able to accurately define the ENERGY STAR® message, they most often said the ENERGY STAR® logo identifies products that conserve energy, are energy efficient, or generate energy bill savings (Table 7.18). Just over 10% of respondents recognized it as a certification or designating a standard of efficiency.

Table 7.18

MEANING OF ENERGY STAR® AMONG C&I FIRMS (MULTIPLE RESPONSES)

MEANING OF ENERGY STAR®	FIRMS WITH CONSTRUCTION PROJECTS (N=137)	GENERAL C&I SAMPLE (N=261)
Conserves Energy, Energy Efficient	79%	70%
Savings on Energy Bill	25%	37%
Uses Less Energy, Energy-Saving Shutdown Feature	7%	15%
Good for the Environment	4%	7%
Certified as Energy Efficient, Standard of Efficiency	10%	13%

Concern for Energy Efficiency

Just over one-third of general C&I firms occupy space they lease (refer to Table 7.7). As Table 7.19 shows, nearly half of these firms (45%) rated the energy efficiency of the building as important to them. These firms rated its importance a “9” or “10” on a ten-point scale, where “1” is not at all important and “10” is very important. About 5% of general C&I firms owned a facility that they leased to tenants (again, refer to Table 7.7); about one-third of these firms thought the energy efficiency of the buildings was very important (“9” or “10”) to their tenants. The sample of firms with construction projects that either occupied lease space or leased space to others was too few to draw meaningful conclusions. Forty-four percent of firms with construction projects and one-third of general C&I firms said they now are more concerned about energy use than they were in previous years.

Table 7.19

HIGH CONCERN FOR ENERGY EFFICIENCY AMONG C&I FIRMS (TOP TWO BOXES)

MEASURES OF CONCERN FOR ENERGY EFFICIENCY	FIRMS WITH CONSTRUCTION PROJECTS*	GENERAL C&I SAMPLE**
Building's Energy Efficiency Is Important to Tenant-Respondent	NA	45% (n=148)
Building's Energy Efficiency Is Important to Tenants Leasing from the Respondent's Firm	NA	32% (n=28)
More Concerned About Energy Use Now Than In Previous Years	44% (n=200)	33% (n=396)

* *Respondents rating the importance of energy efficiency with a "9" or "10" on a ten-point scale with 1 as "not at all important," and 10 as "very important."*

We asked the firms with construction projects why they were more concerned about energy use now than they had been in the past (Table 7.20).

Table 7.20

REASONS FOR HIGHER CONCERN FOR ENERGY EFFICIENCY AMONG C&I FIRMS (MULTIPLE MENTIONS)

REASONS FOR HIGHER CONCERN FOR ENERGY EFFICIENCY	FIRMS WITH CONSTRUCTION PROJECTS (N=88)
Cost of Energy, Price of Fuel	73%
Budget or Financial Concerns	11%
Concern for the Environment	11%
Concern about Terrorism, National Energy Policy or the National Economy	9%
Other	9%

Table 7.20 shows nearly three-quarters (73%) cited concerns about the cost of energy or the price of fuel. Another 11% mentioned a related concern—budget or financial constraints. When these two related concerns are combined, the proportion of firms who are worried about the cost of energy rises to over four-fifths of firms with construction projects.

Barriers to Implementing Energy Efficiency

Lighting Equipment Criteria and Associations

Quality, operating costs, and energy savings potential are the top three criteria for the selection of lighting equipment (Table 7.21).

Table 7.21

PROPORTION OF C&I FIRMS ASSIGNING HIGH IMPORTANCE TO LIGHTING EQUIPMENT CRITERIA (TOP TWO BOXES)

LIGHTING CRITERIA	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Quality	91%	88%
Operating Costs	86%	84%
Energy Savings Potential	84%	81%
Pattern of Light Distribution	82%	69%
Maintenance Effort or Cost	81%	74%
Availability	80%	71%
Initial Cost	70%	74%
Compatibility with Existing Fixtures	56%	64%
Style	38%	31%

High importance is defined as a respondent rating of a "4" or "5" on a five-point scale in which 1 is "not at all important" and 5 is "very important." The responses of firms with and without construction projects are similar. (Only responses to the criterion "pattern of light distribution" differ significantly.) The proportion of firms rating each criterion highly did not vary according to location, facility size, construction activity, or equipment installation. The responses also did not vary significantly by whether the firms had installed lighting equipment, with one exception. For firms with construction projects, those who had installed lighting were more likely to rate "quality" highly than those who had not installed lighting.

Respondents were asked what comes to mind when they think of energy efficient lighting. Table 7.22 shows the primary associations for firms with and without construction projects are "low operating costs" and "saving money." Both groups frequently mentioned "fluorescent lighting" or "CFLs". Most of the associations mentioned were positive or neutral. About 20% of the firms included a negative comment. The greatest proportion of negative associations concerned the performance, quality, or availability of energy efficient lighting.

Table 7.22

ASSOCIATIONS BY C&I FIRMS TO ENERGY EFFICIENT LIGHTING EQUIPMENT (MULTIPLE MENTIONS)

ASSOCIATIONS	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
COSTS, SAVINGS		
Low Operating Cost, Saves Money	28%	34%
Saves Electricity, Saves Energy	12%	9%
Saving Energy for the Future, Save the Environment, Conservation	5%	1%
Lower Heat Output	0%	2%
Expensive, Higher Initial Cost	4%	2%

ASSOCIATIONS	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
		Continued
PERFORMANCE, QUALITY, AVAILABILITY		
Attractive, Good Quality Light	7%	5%
Longer Lasting Bulbs	4%	0%
Bulbs are Easy to Replace, Maintain	0%	1%
Dim Light, Inadequate Illumination for End Use	7%	7%
Color of Light Not Suitable for End Use	2%	2%
Delay In Reaching Full Illumination is Problem	3%	2%
Lower Availability of Product	2%	0%
APPEARANCE OF PRODUCT		
Odd-Shaped, Ugly, Tubular Bulbs	3%	2%
Incompatible with Existing Fixtures	1%	0%
ASSOCIATIONS WITH SPECIFIC TECHNOLOGIES OR MEASURES		
Fluorescent Lighting or CFLs	17%	16%
Daylighting	4%	2%
T-8 Lights	3%	1%
Electronic Ballasts	3%	2%
LEDs, Sodium Lights, Halogen, Neon Lights	2%	2%
Newer Technology, Innovative Products	2%	0%
Occupancy Sensors	1%	0%
OTHER ASSOCIATIONS		
Other	21%	20%

We conclude from a comparison of the importance of the criteria and the associations to energy efficient lighting that firms' attitudes about quality might constitute a barrier to efficient lighting purchases. Quality was rated with high importance by about 90% of firms. Eleven percent of firms with construction projects spontaneously mentioned high quality in association with efficient lighting, yet an equal proportion (12%) made remarks suggesting lower quality. Among general C&I firms, 5% spontaneously mentioned a high quality in association with efficient lighting yet 9% made remarks suggesting lower quality.

On a positive note, operating costs were rated with high importance by about 85% of firms and about 40% of firms spontaneously associated low operating costs with efficient lighting. The importance of operating costs bodes well for the market acceptance of energy efficient lighting and suggests that greater acceptance will occur as firms better understand the very large cost savings.

About three-quarters of respondents said that initial cost was an important criteria for lighting equipment. The higher cost of efficient lighting equipment might therefore be a barrier. However, this factor came in seventh in importance among the criteria explored. The ranking that resulted from the respondents' rating of importance suggests that, for many respondents, lower operating costs might overcome the higher first cost barrier.

Heating and Cooling Equipment Criteria and Associations

Durability, energy savings, and comfort are the top three criteria for heating and cooling equipment (Table 7.23). High importance is defined as a respondent rating of a "4" or "5" on a five-point scale in which 1 is "not at all important" and 5 is "very important." As found for lighting, the responses of firms with and without construction projects are similar. The proportion of firms rating each criterion highly did not vary according to location, facility size, or by type of permitted construction activity (e.g., new construction, renovation, addition). Among general C&I firms, two criteria—initial cost and availability—differed in importance between subgroups. Firms who had installed equipment in the last two years were *less* likely than those who had not to rate these two criteria as important. Responses did not depend on whether heating equipment or some other type of equipment had been installed.

Table 7.23

PROPORTION OF C&I FIRMS ASSIGNING HIGH IMPORTANCE TO HEATING AND COOLING EQUIPMENT CRITERIA (TOP TWO BOXES)

HEATING CRITERIA	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Durability	96%	91%
Energy Savings	90%	90%
Comfort	91%	85%
Maintenance Effort or Cost	86%	82%
Life Cycle Cost	83%	82%
Availability	78%	72%
Initial Cost	73%	77%

Respondents were asked what comes to mind when they think of energy efficient heating and cooling equipment. Table 7.24 shows the associations most often mentioned by firms both with and without construction projects are "saving money" and "low operating costs." Not surprisingly, the "efficient use of fuel" was frequently associated with energy-efficient heating and cooling equipment. Less than 10% of firms included a negative remark (such as "initial investment is high") among their associations.

Our comparison of the importance of the criteria and the associations to energy efficient heating and cooling equipment did not reveal any attitudes that comprise barriers to efficient HVAC purchases. Energy savings were rated with high importance by about 90% of firms and maintenance effort or cost was rated highly by about 85% of firms. Fifty-one percent of firms with construction projects and 44% of general C&I firms spontaneously mentioned money and fuel savings in association with efficient heating and cooling equipment. Similarly, the criteria of durability and comfort were rated highly by over 90% of firms and both of these qualities were spontaneously mentioned as positive associations to efficient equipment by about 15% of

firms with construction projects, making them the most frequent associations after money and fuel savings.

Table 7.24

ASSOCIATIONS OF C&I FIRMS TO ENERGY EFFICIENT HEATING AND COOLING EQUIPMENT (MULTIPLE MENTIONS)

ASSOCIATIONS	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
COSTS		
Saves Money, Lower Energy Bills, Operating Costs are Low	33%	29%
Initial Investment Is High	5%	1%
PERFORMANCE, QUALITY, AVAILABILITY		
Efficient Use of Fuel	18%	15%
Dependable, Reliable, Durable, Fast Startup	15%	9%
Provides Comfort for Occupants, Heating and Cooling is Evenly Distributed Throughout Conditioned Space	14%	10%
Low Maintenance, Easy to Maintain, Easy to Use	6%	10%
Programmable Controls	3%	4%
Clean or Renewable Energy Source, Low Emissions	1%	4%
Quiet, Unobtrusive Size, Compatible with Existing Systems	3%	5%
Negative Comments about Performance, Maintenance*	2%	1%
Associations with Specific Technologies or Fuels		
Radiant Heat, Zoned Heating, Heat Pumps, Economizers, Condensing Boilers	6%	3%
Gas, Propane, Oil	5%	5%
Insulation, Ventilation, Air Exchangers	5%	2%
Solar Panels, Cogeneration	2%	4%
OTHER ASSOCIATIONS		
Environment, Conservation, ENERGY STAR®	4%	3%
Other	2%	0%

* *Comments were "noisy," "more expensive to repair," "not dependable," and "heating and cooling is not distributed evenly throughout conditioned space." Each comment was made by one respondent (four respondents in total).*

Of all the criteria rated by firms, initial cost was rated with high importance the least frequently. Nonetheless, about three-quarters of respondents did identify just initial cost to be important. Only 5% of firms with construction projects and 1% of general C&I firms spontaneously mentioned the initial investment for efficient heating and cooling equipment is high. Taken together, these two findings suggest the initial cost of efficient HVAC equipment, while somewhat of a barrier, may not be "show-stopper" for many firms.

USE AND AWARENESS OF ENERGY EFFICIENCY MEASURES

This section presents results from analyses to identify current practices among Vermont's C&I end-use firms regarding the efficiency measures discussed with professionals and installed. Current practices are explored for those groups installing equipment—firms with construction projects and firms with equipment projects.

Awareness of Efficiency Measures

We hypothesized that firms who had conducted a construction or equipment project would have greater awareness of energy efficiency options than would firms who had installed no building systems equipment in the last two years. Table 7.25 confirms this hypothesis.

Respondents were more aware of programmable thermostats than any other measure—approximately 90% of each group were aware. More than half of the respondents in all three groups were aware of low-e windows, energy management systems, and three types of lighting efficiency measures, in addition to programmable thermostats.

The sample of C&I respondents is large enough to permit multivariate statistical analysis. At the end of this chapter, we discuss the characteristics of C&I firms that are associated with awareness of efficiency measures.

Table 7.25

AWARENESS OF EFFICIENCY MEASURES AMONG C&I FIRMS

EFFICIENCY MEASURES	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)	
		FIRMS WITH EQUIPMENT PROJECTS (N=158)	FIRMS WITH NO EQUIPMENT INSTALLED (N=238)
LIGHTING			
Electronic Ballasts	84%	84%	68%
CFLs	82%	72%	69%
LED Exit Signs	78%	66%	56%
Occupancy Sensors for Lights	58%	53%	44%
Multi-Level Switching Controls for Lighting	58%	45%	36%
T-8 Lights	47%	35%	20%
Features to Bring Daylighting In	43%	49%	40%
HEATING			
Programmable Thermostat	90%	92%	87%
Energy Management System	59%	58%	48%
Condensing Furnace or Boiler	52%	40%	32%
Economizer	48%	44%	36%
OTHER MEASURES			
Low-E Glass	83%	85%	72%
Distributed Generation	17%	12%	11%

Efficiency Measures Discussed with Professionals

Just over half (55%) of the firms with construction projects reported discussing energy use for their construction project with one or more building professionals (Table 7.26).[65] Conversations about energy use most likely occurred with contractors, with approximately one-fifth of firms naming general contractors (20%), heating and cooling contractors (19%), and lighting and electrical contractors (17%). Conversations were less likely to occur with engineers, with 13% of firms naming electrical engineers and 9% naming mechanical engineers. The prevalence of conversations with architects fell in between that of contractors and engineers (16%).

When account is taken of the rate at which a professional was used at all on a construction project, firms conferred with electrical engineers about energy use more than any other professional. Nearly half (45%) of firms using an electrical engineer discussed energy use with him or her. Lighting contractors fell at the other end of the spectrum; those using lighting contractors discussed energy use with them only 19% of the time. Responses did not vary by location or size of facility.

Table 7.26

PROPORTION OF C&I FIRMS DISCUSSING ENERGY USE WITH PROFESSIONAL

PROFESSIONAL	FIRMS WITH CONSTRUCTION PROJECTS (N=200)
Did Not Discuss with Any Professional*	45%
Discussed with One of More Professionals	55%
	Continued

[65] Only those with construction projects were asked to distinguish among the roles of the different types of professionals involved in a project.

PROFESSIONAL	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	
PROFESSIONALS (MULTIPLE MENTIONS)	DISCUSSED WITH PROFESSIONALS (N=200)	DISCUSSED WITH PROFESSIONALS AS A PERCENT OF FIRMS USING THOSE PROFESSIONALS
General Contractor	20%	25% (n=158)
Heating and Cooling Contractor	19%	27% (n=136)
Lighting or Electrical Contractor	17%	19% (n=170)
Architect	16%	33% (n=96)
Electrical Engineer	13%	45% (n=60)
Mechanical Engineer	9%	27% (n=66)

* *Percentage (45%) includes 8% who did not know whether energy use was discussed with a professional and 38%who said they did not discuss it with any professionals*

** *N=200. To derive statistics as a proportion of those who discussed energy with any professional, multiply by 1.0/0.55 = 1.82. General contractor=36%, HVAC contractor=35%; lighting/electrical contractor=31%, architect=29%; EE=24%; ME=16%.*

While Table 7.26 reports the findings on discussions C&I firms had about energy *use*, Table 7.27 reports on the encouragement C&I firms had about pursuing energy *efficiency*. Firms reported that architects, mechanical engineers, and general contractors encouraged the consideration of energy efficiency more than other building and construction professionals. Very few firms received discouragement from building professionals regarding energy efficiency measures. Neither encouragement nor discouragement of energy efficiency varied by location, size of facility, or type of project.

Table 7.27

PROFESSIONALS' RECOMMENDATION OF ENERGY EFFICIENCY MEASURES TO C&I FIRMS

PROFESSIONAL	FIRMS WITH CONSTRUCTION PROJECTS THAT SPOKE WITH PROFESSIONAL	
	ENCOURAGED	DISCOURAGED
Architect (n=32)	75%	6%
Mechanical Engineer (n=18)	67%	0%
General Contractor (n=39)	62%	8%
Lighting Contractor (n=33)	55%	0%
Electrical Engineer (n=27)	44%	0%
Heating and Cooling Contractor (n=37)	38%	3%

Most firms (80%) indicated they did not bring up any specific requirements they had for energy use in their construction projects during their discussions with their building professionals (Table 7.28).

Table 7.28

C&I FIRMS' REQUIREMENTS FOR ENERGY USE (MULTIPLE MENTIONS)

PROFESSIONALS USED	FIRMS WITH CONSTRUCTION PROJECTS (N=200)
No Requirements for Energy Use	80%
More Energy-Efficient Than Space Was Previously	11%
More Energy-Efficient Than Similar Buildings	7%
Have Energy Budget or Target for Energy Use	2%
Do What Could Be Done Within Budget Constraints	1%

Analyze the Cost-Effectiveness of the Features and Equipment	6%

Table 7.29 shows the percent of firms with construction projects who discussed using various efficiency measures with professionals. The firms most frequently discussed electronic ballasts (82%) and low-e glass (67%). Over 50% of firms reported discussing programmable thermostats and LED exit signs, in addition to ballasts and glass.

Table 7.29 also shows the proportion of those who discussed the measure as a percent of those who had heard of it prior to the survey. For the most part, the ordering that resulted from most frequently discussed to least frequently discussed also gives a descending order of frequency for discussed as percent of aware.

The data suggest that being aware of an efficiency measure does not, in itself, result in discussing the measure with professionals. Were that the case, the proportions for discussed as a percentage of aware would not show the variation across measures that we see.

The table (Table 7.29) presents the same information for firms with equipment projects as it presents for firms with construction projects. Were we to order the measures by descending frequency of discussed for this group, the order of measures would be somewhat different, but not strikingly so. For example, CFLs would rank second and LED exit signs would rank third, whereas for firms with construction projects, these measures rank third and second, respectively. Again, given the variation in the proportions of discussed as a percent of aware, we conclude it is *not* lack of awareness that is limiting discussion.

For all but one measure (VFDs), firms with construction projects discussed using efficiency measures more frequently than firms with equipment projects.[66] The table (Table 7.29) marks with an asterisk those differences

[66] We have not identified a reason why VFDs are more frequently discussed among the group with no permits. 17% of the group with permits are in industrial facilities, compared with 14% of the group with no permits. It

between the two groups of firms that are statistically significant. About half of the differences among the measures are statistically significant.

Discussion of measures showed some significant correlations with facility size and location. However, as can be seen in the next table on measure installation rates, there exits a high correlation between discussing a measure and installing a measure. A section at the end of this chapter summarizes the characteristics of C&I firms associated with measure installation rates.

Table 7.29

EFFICIENCY MEASURES C&I FIRMS DISCUSSED WITH PROFESSIONALS

EFFICIENCY MEASURES	FIRMS WITH CONSTRUCTION PROJECTS		FIRMS WITH EQUIPMENT PROJECTS	
	DISCUSSED USING	DISCUSSED AS PERCENT OF AWARE	DISCUSSED USING	DISCUSSED AS PERCENT OF AWARE
LIGHTING				
Electronic Ballasts	82% (n=182)	82% (n=152)	63%* (n=90)	71% (n=77)
LED Exit Signs	53% (n=182)	64% (n=143)	33%* (n=90)	47%* (n=64)
CFLs	48% (n=182)	55% (n=150)	46% (n=90)	56% (n=70)
T-8 Lights	45% (n=182)	78% (n=76)	33% (n=90)	64% (n=39)
Multi-Level Switching Controls for Lighting	31% (n=182)	43% (n=108)	14%* (n=90)	25%* (n=48)
Occupancy Sensors for Lights	24% (n=182)	36% (n=108)	22% (n=90)	35% (n=51)
Daylighting Features	15% (n=200)	NA	NA	NA

could be the result of outreach to vendors through EVT and BED's involvement in the Northeast Premium Efficiency Motors Initiative, the permit process or some other factor yet to be determined.

EFFICIENCY MEASURES	FIRMS WITH CONSTRUCTION PROJECTS		FIRMS WITH EQUIPMENT PROJECTS	
	DISCUSSED USING	DISCUSSED AS PERCENT OF AWARE	DISCUSSED USING	DISCUSSED AS PERCENT OF AWARE
HEATING AND COOLING				
Programmable Thermostat	56% (n=165)	59% (n=153)	33%* (n=85)	36%* (n=78)
Economizer	31% (n=165)	57% (n=74)	12%* (n=85)	15%* (n=40)
Condensing Furnace or Boiler	30% (n=165)	51% (n=82)	14%* (n=85)	23%* (n=40)
Energy Management System	30% (n=165)	31% (n=95)	19% (n=85)	23% (n=52)
OTHER MEASURES				
Low-E Glass	67% (n=151)	74% (n=129)	55% (n=66)	61% (n=56)
Variable Frequency Drives	21% (n=33)	NA	50%* (n=26)	NA

* *Values for firms with equipment projects differ significantly from those for firms with construction projects.*

Efficiency Measures Installed

Table 7.30 uses a similar format as Table 7.29 to present findings on the efficiency measures installed. Firms reported most frequently installing electronic ballasts, electronic controls, and low-e glass. The measures are listed in descending order of frequency among firms with construction projects. The order is the same as Table 7.29; that is, an ordering by frequency of installation is the same as an ordering by frequency discussed.

The frequency of measure installation among firms with construction projects exceeds those for firms with equipment projects for every measure except VFDs. The table (Table 7.30) identifies with an asterisk the frequencies among

general C&I firms that differ significantly from those with construction projects.

Table 7.30

EFFICIENCY MEASURES INSTALLED BY C&I FIRMS

EFFICIENCY MEASURES	FIRMS WITH CONSTRUCTION PROJECTS		FIRMS WITH EQUIPMENT PROJECTS	
	INSTALLED	INSTALLED AS PERCENT OF DISCUSSED	INSTALLED	INSTALLED AS PERCENT OF DISCUSSED
LIGHTING				
Electronic Ballasts	70% (n=182)	98% (n=131)	58% (n=90)	92% (n=57)
LED Exit Signs	49% (n=182)	93% (n=97)	29%* (n=90)	87% (n=30)
CFLs	45% (n=182)	93% (n=88)	40% (n=90)	89% (n=41)
T-8 Lights	38% (n=182)	84% (n=83)	31% (n=90)	93% (n=30)
Multi-Level Switching Controls for Lighting	26% (n=182)	82% (n=57)	11%* (n=90)	77% (n=13)
Occupancy Sensors for Lights	19% (n=182)	77% (n=44)	14% (n=90)	65% (n=20)
Daylighting Features	9% (n=200)	57% (n=30)	NA	NA

Continued

EFFICIENCY MEASURES	FIRMS WITH CONSTRUCTION PROJECTS		FIRMS WITH EQUIPMENT PROJECTS	
	INSTALLED	INSTALLED AS PERCENT OF DISCUSSED	INSTALLED	INSTALLED AS PERCENT OF DISCUSSED
HEATING AND COOLING				
Programmable Thermostat	52% (n=165)	92% (n=93)	31%* (n=85)	93% (n=28)
Economizer	25% (n=165)	80% (n=51)	8%* (n=85)	70% (n=10)
Condensing Furnace or Boiler	23% (n=165)	76% (n=50)	12% (n=85)	83% (n=12)
Energy Management System	18% (n=33)	86% (n=49)	13% (n=85)	69% (n=16)
OTHER MEASURES				
Low-E Glass	62% (n=151)	93% (n=101)	44%* (n=66)	81% (n=36)
Variable Frequency Drives	18% (n=33)	86% (n=7)	35% (n=26)	69% (n=13)
Installed Electronic Controls for Any System**	68% (n=200)	NA	NA	NA

* *Values for firms with equipment projects differ significantly from those for firms with construction projects.*

** *Firms with equipment projects were not asked this question.*

Again, the concluding section to this chapter explores the characteristics of C&I firms that are associated with measure installation.

PROGRAM PROCESS ASSESSMENT

This section describes Vermont's C&I end-use firm response to Act 250 and EVT.

Act 250

Among the firms with construction projects, less than half (41%) reported the project required Act 250 reviews demonstrating the project would meet the energy guidelines (Table 7.31).

Table 7.31

INVOLVEMENT WITH ACT 250 AMONG C&I FIRMS

INVOLVEMENT WITH ACT 250	FIRMS WITH CONSTRUCTION PROJECTS*	GENERAL C&I SAMPLE*
Current Project Required Act 250 Reviews	41% (n=160)	NA
Other Projects that Required Act 250 Reviews**	40% (n=192)	17% (n=392)
• One	30% (n=86)	55% (n=65)
• Two to Five	43% (n=86)	31% (n=65)
• More Than Five	27% (n=86)	14% (n=65)
Current or Past Involvement in Act 250	43% (n=200)	17% (n=392)

** Base excludes don't know responses.*

*** For general C&I firms, the question was phrased "Have you been involved in the process to obtain Act 250 reviews, specifically demonstrating that a project will meet the energy guidelines?"*

Firms with construction projects were more likely than general C&I firms to have had previous experience with Act 250, and to have had repeated experience with Act 250 for multiple projects. In fact, among the firms with construction projects, those whose current project required an Act 250 review were more likely to have had past involvement with Act 250 than those without current Act 250 involvement (59% versus 32%). There were no differences in having had current or past involvement in Act 250 by location or size of facility.

Firms with projects entailing construction of a *new building* were more likely to have undertaken six or more Act 250 projects in the past than firms with building *additions* or doing a *major renovation*. All firms in the latter group had conducted five or fewer Act 250 projects in the past. The number of Act 250 projects for firms does not vary significantly by location or size of facility.

Of the firms who have had involvement with Act 250, 55% of those with construction projects, and 35% of general C&I firms, believe Act 250 projects have incorporated a higher level of energy efficiency than non-Act 250 projects (Table 7.32). General C&I firms were more likely than firms with construction projects to offer no opinion on the subject. There were no differences in opinions by location or size of facility.

Table 7.32

RESULTS OF ACT 250 ACCORDING TO C&I FIRMS

RESULTS OF ACT 250 PROJECTS COMPARED TO NON-ACT 250 PROJECTS	FIRMS WITH CONSTRUCTION PROJECTS (N=86)	GENERAL C&I SAMPLE (N=65)
Believe Act 250 Results in a Higher Level of Energy Efficiency	55%	35%
Believe Act 250 Results in the Same Level of Energy Efficiency	31%	29%
Believe Act 250 Results in a Lower Level of Energy Efficiency in Projects	11%	8%
Don't Know/Refused	2%	28%

We conducted an analysis of the relationship between the energy efficiency outcomes and Act 250 involvement. Results from this analysis are presented at the end of the next section.

Efficiency Vermont

Twenty-eight percent of firms with construction projects and 18% of general C&I firms spontaneously mentioned "Efficiency Vermont," "Vermont Efficiency," or "EVT" as the name of "an organization that promotes energy efficiency in Vermont" (Table 7.33). When we include those who recognized the various names of EVT when prompted, about one-half of both firms with construction projects and general C&I firms were aware of Efficiency Vermont. There were no differences in awareness among firms by location or size of facility. Awareness did not vary by type of project among those with construction projects. For general C&I firms, awareness of EVT increased with the number of building systems installed (e.g., lighting and HVAC).

Table 7.33

AWARENESS OR RECOGNITION OF EFFICIENCY VERMONT AMONG C&I FIRMS

AWARENESS, RECOGNITION OF EFFICIENCY VERMONT	FIRMS WITH CONSTRUCTION PROJECTS (N=200)	GENERAL C&I SAMPLE (N=396)
Spontaneous Mention of "Efficiency Vermont," "Vermont Efficiency, or "EVT" as Organization That Promotes Energy Efficiency in Vermont	28%	19%
Recognized "Efficiency Vermont," "Vermont Efficiency, or "EVT" When Mentioned	21%	26%
Total Aware of Efficiency Vermont	49%	45%

Twenty-eight percent of firms with construction projects and 20% of general C&I firms reported contact with Efficiency Vermont or the Burlington Electrical Department (Table 7.34).[67]

[67] Twenty percent of general C&I firms corresponds with 79 respondents. Of these, 37 had installed no equipment in the past two years; 42 had installed windows, heating, or lighting equipment in the past two

Those with contact comprise about half of those who had accurate awareness of Efficiency Vermont. The direction of contact (that is, whether the firm contacted or was contacted by EVT or BED) did not differ significantly between the two groups of firms. The contact flowed from the C&I firm to the organizations about one-third of the time; EVT or BED contacted (either unilaterally or mutually) the C&I firm about two-thirds of the time. Contact with Efficiency Vermont did not differ by location of firm. Among firms with construction projects, larger firms were more likely to have had contact with EVT. There were no significant differences in rates of contact by size of facility among the general C&I sample.

Table 7.34

CONTACT WITH EFFICIENCY VERMONT AMONG C&I FIRMS

CONTACT WITH EFFICIENCY VERMONT	FIRMS WITH CONSTRUCTION PROJECTS	GENERAL C&I SAMPLE
Had Contact with Efficiency Vermont or Burlington Electric Department	28% (n=200)	20%* (n=396)
Had Contact with EVT/BED—Percent of those with Accurate Awareness of EVT/BED	56% (n=98)	44% (n=178)
NAME OF AGENCY INVOLVED IN CONTACT	**(N=55)***	**(N=79)***
Efficiency Vermont	89%	80%
Burlington Electric Department	0%	4%
Both Efficiency Vermont and Burlington Electric Department	7%	13%
Don't Recall Which Agency Contacted	4%	5%
DIRECTION OF CONTACT	**(N=55)**	**(N=79)**
C&I Firm Contacted EVT or BED	33%	39%

years. Thus, of those not installing equipment, 18% have had contact with EVT/BED. Of those installing equipment, 27% have had contact.

EVT or BED Contacted C&I Firm	16%	24%
Mutual Contact	49%	33%
Don't Recall Direction of Contact	0%	3%

** 28%of firms with construction projects corresponds with 55 respondents. 20%of general C&I firms corresponds with 79 respondents*

Of the firms with accurate awareness of Efficiency Vermont, over one-third of those with construction projects (36%) had conducted a project with or received services from Efficiency Vermont or the Burlington Electric Department. Table 7.35 shows nearly one-quarter (24%) of the general C&I sample who had accurate awareness of EVT reported having conducted a project with or receiving services from Efficiency Vermont or the Burlington Electric Department.

Table 7.35

PROPORTION OF C&I FIRMS WITH EVT CONTACT WHO RECEIVED SERVICES FROM EVT OR BED

CONDUCTED A PROJECT WITH OR RECEIVED SERVICES FROM EFFICIENCY VERMONT OR THE BURLINGTON ELECTRIC DEPARTMENT	FIRMS WITH CONSTRUCTION PROJECTS	GENERAL C&I SAMPLE
Percent of Respondents Who Either Spontaneously Mentioned EVT Name or Recognized EVT From Prompt.	36% (n=98)	24% (n=179)
Percent of Total Sample	18% (n=200)	11% (n=396)

Among all firms, those with larger facilities were more likely than those with smaller facilities to have received services from EVT or BED. Also among all firms, no differences were apparent by facility location. Among those with construction projects, no significant differences were found among those engaging in different project types. As we would expect, among general C&I

firms, those installing two or three building systems were more likely to have received services than those installing one building system, which in turn were more likely than those not installing equipment.

Staff at the respondent's company or a colleague at another company were the most frequently cited sources of recommendations to use EVT or BED. Each of these sources was mentioned by about 10% of respondents. Another 17% of firms with construction projects and 11% of general C&I firms said they were referred to EVT/BED by a building professional. However, about one-half of firms got to EVT or BED through another, unspecified source.

Firms used lighting rebates more frequently than any other EVT service; 63% of both groups of firms received them (Table 7.36). Among firms with construction projects, HVAC rebates, motor rebates, and technical assistance for their Act 250 project were used most frequently after lighting rebates. General C&I firms were most likely to use technical assistance for remodeling/equipment replacement or for non-Act 250 projects most frequently after lighting rebates.

Table 7.36

EFFICIENCY VERMONT SERVICES USED BY C&I FIRMS (MULTIPLE MENTIONS)

SERVICE OR EVENT	FIRMS WITH CONSTRUCTION PROJECTS (N=35)	GENERAL C&I SAMPLE (N=43)
Lighting Rebates	63%	63%
HVAC Rebates	29%	23%
Motor Rebates	26%	28%
Technical Assistance for Act 250 Project	26%	23%
Technical Assistance for Remodeling or Equipment Replacement	17%	44%
Technical Assistance for Non-Act 250 Project	17%	40%
Building Solutions Conference	14%	16%

Rebates for Other, Unspecified Equipment	11%	NA
Don't Recall the Type of Project for Which Technical Assistance Was Received	9%	0%
Other Technical Assistance	3%	0%

Among general C&I firms, those located in Chittenden County were more likely than those located elsewhere to use technical assistance for a non-Act 250 project and for lighting rebates (see Table 7.37). For other services, and among firms with construction projects, there were no significant differences in service utilization rates by firm location.

Among both groups of firms, those with larger facilities were more likely to have used the services of EVT/BED overall. Among firms with construction projects, those with smaller facilities were more likely to have used lighting and HVAC rebates. As smaller facilities outnumber larger ones, this finding is consistent with the high proportion of firms overall who used lighting and HVAC rebates.

Table 7.37

SUMMARY OF DIFFERENCES IN EVT SERVICE UTILIZATION RATES BY C&I FIRM CHARACTERISTICS

SIGNIFICANT DIFFERENCES AMONG GROUPS	FIRMS WITH CONSTRUCTION PROJECTS (N=35)	GENERAL C&I SAMPLE (N=43)
Differences by Location	None	Chittenden County more likely to have used: --non-Act 250 assistance --lighting rebates
Differences by Size	Large more likely to have used EVT services overall. Small more likely to have used lighting and HVAC rebates	Large more likely to have used: --EVT services overall

Differences by Project Type	None	The greater the number of equipment installations, the more likely to have used: -–technical assistance for remodeling/equipment replacements -–technical assistance for non-Act 250 projects

Among firms with construction projects, service utilization rates did not vary by type of project. Among general C&I firms, service utilization rates were highest for firms who had installed two or three building systems, followed by those who had installed one building system. Service utilization rates were lowest for those who had not installed building systems in the past two years. These differences were significant for technical assistance for remodeling/equipment replacement projects and for non-Act 250 projects.

Experiences with Efficiency Vermont differed somewhat between firms with construction projects and general C&I firms. Table 7.38 shows about two-thirds (63%) of firms with construction projects volunteered they found EVT staff to be responsive, helpful and professional or that they had gained insight from their contact with EVT, compared with about half as many (37%) general C&I firms.

Table 7.38

EXPERIENCE WITH EFFICIENCY VERMONT AMONG C&I FIRMS (MULTIPLE MENTIONS)

EXPERIENCE	FIRMS WITH CONSTRUCTION PROJECTS (N=35)	GENERAL C&I SAMPLE (N=43)
Responsive, Professional, Helpful	37%	26%
Gained Insight, Learned	26%	21%
Good Program, Service, Pleased With Results	14%	0%

Experienced, Had Good Information, Knowledgeable	14%	5%
Subtotal: Positive Comments	*91%*	*52%*
Retrofit (Lighting or HVAC)	6%	16%
Rebates	6%	7%
Other	6%	5%
Used Audit Service	0%	12%
Subtotal: Neutral Comments	*18%*	*40%*
Not Useful, Helpful, Knowledgeable	0%	12%

Over one-quarter of the firms with construction projects (28%) also volunteered they were "pleased with the results" of their projects with EVT or felt EVT's staff was knowledgeable and offered good information. In contrast, 5% of the general C&I firms volunteered these opinions. General C&I firms made all of the negative comments received. No differences were found for reported experience by project type, location, or size of facility.

The data do not illuminate the differences in the reported experience of firms with construction projects and general C&I firms. However, it is reasonable to assume that firms with construction projects had more extensive and individualized interactions with EVT than general C&I firms, which typically worked with EVT on equipment replacement and audit projects. This difference in interactions with EVT may underlie the apparent differences in spontaneous comments reported in the table.

We asked the firms who had used one or more of Efficiency Vermont's services to rate EVT on four criteria. Table 7.39 shows firms indicated high levels of satisfaction, although as expected from Table 7.36, the general C&I sample had somewhat lower levels of satisfaction. No differences were found for reported satisfaction by project type, location, or size of facility.

Table 7.39

SATISFACTION WITH EFFICIENCY VERMONT'S SERVICES AMONG C&I FIRMS

CRITERIA	FIRMS WITH CONSTRUCTION PROJECTS* (N=35)	GENERAL C&I SAMPLE* (N=43)
Knowledge of Energy Efficiency Solutions	89%	77%
Quality of Services	83%	72%
Responsiveness to Project Needs	80%	70%
Usefulness of Information Provided	80%	74%

** Respondents who rated criterion with a "4" or "5" on a five-point scale in which 1 is "not at all satisfied," and 5 is "very satisfied."*

Nearly all of the firms who had worked with Efficiency Vermont said they were "very likely" to use EVT in the future. Table 7.40 shows 100% of those with construction projects and 94% of general C&I firms were either "very likely" or "somewhat likely" to use EVT's assistance. No differences were found for likelihood of using EVT in the future by project type, location, or size.

Table 7. 40

LIKELIHOOD OF C&I FIRMS USING EFFICIENCY VERMONT IN THE FUTURE

LIKELIHOOD	FIRMS WITH CONSTRUCTION PROJECTS (N=35)	GENERAL C&I SAMPLE (N=43)
Very Likely	86%	83%
Somewhat Likely	14%	10%
Not at All Likely	0%	7%
Not Sure	0%	0%

General C&I firms were asked to elaborate on why they thought they would or would not use EVT in the future. Table 7.41 shows over half (58%) valued EVT for its good service or expertise.

Table 7.41

REASONS FOR USING OR NOT USING EVT IN THE FUTURE GIVEN BY C&I FIRMS

REASON	GENERAL C&I SAMPLE (N=43)
Good Service	30%
Expertise, Knowledge, Information, Reputation	28%
Rebates Received	12%
Cost-Effective Service	9%
Company Commitment to Energy Efficiency	9%
Required to Use EVT	5%
Company Can Meet Efficiency Standards Without EVT Assistance	5%
Other	2%

It is interesting to note that, while rebates were among the most frequently mentioned services received, only 12% of firms cited rebates as the reason they would be likely to use EVT in the future.[68]

[68] Of course, the relative absence of rebates among spontaneous elaborations of why respondents would use EVT services in the future is not the equivalent of a "no" response to the direct query "might you use EVT rebates in the future." Thus, one cannot conclude that these respondents will not use rebates in the future. One can only note that, for whatever reason, "rebates" was not the most commonly mentioned theme.

FIRM AND PROJECT CHARACTERISTICS RELATING TO USE AND AWARENESS OF EFFICIENCY MEASURES

The samples of firms with construction projects and general C&I firms were large enough to permit a multivariate analysis of characteristics associated with high measure installation and awareness rates.

A multivariate analysis enables us to separate out the independent influence of characteristics on installation and awareness. For example, simple correlations may show that both large projects and projects that use many professionals have higher measure installation rates than other projects. One would be left with the question of whether both size and number of professionals is important, or whether large projects use lots of professionals and only one or the other of these characteristics is key to understanding the use of efficiency measures. A multivariate analysis answers questions such as this.

We explored the characteristics associated with the following outcomes:

- Number of measures installed:
  - Among all efficiency measures explored in the surveys (range: 0 to 12)[69]
  - Among the lighting efficiency measures explored (range: 0 to 6)
  - Among the heating efficiency measures explored (range: 0 to 4)
- Number of measures aware of:
  - Among all efficiency measures explored in the surveys (range: 0 to 12)
  - Among the lighting efficiency measures explored (range: 0 to6)

[69] For the general C&I population, we looked only at respondents who had installed a given building system. Thus, we do not summarize total number of efficiency measures installed but instead look only at total lighting measures installed among those installing lighting systems, and total heating measures installed among those installing heating systems, and low-e glass installed among those installing windows.

- Among the heating efficiency measures explored (range: 0 to 4)

We explored the following project and firm characteristics that might be associated with measure installation or awareness rates:

- Professionals used on construction projects:[70]
  - Total number of professionals used (range 0 to 6)
  - Types of professional used (one binary variable for each type of professional)
  - Type of professional most influencing HVAC decisions (one binary variable for each type of professional; for HVAC and total measures)
  - Type of professional most influencing lighting decisions (one binary variable for each type of professional; for lighting and total measures)
  - Type of professional with whom energy use was discussed (one binary variable for each type of professional)
  - Type of professional who encouraged energy efficiency (one binary variable for each type of professional)
- Size and location of construction project:
  - Size of project (three binary variables)[71]
  - Size of facility (three binary variables)
  - Location of facility (three binary variables)

[70] This information is not available for firms with equipment projects.

[71] Because the original size and location variables are forced-choice, only two of three binary variables are used in any given multivariate analysis. This contrasts with the binary variables created for professionals, which were derived from original data that permitted multiple responses.

- Act 250, EVT involvement:
  - Involved in Act 250 (binary variable)
  - Used EVT services (binary variable)[72]

Table 7.42 summarizes our findings from the multivariate regression analysis.

From Table 7.42 we can see overall efficiency measure installation rates (denoted "all" in the table) among permitted projects are influenced by:

- *Professionals*—the number used on the project and discussions about energy with a mechanical engineer (or alternatively, instead of these two variables, "discussed energy with architect or general contractor"),
- *Size*—the size of the project or facility (two closely related variables), and
- *EVT*—used EVT services.[73]

The data support the following hypotheses:

1. Larger C&I firms, larger construction projects, and more complex construction projects (those using more professionals) install more energy efficiency measures than other types of firms and projects.
2. More energy efficiency measures are installed when firms discuss energy use with their designers or general contractor.
3. More efficiency measures are installed when firms use the services of EVT.

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[72] Simple correlations conducted in advance of the regression analysis showed the anticipated result that use of EVT services was more strongly associated with installation of measures than was contact with EVT, which in turn was more strongly associated with installation of measures than was awareness of EVT.

[73] Note that a lack of significant findings for involvement with Act 250 is not evidence that Act 250 is ineffectual. Given the long history of Act 250 in Vermont and the limitations of the current study and survey length, we are unable to assess the effectiveness of Act 250. See the recommendations given in chapter 9 for pursuing this research topic.

Table 7.42

VARIABLES SIGNIFICANT IN MODELS OF MEASURE INSTALLATION AND AWARENESS AMONG C&I FIRMS

FACTORS	FIRMS WITH PERMITS		FIRMS WITH NO PERMITS	
	INSTALLED	AWARE	INSTALLED[A]	AWARE[B]
PROFESSIONALS USED				
Total Number of Professionals Used	All, Lighting, Heating	All, Lighting	NA	
Spoke with Mechanical Engineer[c]	All	Heating		
SIZE, LOCATION				
Large Project or Facility (> 25,000 sf)	All, Lighting, Heating	NA	Lighting	All, Lighting, Heating
Medium Project (>5,000 sf, < 25,000 sf) (Negative effect)	NA	All, Lighting	NA	NA
Chittenden County		NA		All
Small Urban			Lighting	NA
Rural (Negative effect)	Heating	Heating	NA	Lighting
ACT 250, EVT				
Involved in Act 250	NA	All, Lighting, Heating	NA	All, Lighting, Heating
Used EVT Services	All, Lighting	All, Lighting, Heating	Lighting, Heating	All, Lighting, Heating

[a] *Sample comprised of those who installed the building system to which the measures apply (i.e., lighting, HVAC). No model was run for installation of all 14 measures, because most measures are not relevant to most of the firms with no permits.*

[b] *Sample comprised of all general C&I firms.*

[c] *The model reported on here uses total number of professionals and "discussed energy use with mechanical engineer". A model with almost as high explanatory power does not include number of professionals and uses "discussed energy use with architect or general contractor" instead of discussions with mechanical engineers.*

We believe the following characteristics and conditions result in larger firms and projects installing more efficiency measures than smaller ones:

- Larger firms have more capital, and more access to capital, which enables them to cover higher initial costs of efficient equipment more easily than smaller firms can.
- Larger firms have more staff and thus more staff time available to oversee and make decisions about project and equipment specifications than smaller firms have.
- Larger firms have more staff and thus have more specialized staff; larger firms are more likely to have one or more staff members experienced in construction or knowledgeable about construction alternatives.
- Larger projects are more complex than smaller projects, and so bring together more professionals. The larger the number of professionals consulted, the more likely one encounters a professional that strongly encourages energy efficiency.
- Larger projects have more opportunity to install efficiency measures as they include more varieties of lighting, HVAC equipment, and so on, and have a greater need for such measures as energy management systems.
- Larger firms have been targeted by EVT.

We do *not* see evidence to support the following hypotheses:

1. Larger professional firms tend to work with primarily with large customers on large projects.
2. Smaller professional firms tend to work primarily with small or medium-size firms on small or medium-size projects
3. Larger professional firms are more likely to encourage the use of energy efficiency than smaller professional firms.

4. Larger professional firms have more projects that use efficiency measures than do smaller professional firms.[74]

5. Firms located in some areas of Vermont install more efficiency measures than firms located in other areas of Vermont.

So we do not see that size of professional (market actor) firm or location within Vermont of C&I end user firm is responsible for the installation of efficiency measures. The small population size of the state of Vermont makes it possible and indeed, highly likely, that most commercial construction professionals in good standing are qualified to work on most commercial construction projects done in the state. In Vermont, it is the exceptional project that would require more expertise than is available from the typical, competent local building and construction professional.

Because Vermont is small in both territory and population, one's social network can extend through most of the state. We see indirect evidence of the use of social and professional networks for Vermont construction activities: People tend to work with the people they know or are familiar with, and this familiarity promotes a feeling of trust prior to the establishment of the working relationship.

A theory of social networks was not incorporated in the design of the current, initial research and so has not been directly tested. Nonetheless, the findings from the research undertaken consistently point to a need to increase communication with all market actors—designers, contractors, and suppliers—about energy efficiency solutions. The designers have had a great deal of exposure to these new ideas, but the rest of the community is just beginning to learn about these solutions.

[74] The one exception found for this statement is discussed in chapters 4 and 5: large architectural firms and general contracting firms are more likely to work with daylighting features than are smaller firms.

The conclusions and recommendations in Chapter 9 can help to increase building and construction professionals' knowledge and communication skills so that the social networks in Vermont can further the effectiveness of EVT.

CHAPTER 8. ON-SITE SURVEY FINDINGS

During the fourth quarter of 2002, 76 on-site surveys were conducted at commercial and industrial establishments in Vermont. The sampling frame for the surveys was derived from the recently completed phone interviews with nearly 600 business owners or managers in Vermont. Respondents from this phone survey who indicated that they had recently completed a new construction, renovation/addition, or equipment replacement project were included in the pool of possible site survey participants.

The primary research objectives for these on-site surveys were specified in the GDS Team's March 15, 2002 Site Visit Sampling Plan and are restated briefly here:

1. **Examine and Document Current Practices –** accomplished through a section of the site survey on establishment characteristics.

2. **Verify and Calibrate Responses From End Users –** accomplished by comparing results from the site visits (what is observed in the field) with responses obtained through the earlier telephone surveys (what customers are saying they did).

3. **Examine Differences in Practices Between Act 250 and Non-Act 250 Properties –** accomplished by conducting the site surveys without surveyor knowledge of which were Act 250 sites, and comparing results from the two types of projects to identify any clear differences in practices.

4. **Assess Missed Opportunities –** our field team attempted to identify missed opportunities for efficiency as time permitted. The on-site surveys were not formal technical assistance-type audits, rather a walk-through with visual inspection by trained field observers—efficiency engineers and technicians—who noted possible opportunities.

In all cases, data collected during end-user phone surveys were in the hands of the field observers so that the visits could focus on verifying on-site physical elements. The site visits targeted three subgroups of C&I customers that completed telephone surveys. The planned and completed samples for each group are:

1. **New Construction** – 40 sites drawn from permitted new construction projects (40 on-sites completed, of which 36 were indeed new construction and 4 were, in fact, renovation/remodel projects accounted for in #2, below, for a total of 36 "new construction" completes);

2. **Renovation and Remodeling** – 25 sites drawn from permitted construction projects for existing facilities (25 on-sites completed, plus 4 from the new construction sample for a total of 29 completes);

3. **Equipment Replacements** – 15 sites drawn from end users that did not have permitted construction projects yet reported replacing one or more building systems (heating, lighting, or windows) in the two years prior to the phone survey (11 completed).

The on-site surveys took about two to three hours on average. Field engineers performed a visual walk-through inspection of each building to inventory the types of equipment and building materials and operations and maintenance (O&M) practices. Customers were told during the recruitment process that no one from the organization needed to accompany the field engineer during the visit. Nonetheless, the field engineers sought to have someone knowledgeable about the facility to accompany them at least part of the time, so that they might answer questions the engineer had. Participating customers were offered incentives in the form of a $50 donation to the customer's charity of choice. These were prepared and mailed after the site visits. Three customers requested a charitable donation.

This chapter addresses the key findings from our on-site surveys. Results have been analyzed by the following topic areas: General Establishment Characteristics, Building Shell, Heating Systems, Cooling Systems, Compressed Air Systems, Ventilation/Air Handling Units, Motors, Domestic Hot Water, Indoor Lighting, Outdoor Lighting, Food & Process Refrigeration Equipment, Swimming Pools, Other Major Loads, and On-Site Generation.

Data Interpretation Guide

The tables that follow attempt to provide a lot of data succinctly. The data collection instrument for the site survey can be found in an Appendix to this report. It included 28 questions (with multiple sub-sections/response possibilities) in the general business data portion of the survey instrument and 128 building system/equipment-specific areas (also with multiple sub-sections/response possibilities and equipment description tables). These questions generated nearly 900 variables.

The on-site information has been analyzed and grouped, for purposes of this report, into five distinct categories. The tables in this chapter show building system/equipment-specific observed efficiency activities within:

(1) New construction projects where Act 250 permits were obtained;

(2) New construction projects where no such permits were obtained;

(3) Renovation and remodeling projects where Act 250 permits were obtained;

(4) Renovation and remodeling projects where no such permits were obtained; and

(5) Any/all equipment replacement projects (Act 250 permits are not applicable within this grouping).

There is significant room for misinterpretation of these summarized data. Reasons for potential misinterpretation include:

- The small sample size (76 on-site survey completions);
- The self-selected nature of this sample (*i.e.*, site visits were conducted with end-user phone survey participants that had reported having recently completed a new construction, renovation or equipment replacement project and had expressed a willingness to receive a site visit);
- The small number of sites actually visited within each of the major building areas (36 “New Construction”, 29 “Renovation/Remodeling”,

and 11 "Equipment Replacements") and the associated Act 250/non-Act 250 subsets that make up the 5 categories noted above; and

- The limited number of building system/equipment-specific observed efficiency activities occurring in any one category.

To minimize the likelihood for such misinterpretation, please note the following conventions have been used in this chapter:

- The table columns give the total sample size for the group;
- The cell percents are calculated from the proportion answering the specific question, which may be less than the sample size. Thus, the percentage corresponding to a single observation varies (e.g., it might be 4% for one variable and 5% for another for which a smaller proportion of respondents answered the specific question);
- When column totals for responses within a variable add to 98%, 99%, 101% or 102%, these differences from 100% should be understood as rounding error; and
- Response categories that were not endorsed by any respondent are typically omitted from tables. Thus, when a category that seems like it should be reported is not in a table, the reader should infer that the option existed in the data collection instrument, but it was not encountered or applicable within any of the sites visited.

The remainder of this chapter is organized into the following sections:

- General characteristics of facilities visited;
- Detailed results presented by building system/equipment type (using the five-category break-out) - including summary discussion and characterizations of noteworthy observations within each Vermont market/category area, and identification/discussion of information observed and learned regarding missed or remaining potential lost opportunities for energy efficiency improvement;

- Overall summary comparing and contrasting the three major Vermont C&I markets/project area categories (new construction, renovation/remodeling, and equipment replacement);
- Comparison of data from on-sites with the earlier end-user telephone surveys; and
- Recommendations for future research.

GENERAL CHARACTERISTICS OF FACILITIES VISITED

Table 8.1 shows the location distribution of the on-site sample. For comparative purposes, Table ES.4 (in the Executive Summary) gives the location distribution of Vermont's firms, both in total and for those with permits for new construction or renovation projects. The distribution of firms receiving an on-site survey *with new construction and renovation projects* is roughly comparable to that of the Vermont population with construction and renovation permits. The proportions conducted in Chittenden County were about the same for the on-site sample and the Vermont population. The on-site proportion in the small urban areas was a bit larger than the Vermont population, which comes at the expense of the rural sample. *For equipment replacement projects,* the on-site sample was skewed to the small urban area when compared with the Vermont population, with roughly one-third of firms in each of the three location types.[75]

[75] It is important to note that, targeting the on-site visits to specific regions of the state was not identified as a priority in the sampling plan. Given the limited pool of willing on-site survey participants (taken from those in the end-user telephone surveys that expressed a willingness to participate in an on-site), the focus for scheduling and conducting on-sites was limited to ensuring the proper number of completes within each of the three major project categories.

TABLE 8.1 - LOCATION

LOCATION	NEW CONSTRUCTION	RENOVATION	EQUIPMENT REPLACEMENT	TOTAL
Chittenden County	4% (n=3)	9% (n=7)	3% (n=2)	16% (n=12)
Small Urban	14% (n=11)	16% (n=12)	9% (n=7)	39% (n=30)
Rural	29% (n=22)	13% (n=10)	3% (n=2)	45% (n=34)
Total	47% (n=36)	38% (n=29)	15% (n=11)	100% (n=76)

The principal business activities of the on-site sample are given in Table 8.2. The on-site sample of *new construction and renovation projects* has many more facilities in the "other" category and more industrial firms than the correspondent population and fewer offices, retail, and warehouses (compare with Table 7.2). The on-site *equipment replacement* sample has more retail and public buildings and fewer office and industrial facilities than the population as a whole.

TABLE 8.2 - PRINCIPAL BUSINESS ACTIVITY

BUSINESS ACTIVITY	NEW CONSTRUCTION (N=35)	RENOVATION (N=27)	EQUIPMENT REPLACEMENT (N=9)
Office	9%	15%	11%
Retail	11%	15%	56%
Industrial	23%	22%	0%
School (non-college)	3%	7%	11%
Warehouse	11%	4%	0%
Public Building, Healthcare, College, Church, etc.	17%	22%	22%
Other (Lodging, Utility, etc.)	26%	15%	0%
Total	100%	100%	100%

Seventy-one percent of firms with *new construction* projects had Act 250 involvement, compared with 48% of firms with *renovation* projects (see Table 8.3). No firms with *equipment replacement* projects reported Act 250 involvement, although the facilities person that provided information to the field engineer may not have had access to that information, as such involvement would not have been recent.

About one-quarter of respondents with *new construction and renovation* projects reported using Efficiency Vermont (EVT) for the projects, as did a little more than half (55%) of firms with *equipment replacement* projects. This difference reflects the timing of the projects compared to the existence of EVT. EVT began operating in 2000; the new construction and renovation projects received permits in 1998 and 1999; and the equipment replacement projects occurred in the two years prior to the survey, or mid-2000 through mid-2002. Respondents that used EVT services did so for the following end-uses: lighting, equipment replacement, compressors, motors, heat recovery, and heating and cooling.

TABLE 8.3 - BUILDING DESIGN AND OCCUPANCY CHARACTERISTICS

DESIGN AND OCCUPANCY CHARACTERISTICS	NEW CONSTRUCTION	RENOVATION	EQUIPMENT REPLACEMENT
Act 250 Involvement	71%	48%	0%
Used EVT*	23%	24%	55%
Spec Development	53%	45%	30%
Engineering Stamp	56%	45%	30%
Design-build	68%	55%	20%
Owner-Occupied	97%	96%	64%
Free-standing Building	91%	61%	70%
Part of a Free-standing Building	6%	39%	10%
Part of a Strip Mall	0%	0%	20%
Multi-building complex	3%	0%	0%
One Story	74%	43%	40%
Two Stories	14%	54%	20%
Three Stories	9%	0%	10%
Four Stories	0%	0%	30%
Five or More Stories	3%	3%	0%
Average Tenure at Site	3 years**	31 years	25 years
Average Age of Building	3 years (built in 1999)	35 years (built in 1967)	57 years (built in 1945)

**EVT began operation in 2000.* ***Since 1999; permits were issued in 1998 and 1999.*

Table 8.4 shows the average size of projects in the on-site sample and establishments by new construction, renovation and remodeling, and equipment replacement project categories. Newly constructed facilities are

largest, followed by those with renovation projects, which in turn are larger than those replacing equipment. (For project size, data were available for 29 sites; for establishment size, data were available for 48 sites.)

TABLE 8.4 - AVERAGE SIZE OF PROJECTS AND ESTABLISHMENTS BY PROJECT TYPE

AVERAGE SIZE	NEW CONSTRUCTION SQ.FT.	RENOVATION SQ.FT.	EQUIPMENT REPLACEMENT SQ.FT.	AVERAGE TOTAL SQ.FT.
Project (n=29)	NA	7,838	5,540	7,997
Establishment (n=48)	36,426	26,125	20,554	30,667
Project / Establishment	NA	30%	27%	26%

The size of establishment by location is given in Table 8.5.

TABLE 8.5 - SIZE OF ESTABLISHMENT BY LOCATION

SIZE OF ESTABLISHMENT	CHITTENDEN COUNTY (N=8)	SMALL URBAN (N=15)	RURAL (N=25)	TOTAL (N=48)
Less than 5,000 SF (n=20)	13%	33%	56%	42%
5,000 to 25,000 SF (n=13)	25%	27%	28%	27%
Over 25,000 SF (n=15)	62%	40%	16%	31%
Total (n=48)	100%	100%	100%	100%

Of those sites with remodeling projects, 65% of respondents indicated that the remodeling was done for energy efficiency reasons. Other reasons included change of space use (24%), and desire to improve space aesthetics (12%).

Within the context of this general characterization of Vermont commercial and industrial facilities visited, the following building and equipment efficiency activity-related information is presented below.

BUILDING SHELL

The findings regarding building shell elements are summarized in tables for each of the five project types (new construction with Act 250 permits, new construction without Act 250 permits, renovation/remodeling projects with Act 250 permits, renovation/remodeling without Act 250 permits, and equipment replacements). The section concludes with a discussion of potentially missed building shell opportunities.

The following tables and text present findings on:

- Windows
  - Number of panes (single, double, triple)
  - Tinting (low E, clear, tinted, opaque)
  - Window-to-wall and skylight-to-roof ratios
- Daylighting Features
  - On/off photocells, photocell controlled dimming, manual dimming, skylights, light shelves
- Roof Construction
  - Flat, pitched with attic, pitched without attic, light colored roof
- Insulation Practices
  - Foundations, walls, and roofs
- Special Humidity Requirements and Loading Docks with Overhead Doors

As shown in Table 8.6, during our on-sites, the field engineers found only double-paned windows among the Act 250 projects, both new construction and renovation (note that *not* all facilities had windows). Low proportions of the non-Act 250 projects for these two groups had some or all windows of single

pane glass. Facilities with equipment projects had higher proportions of single pane glass: 22% had entirely single-pane windows.

TABLE 8.6 - WINDOW PANES

WINDOW CHARACTERISTICS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Double Layer Glass					
No Windows	13%	8%	14%	29%	0%
No Windows of this Type	0%	17%	0%	7%	22%
1% to 33% of this Type	0%	0%	0%	7%	0%
34% to 66% of this Type	0%	0%	0%	0%	22%
67% to 99% of this Type	0%	0%	0%	7%	11%
All Windows of this Type	87%	75%	86%	50%	44%
Single Layer Glass					
No Windows of this Type	100%	83%	100%	79%	44%
1% to 33% of this Type	0%	0%	0%	7%	11%
34% to 66% of this Type	0%	0%	0%	0%	22%
67% to 99% of this Type	0%	0%	0%	7%	0%
All Windows of this Type	0%	17%	0%	7%	22%
Triple Layer Glass					
No Windows of this Type	100%	100%	100%	100%	100%

Table 8.7 shows that Act 250 new construction projects were the least likely to have clear glass, followed by the non-Act 250 renovation projects, then by the Act 250 renovation projects. The non-Act 250 new construction projects had slightly less incidence of clear glass than the equipment replacement projects, which had the highest incidence.

TABLE 8.7 - WINDOW TINTING

WINDOW CHARACTERISTICS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Low-Emissivity Glass					
No Windows	13%	8%	14%	29%	0%
No Windows of this Type	35%	59%	48%	35%	78%
34% to 66% of this Type	0%	0%	0%	7%	0%
67% to 99% of this Type	4%	0%	7%	0%	0%
All Windows of this Type	48%	33%	31%	29%	22%
Clear Glass					
No Windows of this Type	66%	50%	54%	71%	33%
34% to 66% of this Type	4%	0%	8%	0%	11%
67% to 99% of this Type	0%	0%	0%	0%	0%
All Windows of this Type	30%	50%	38%	29%	55%
Tinted Film					
No Windows of this Type	96%	92%	92%	93%	78%
34% to 66% of this	0%	0%	0%	7%	11%

Type					
All Windows of this Type	4%	8%	8%	0%	11%
Opaque					
No Windows of this Type	100%	100%	100%	100%	100%

Facilities with equipment projects had the highest window-to-wall ratios, as shown in Table 8.8. These data are consistent with the large proportion of retail establishments in the equipment sample, as shown in Table 8.2. About 10% or fewer of the establishments in any group had skylights in excess of 5% of the roof area.

TABLE 8.8 - WINDOW-TO-WALL AND SKYLIGHTS-TO-ROOF RATIOS

RATIOS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Window-to-wall Ratios					
No Windows	13%	8%	14%	29%	0%
Less than 10%	42%	18%	31%	13%	9%
10%	8%	33%	14%	7%	9%
11% to 33%	37%	41%	24%	51%	36%
More than 33%	0%	0%	17%	0%	45%
Skylights-to-roof Ratio					
Exceeds 5%	4%	8%	8%	7%	11%

On-off photocells take advantage of the natural light that enters in one-quarter of the new constructed facilities, almost that many renovated facilities, and 11% of facilities with equipment projects (Table 8.9). Act 250 involvement did not seem to have a bearing on these findings.

TABLE 8.9 - DAYLIGHTING FEATURES

DAYLIGHTING FEATURES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
On/Off Photocell	25%	25%	23%	21%	11%
Photocell Controlled Dimming	0%	0%	8%	8%	0%
Manual Dimming	4%	17%	0%	31%	11%
Skylights	4%	8%	23%	8%	0%
Light Shelves	0%	8%	0%	0%	0%

Most facilities in all groups had pitched roofs with attics (Table 8.10). Light-colored roofs varied between 29% and 50% of the groups. Act 250 involvement was associated with higher proportions of light-colored roofs among renovation projects, but not among new construction projects.

TABLE 8.10 - ROOF CONSTRUCTION

ROOF CONSTRUCTION	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Flat Roof	30%	8%	21%	20%	29%
Pitched Roof with Attic	43%	58%	54%	47%	43%
Pitched Roof without Attic	29%	33%	23%	33%	29%
Light Colored Roof	29%	50%	50%	36%	33%

The field engineers were able to identify the levels of foundation, wall, and roof insulation for about half of the new construction and renovation sites and for two of the eleven equipment replacement sites. Table 8.11 provides the number of sites for which insulation levels could be determined. The table also shows, for those sites with insulation data, the proportion whose insulation level is less than, meets, or exceeds specified levels. All foundation insulation had observed R-values equal to or greater than 10. Some proportion of renovation projects had observed R-values below 19 for walls and below 30 for roof insulation. For renovation Act 250 facilities, wall insulation was at lower levels more commonly than roof insulation. For renovation non-Act 250 projects, the reverse was true.

TABLE 8.11 - INSULATION LEVELS (PROPORTION OF SITES)

ROOF CONSTRUCTION	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Foundation					
Sites with Data Available	9	7	5	2	2
R-Value Less than 10	0%	0%	0%	0%	0%
R-Value Equal to 10	66%	86%	60%	50%	100%
R-Value Greater than 10	33%	14%	40%	50%	0%
Walls					
Sites with Data Available	13	6	8	7	2
R-Value Less than 19	8%	0%	38%	14%	50%
R-Value Equal to 19	54%	62%	38%	28%	50%
R-Value Greater than 19	38%	48%	24%	58%	0%

Roof					
Sites with Data Available	12	4	10	6	3
R-Value Less than 30	0%	25%	30%	83%	33%
R-Value Equal to 30	25%	0%	30%	0%	33%
R-Value Greater than 30	75%	75%	40%	17%	33%

Between about 10% and 30% of the facilities had special humidity requirements (Table 8.12). These differences likely owe to the building types visited in each group, although a comparison with Table 8.2 does not provide a ready-explanation. Loading docks and overhead doors were fairly common, with 57% of the sites visited having at least one installed (also Table 8.12). These docks were used to move materials, supplies and finished goods in and out of the building. On average these doors were opened between one and five times per day.

TABLE 8.12 - SPECIAL HUMIDITY REQUIREMENTS AND LOADING DOCKS WITH OVERHEAD DOORS

HUMIDITY AND LOADING DOCKS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Special Humidity Requirements	17%	8%	14%	29%	10%
Loading Docks with Overhead Doors	63%	42%	79%	60%	30%

The predominant construction type materials found during the on-sites were wood (33%) and steel (29%) based. Other construction material types found included brick (9%) and concrete/cinderblocks (7%).

Missed Opportunities: Building Shell

Based on the observations of our field engineers during their site visits, the following building shell efficiency opportunities were identified:

- A new construction, Act 250 project needs plastic strips on its loading dock doors.
- An existing hotel with a new construction, non-Act 250 project needs new windows.
- Another existing facility with a new construction, non-Act 250 project has significant heat loss through garage doors on an existing building.
- A renovation, Act 250 project needs an air curtain for its warehouse.
- A renovation, non-Act 250 project needs a new roof gutter. Currently, rain is running into the condenser and causing mildew problems.
- A renovation, non-Act 250 project needs improved building insulation.

INDOOR LIGHTING

The findings regarding indoor lighting are summarized in tables and text for each of the five project types. The section concludes with a discussion of potentially missed indoor lighting opportunities. The tables present findings on:

- Description of lighting equipment in use
    - Lighting equipment types: incandescents, halogens, CFLs, T-8 with electronic ballast, T-8 with magnetic ballast, T-12 with electronic ballast, T-12 with magnetic ballast, and HID (total HID with subtotals for metal halide, HPS, unspecified HID, and HID with pulse-start ballasts); lighting types with controls other than standard switches
    - Proportion of sites, proportion of square footage, and approximate number of fixtures for each type of lighting equipment
    - Exit signs
- Condition of lighting systems (good, fair, poor)
- Ballast replacement practices
    - Group reballasting vs. replaced on failure
    - Type of ballast used when replaced (standard, high efficiency, electronic)
- Lamp replacement practices (group relamping vs. replaced on burnout)
- Average wattage of lamp replacement stock
- Observed footcandles for facilities visited (by type of project)
- Fixture installation practices and reasons for change

Tables 8.13 through 8.15 describe the lighting types in use at the surveyed sites. T8 lamps with electronic ballasts were a common equipment type found most frequently in new construction Act 250 projects and all renovation project sites visited. T12 lamps with magnetic ballasts predominated in equipment replacement projects, and tied in frequency with the T8 electronic equipment observed in new construction non-Act 250 projects. The acronym "CFL" represents compact fluorescent lamps and "HID" represents high-intensity discharge lamps.

TABLE 8.13 - LIGHTING TYPES—PERCENT OF SITES

LIGHTING TYPES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Lighting Types					
Incandescent	17%	33%	14%	20%	27%
Halogen	8%	8%	0%	13%	0%
CFL	25%	17%	14%	20%	36%
T12 Magnetic	25%	42%	36%	33%	55%
T12 Electronic	8%	0%	0%	0%	0%
T8 Magnetic	0%	0%	14%	7%	0%
T8 Electronic	75%	42%	71%	66%	45%
T5 Electronic	8%	0%	0%	7%	0%
HID Non-pulse Start	8%	17%	53%	20%	0%
HID Pulse start	13%	0%	0%	7%	0%
HID Types					
Metal Halide	21%	17%	50%	20%	9%
HPS	0%	0%	7%	7%	0%

As shown in Table 8.14, T8 electronic equipment was observed to be illuminating between 20% and 33% of the floorspace, depending on the project type. Its lowest floorspace percentage was in new construction non-Act 250 projects and its highest floorspace percentage was in renovation Act 250 projects. HID lamps (predominately metal halide) without pulse start ballasts illuminated more floorspace than any other lighting equipment in all renovation projects and in new construction non-Act 250 projects. For new construction Act 250 projects, HID lamps (metal halide) with pulse start ballasts tied for first place in percent of floorspace illuminated. In equipment replacement projects, T12 magnetic equipment illuminated about half of the observed floorspace. Controls other than standard switches (*i.e.*, dimming switches, occupancy sensors, and plug control) control the illumination of less than 5% of the floorspace of any group.

TABLE 8.14 - LIGHTING TYPES—PERCENT OF FLOORSPACE ILLUMINATED

LIGHTING TYPES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Lighting Types					
Incandescent	1%	7%	0.3%	6%	18%
Halogen	0.2%	3%	0%	1%	0%
CFL	7%	2%	1%	6%	3%
T12 Magnetic	31%	13%	5%	23%	49%
T12 Electronic	0.2%	0%	0%	0%	0%
T8 Magnetic	0%	0%	4%	4%	0%
T8 Electronic	26%	20%	33%	22%	30%
T5 Electronic	0.3%	0%	0%	3%	0%
HID Non-pulse Start	4%	55%	56%	27%	0%
HID Pulse start	30%	0%	0%	8%	0%
HID Types					

Metal Halide	34%	55%	48%	27%	0%
HPS	0%	0%	8%	8%	0%
Controls Other than Standard Switches					
CFL—Dimming Switches	0.2%	2%	0%	3.3%	0%
CFL—Occupancy Sensor	0%	0%	0%	0%	0.1%
CFL—Plug Control	0%	0%	0%	0%	0.1%
Halogen—Dimming Switches	0%	2.3%	0%	0%	0%
T12 Magnetic—Occupancy Sensors	0%	0%	0.1%	0%	0%
T12 Magnetic—Plug Control	0%	0%	0%	0%	1.5%

Table 8.15 identifies the approximate number of fixtures of each observed type of lighting equipment.

TABLE 8.15 - LIGHTING TYPES—APPROXIMATE NUMBER OF FIXTURES

LIGHTING TYPES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Lighting Types					
Incandescent	108	32	6	62	36
Halogen	17	3	0	29	0
CFL	424	18	15	62	71
T12 Magnetic	523	55	51	92	202
T12 Electronic	13	0	0	0	0

T8 Magnetic	0	0	16	42	0
T8 Electronic	1,134	130	475	125	118
T5 Electronic	12	0	0	16	0
HID Non-pulse Start	23	31	200	27	0
HID Pulse start	168	0	0	17	0
Total	2,422	269	763	472	427
HID Types					
Metal Halide	191	31	184	27	0
HPS	0	0	14	17	0

Concerning exit signs, new construction and renovation projects were observed to use LEDs more often than any other lighting type (Table 8.16). The highest proportion of LED use was in non-Act 250 renovation projects. CFLs were the most coming lighting type in the exit signs of facilities with equipment projects.

TABLE 8.16 - LAMPS USED IN EXIT SIGNS

EXIT SIGN LAMPS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
LED	57%	33%	42%	75%	11%
CFL	26%	33%	33%	0%	67%
Mixed LED & CFL	4%	0%	8%	0%	0%
Incandescent	9%	22%	17%	13%	11%
None	4%	11%	0%	13%	0%

The condition of the indoor lighting equipment, shown in Table 8.17, is pertinent to facilities with renovation or equipment replacement projects.

Renovation Act 250 projects included spaces with the poorest condition of equipment.

TABLE 8.17 - CONDITION OF INDOOR LIGHTING

CONDITION OF INDOOR LIGHTING SYSTEM	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Good	100%	100%	71%	93%	80%
Fair	0%	0%	21%	7%	20%
Poor	0%	0%	7%	0%	0%

About 90% of all facilities visited (and for all fixture types) replaced lamps and ballasts upon failure, rather than through a group relamping or reballasting process (Table 8.18). The facilities with equipment replacement projects reported a higher proportion of group relamping and reballasting than did new construction or renovation projects. Electronic ballasts were the replacement ballast used by half of the Act 250 new construction and renovation firms visited. High efficiency ballasts were more common (or tied with electronic ballasts) among the other groups.

TABLE 8.18 - LAMP AND BALLAST REPLACEMENT

LAMP AND BALLAST REPLACEMENT	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Lamp Replacement					
Group Relamping	8%	8%	7%	29%	0%
Replaced on Burnout	92%	92%	93%	71%	100%
Ballast Replacement					
Group Reballasting	0%	8%	7%	15%	0%

Replaced on Failure	100%	92%	93%	85%	100%
Replacement Ballast Type					
Standard	17%	27%	33%	27%	22%
High Efficiency	33%	36%	17%	47%	44%
Electronic	50%	36%	50%	27%	33%

Table 8.19 shows the average wattage of the lamp replacement stock and average footcandles read across the entire facility. The average footcandles are similar across project types, whereas the wattage levels stocked are much higher in the addition and renovation project sites than in the other two project types.

TABLE 8.19 - AVERAGE WATTAGE OF LAMP REPLACEMENT STOCK AND FOOTCANDLES FOR ENTIRE FACILITY BY TYPE OF PROJECT

AVERAGE WATTAGE	NEW CONSTRUCTION	RENOVATION	EQUIPMENT REPLACEMENT	TOTAL SITES
Average Wattage of Lamp Replacement Stock	61	119	56	82
Average Footcandles for Entire Facility	45	46	49	46

Of firms that had changed out their lighting systems during a remodel, most reported doing so to increase the energy efficiency of their systems (Table 8.20).

TABLE 8. 20 - FIXTURE INSTALLATION

FIXTURE INSTALLATION	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
When Fixtures Were Installed					
During Original Construction	100%	100%	62%	29%	29%
During Major Renovation	0%	0%	31%	29%	14%
During Space Remodel	0%	0%	8%	43%	57%
Reason for Fixture Change Out During Remodel					
Change of Space Use	NA	NA	33%	33%	0%
Increase Energy Efficiency	NA	NA	67%	56%	75%
Improve Space Aesthetics	NA	NA	0%	11%	25%

Missed Opportunities: Indoor Lighting

Even though the field engineers characterized about 90% of the indoor lighting systems as "good", during their site visits they identified potentially missed indoor lighting efficiency opportunities in many sites. These opportunities are shown in Table 8.21. Renovation Act 250 projects had the lowest proportion of sites with identified missed opportunities, followed by new construction Act 250 projects.

TABLE 8. 21 - INDOOR LIGHTING MISSED OPPORTUNITES

MISSED OPPORTUNITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
One or More Opportunities Found	46%	58%	36%	53%	64%
Replace T12	8%	33%	29%	27%	36%
Replace Incandescent	4%	25%	21%	13%	9%
Replace Halogen	4%	0%	0%	0%	0%
Replace HPS with Metal Halide	0%	0%	7%	0%	0%
Occupancy Sensors	29%	33%	21%	27%	45%
LED Exit Signs	4%	17%	0%	0%	9%
Controls to Maximize Daylighting Benefit	8%	8%	0%	0%	0%
Daylighting	8%	0%	0%	0%	9%
Pulse Start Ballast	0%	0%	7%	7%	0%
Electronic Ballast	0%	0%	0%	0%	9%
Task Lighting	0%	0%	0%	7%	0%
Efficient Track Lighting	0%	0%	0%	7%	0%

Note that a given opportunity identified was often restricted to a portion of the facility (such as occupancy sensors needed for the office) and did not indicate that the entire facility needed the efficient equipment identified. Also note that all of the less efficient lighting equipment shown in the indoor lighting tables

might be candidates for efficiency upgrades. Table 8.21 presents the specific opportunities identified by the field engineers.

OUTDOOR LIGHTING

The findings regarding outdoor lighting are summarized in tables and text for each of the five project types. The section concludes with a discussion of potentially missed outdoor lighting opportunities.

Specific outdoor lighting elements addressed include:

- General outdoor lighting information
    - Does facility have outdoor lighting
    - Importance of nighttime illumination of walkways/driveways to the safety and/or security of customers and/or employees
    - Outdoor lighting ownership
    - Approximate capacity of outdoor parking lot
- Predominant lighting types: High pressure sodium, mercury vapor, metal halide, CFL, incandescent, other
- Lighting controls used (manual, timeclock, photocell, energy management control system, other)

Equipment replacement projects were least likely to have outdoor lighting (82%, as shown in Table 8.22) and to own their outdoor lighting system (60%). For the other four project types, all of the sites or all but one of the sites had outdoor lighting, and all facilities owned their outdoor lighting.

TABLE 8. 22 - OUTDOOR LIGHTING USE

OUTDOOR LIGHTING USE	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Outdoor Lighting Present	96%	92%	100%	93%	82%
Outdoor Lighting Critical to Safety or Security	83%	82%	93%	79%	100%
Own (vs Rent) Outdoor Lighting	100%	100%	100%	100%	60%
Have an Outdoor Parking Lot	88%	100%	92%	100%	100%
Parking Lot Size					
1 to 9 Cars	10%	27%	0%	7%	0%
10 to 33 Cars	38%	83%	42%	72%	40%
34 to 66 Cars	24%	0%	17%	7%	0%
67 to 99 Cars	14%	0%	33%	7%	40%
100 or More Cars	14%	0%	8%	7%	20%

About half of the new construction facilities use metal halide lamps (Table 8.23). Facilities with renovation projects were equally likely to use metal halide and high pressure sodium (HPS) lamps. Facilities with equipment replacement projects are most likely to use HPS lamps. The metal halide and HPS lamps are controlled by photocells more than any other control type. The other lighting types were controlled in roughly equal proportions by manual switches, time clocks, and photocells.

TABLE 8. 23 - OUTDOOR LIGHTING LAMP AND CONTROL TYPES—NUMBER OF SITES

OUTDOOR LIGHTING LAMP TYPES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Metal Halide					
Total Sites w/MH	11	5	5	3	2
Proportion of Outdoor Lighting Sites with MH	49%	45%	29%	21%	22%
Controlled by Manual Switch	2	0	1	1	0
Controlled by Time Clock	3	0	1	0	0
Controlled by Photocell	7	5	4	2	2
Light Cut-Offs Present	1	0	1	0	0
Mercury Vapor					
Total Sites w/MV	2	1	0	1	2
Proportion of Outdoor Lighting Sites with MV	9%	9%	NA	7%	22%
Controlled by Manual Switch	1	1	NA	0	0
Controlled by Time Clock	0	0	0	1	0
Controlled by Photocell	1	0	NA	0	1
Light Cut-Offs Present	0	0	NA	0	0
High Pressure Sodium					

Total Sites w HPS	8	3	4	4	6
Proportion of Outdoor Lighting Sites with HPS	35%	27%	29%	29%	55%
Controlled by Manual Switch	3	0	1	0	1
Controlled by Time Clock	3	1	0	1	2
Controlled by Photocell	4	2	3	3	5
Light Cut-Offs Present	0	0	0	0	1
Compact Fluorescent Lamps					
Total Sites w CFL	3	3	2	1	NA
Proportion of Outdoor Lighting Sites with CFL	13%	27%	14%	7%	0
Controlled by Manual Switch	2	1	0	1	0
Controlled by Time Clock	1	0	1	0	0
Controlled by Photocell	0	2	1	0	0
Light Cut-Offs Present	0	0	0	0	0
Fluorescent					
Total Sites with Fluorescent	2	1	0	1	NA
Proportion of Outdoor Lighting Sites with Fluorescent	9%	9%	NA	7%	0

Controlled by Time Clock	1	0	NA	0	0
Controlled by Photocell	1	1	NA	1	0
Light Cut-Offs Present	0	0	NA	0	0
Incandescent					
Total Sites with Incandescent	5	4	3	7	3
Proportion of Outdoor Lighting Sites with Incandescent	2%	36%	21%	50%	33%
Controlled by Manual Switch	1	3	2	4	1
Controlled by Time Clock	3	0	0	0	0
Controlled by Photocell	1	1	2	2	2
Controlled by Motion Detector	0	0	0	1	0
Light Cut-Offs Present	0	0	0	0	0

Note: Some subsets of data do not sum to total number of sites due to (1) sites with multiple responses (i.e., more than one equipment type) and (2) sites with missing observations for some data elements.

The information in the above table is presented by number of sites. Next, Table 8.24 presents similar information by number of fixtures present at the sites. For both types of new construction projects and for Act 250 renovation projects, there are more metal halide fixtures than any other type of fixture. For renovation non-Act 250 projects and for equipment replacement projects, there are more HPS fixtures than any other type.

TABLE 8. 24 - OUTDOOR LIGHTING LAMP AND CONTROL TYPES—NUMBER OF FIXTURES

OUTDOOR LIGHTING LAMP TYPES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Metal Halide					
Total MH Fixtures	133	33	113	14	25
Average Number Per Site with MH	12	7	23	5	12
Controlled by Manual Switch	70	0	5	2	0
Controlled by Time Clock	29	0	84	0	0
Controlled by Photocell	34	33	24	11	25
Light Cut-Offs Present	14	0	6	0	0
Mercury Vapor					
Total MV Fixtures	3	6	0	3	4
Average Number Per Site with MV	2	6	NA	3	2
Controlled by Manual Switch	1	6	NA	0	0
Controlled by Time Clock	0	0	0	3	0
Controlled by Photocell	2	0	NA	0	2
Light Cut-Offs Present	0	0	NA	0	0
High Pressure Sodium					
Total HPS Fixtures	64	11	9	21	40
Average Number Per Site with HPS	8	4	2	5	7

Controlled by Manual Switch	12	0	2	0	3
Controlled by Time Clock	19	2	0	NA	18
Controlled by Photocell	33	9	7	21	19
Light Cut-Offs Present	0	0	0	0	6
Compact Fluorescent Lamps					
Total CFL Fixtures	12	4	5	2	NA
Average Number Per Site with CFL	4	1	2	2	0
Controlled by Manual Switch	5	1	0	2	0
Controlled by Time Clock	7	0	3	0	0
Controlled by Photocell	0	3	2	0	0
Light Cut-Offs Present	0	0	0	0	0
Fluorescent					
Total Fluorescent Fixtures	15	9	0	NA	NA
Average Number Per Site with Fluorescent	8	9	NA	NA	0
Controlled by Time Clock	9	0	NA	NA	0
Controlled by Photocell	6	9	NA	NA	0
Light Cut-Offs Present	0	0	NA	NA	0
Incandescent					

Total Incan-descent Fixtures	24	19	9	35	18
Average Number Per Site with Incandescent	5	5	3	6	6
Controlled by Manual Switch	9	7	4	31	12
Controlled by Time Clock	10	0	0	0	0
Controlled by Photocell	5	12	5	2	6
Controlled by Motion Detector	0	0	0	2	0
Light Cut-Offs Present	0	0	0	0	12

Note: Some subsets of data do not sum to total number of fixtures due to sites with missing observations for some data elements.Missed Opportunities: Outdoor Lighting

Based on observations from our field engineers during their site visits, only a few potential missed opportunities for energy efficient outdoor lighting improvements were identified, as shown in Table 8.25. Facilities with renovation, Act 250 projects had no missed outdoor lighting opportunities identified. Missed opportunities were identified for two new construction, Act 250 facilities and one new construction, non-Act 250 facility. The most common missed opportunity was for occupancy sensors, photocells, or other types of controls.

TABLE 8. 25 - OUTDOOR LIGHTING MISSED OPPORTUNITES

MISSED OPPORTUNITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=23)	NON (N=11)	ACT 250 (N=14)	NON (N=14)	NON (N=9)
One or More Opportunities Found	9%	9%	0%	29%	22%

Replace Incandescent	4%	9%	0%	7%	0%
MH Needed/ Replace HPS	4%	0%	7%	7%	11%
Occupancy Sensors or Other Controls	4%	0%	14%	21%	0%

Note that a given opportunity identified was often restricted to a portion of the facility (such as an entrance light) and did not indicate that the entire outdoor lighting system needed the efficient equipment identified. Also note that all of the less efficient lighting equipment shown in the outdoor lighting tables might be candidates for efficiency upgrades. Table 8.25 presents the specific opportunities identified by the field engineers.

HEATING SYSTEMS

Key findings regarding heating systems are summarized in tables and text for each of the five project types. The section concludes with a discussion of potentially missed heating system opportunities. The tables present findings on:

- Primary heating system
  - Primary heating system type
  - Use of condensing furnace or boiler
  - Heating only or with other functions (cooling, hot water)
  - Fuel used for primary heating system
- Primary heating fuel by location in Vermont
- Supplemental heating system and fuel type
- Description of space heated and condition of heating system
  - Number of buildings served
  - Proportions of total and project space that is heated
- Heating system maintenance activities
  - Treatment of heating fluid during maintenance
  - Burner maintenance frequency
  - Boiler maintenance frequency
  - Chimney maintenance frequency
  - Controls calibration/adjustment frequency
- Heating system operational training and system commissioning
  - Training for equipment operators

- Commissioning
- Retro-commissioning

- Heating energy efficiency features
  - Heat recovery on flue gas exhaust
  - Insulated heating/hot water pipes
  - EMS with special control features
  - Control types

All of the facilities visited had heating systems, as shown in Table 8.26. More establishments had boilers than any other equipment type, followed in frequency by forced air furnaces. About one-quarter of new and renovated Act 250 facilities had combined heating and cooling systems. Between one-quarter and 45% of each of the five groups had heated hot water (domestic hot water, or "DHW") with the heating system. Propane was the most commonly used fuel, followed by oil and natural gas. The proportions, and specific ordering of fuel types, varied between the groups.

TABLE 8.26 - PRIMARY HEATING SYSTEM: EQUIPMENT AND FUEL TYPE

	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
No Heating System	0%	0%	0%	0%	0%
System Combined with DHW	33%	45%	29%	27%	25%
Condensing Furnace or Boiler Present	4%	0%	14%	7%	0%
Heating System Type					
Boiler (Water)	67%	50%	43%	67%	75%

Boiler (Steam)	4%	8%	7%	0%	25%
Forced Air Furnace	21%	33%	36%	33%	0%
Air-to-Air Heat Pump	4%	0%	0%	0%	0%
Forced Air Roof Unit	4%	0%	0%	0%	0%
Wall Furnace	0%	8%	0%	0%	0%
Radiant	0%	0%	7%	0%	0%
Other	0%	0%	7%	0%	0%
Fuel Used					
Natural Gas	13%	8%	36%	13%	0%
Steam	0%	0%	7%	0%	0%
Oil	30%	42%	29%	53%	75%
Electricity	0%	0%	0%	0%	13%
Propane	48%	50%	29%	33%	13%
Wood/ wood waste	9%	0%	0%	0%	0%
Other	4%	0%	7%	0%	0%

Table 8.27 shows the fuel used for primary heating system by the site's location.

TABLE 8.27 - PRIMARY HEATING FUEL BY LOCATION

FUEL TYPE	PERCENT OF SITES			
	CHITTENDEN COUNTY (N=12)	SMALL URBAN (N=30)	RURAL (N=34)	TOTAL (N=76)
Oil/Diesel	0%	19%	22%	41%
Propane/Butane	3%	14%	21%	38%

Natural Gas	11%	4%	0%	15%
Steam	0%	0%	1%	1%
Electricity	0%	1%	0%	1%
Other	0%	1%	2%	3%
Don't Know	0%	0%	1%	1%
Total	14%	39%	47%	100%

Supplemental heating systems were found in about one-quarter of the new construction non-Act 250 and renovation Act 250 groups, and in 12% to 13% of the other facility groups (Table 8.28).

TABLE 8.28 - SUPPLEMENTAL HEATING SYSTEM AND FUEL TYPE

	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Supplemental System Present	12%	25%	23%	13%	13%
Fuel Type					
Oil	0%	0%	1 obs.	1 obs.	0%
Propane	1 obs.	0%	1 obs.	0%	0%
Electric	1 obs.	2 obs.	1 obs.	1 obs.	1 obs.

All but three facilities of the 76 with on-sites heated a single building (Table 8.29). Between 70% and 100% of the facilities in each group heated their entire facility. The variation in proportion of space heated likely reflects the variation in business activity among the sites. One-quarter of the heating systems in facilities with heating equipment replacement projects were rated by the field engineers to be in "fair" condition.

TABLE 8.29 - SPACE HEATED AND CONDITION OF SYSTEM

	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Buildings Served					
One Building	88%	100%	100%	100%	100%
Two or More Buildings	12%	0%	0%	0%	0%
Proportion of Total Space that is Heated					
All	81%	100%	79%	73%	91%
67% to 99%	5%	0%	7%	13%	9%
34% to 66%	5%	0%	7%	0%	0%
1 to 33%	0%	0%	7%	13%	0%
Proportion of Project Space that is Heated					
All	NA	NA	85%	79%	NA
67% to 99%	NA	NA	15%	7%	NA
34% to 66%	NA	NA	0%	7%	NA
1 to 33%	NA	NA	0%	7%	NA
Condition of Heating System					
Excellent	88%	83%	86%	67%	25%
Good	12%	17%	7%	27%	50%
Fair	0%	0%	7%	7%	25%
Poor/ Not Working	0%	0%	0%	0%	0%

Table 8.30 describes the maintenance activities undertaken on the observed heating systems. During maintenance, heating fluid is treated by all of the new construction non-Act 250 sites, by two-thirds of the equipment

replacement sites, by 50% of the renovation sites, and by 40% of the new construction non-Act 250. Maintenance of burners and boilers is undertaken once a year by most facilities (between 73% and 100% of facilities, depending on the group). Maintenance of chimneys and controls (*i.e.*, calibration) is also most likely to occur once a year, however for most groups the incidence of maintenance "on request" is higher for these two items than for burners and boilers.

TABLE 8.30 - HEATING SYSTEM—MAINTENANCE ACTIVITIES

HEATING MAINTENANCE ACTIVITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Treatment of Heating Fluid During Maintenance					
Treatment Occurs	40%	100%	50%	50%	67%
Burner Maintenance Frequency					
On Request	5%	20%	9%	0%	0%
Once a Year	85%	80%	73%	92%	86%
Start/ End Season	10%	0%	18%	8%	14%
Boiler Maintenance Frequency					
On Request	0%	0%	11%	0%	0%
Once a Year	89%	100%	78%	92%	75%
Start/ End Season	11%	0%	11%	8%	25%
Chimney Maintenance Frequency					
On Request	20%	38%	0%	38%	67%
Once a Year	73%	62%	100%	63%	33%

Start/ End Season	7%	0%	0%	0%	0%
Controls Calibration/ Adjustment Frequency					
On Request	10%	13%	8%	15%	0%
Once a Year	85%	74%	58%	62%	63%
Start/ End Season	5%	13%	33%	23%	38%

For about half of the facilities in the new construction Act 250 and renovation non-Act 250 groups both trained equipment operators and had the equipment commissioned at the time of equipment installation (Table 8.31). Of those who had their systems commissioned, fewer than half reported using a third party, independent commissioning agent. Over three-quarters of all sites had never conducted retro-commissioning.

TABLE 8.31 - HEATING SYSTEM—OPERATIONAL TRAINING AND EQUIPMENT COMMISSIONING

HEATING SYSTEM TRAINING AND COMMISSIONING	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Operational Training					
Never	29%	58%	23%	47%	75%
Upon Installation	50%	33%	54%	53%	25%
Once per Year	8%	0%	8%	0%	0%
Less than Once per 3 Years	13%	8%	15%	0%	0%
Equipment Commissioning					
Commissioned when Installed	50%	36%	38%	54%	25%
If Commissioned, Done by 3rd Party, Independent Commissioning	43%	50%	0%	33%	25%

Agent					
Equipment Retro-commissioned					
Never	74%	83%	71%	73%	100%
Once per Year	26%	17%	14%	27%	0%
Once Every 2-3 Years	0%	0%	7%	0%	0%
Once Every 3-4 Years	0%	0%	7%	0%	0%
If Retro-commissioned, by Whom					
Installer	3 obs.	0%	2 obs.	3 obs.	NA
3rd Party Independent Commissioning Agent	1 obs.	2 obs.	0%	1 obs.	NA

Table 8.32 describes the heating energy-efficiency features observed on site. Hot water pipes were insulated most frequently in equipment replacement sites (75%) and least frequently on new construction non-Act 250 sites (29%). Between one-third and one-half of the heating systems (depending on the group) used a device other than a standard thermostat to control the space temperature. The most alternative control device was a programmable thermostat. Boilers were most frequently controlled by high/low limit controls.

TABLE 8.32 - HEATING ENERGY-EFFICIENCY FEATURES

HEATING SYSTEM ENERGY-EFFICIENCY FEATURES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Heat Recovery on Flue Gas Exhaust	4%	8%	8%	0%	0%
Insulated Heating Hot Water Pipes	61%	29%	63%	44%	75%
Controls for Space Temperature					

Thermostat	52%	67%	64%	67%	50%
Programmable/ Setback T-stat	35%	25%	29%	20%	13%
EMS Electronic/ Pneumatic	0%	0%	0%	0%	13%
EMS Direct Digital Control	13%	8%	7%	13%	13%
Type of Boiler Controls (of Firms with Boilers)					
High/ Low Limit Control	75%	55%	67%	33%	88%
Burner Wired Directly to T-stat	13%	22%	17%	33%	0%
Reset Control	13%	22%	17%	33%	13%

Missed Opportunities: Heating Systems

Table 8.33 provides the potential opportunities for additional energy efficient heating system improvements noted by the field engineers. Facilities with renovation, Act 250 projects were least likely to have missed opportunities noted, followed by facilities with new construction projects, both Act 250 and non-Act 250. The need for pipe insulation was the most commonly identified opportunity in the new construction projects. Improved heating equipment or system design was the most common opportunity identified for renovation, Act 250 facilities and facilities with equipment replacement projects. The need for programmable thermostats, followed by an opportunity for exhaust heat recovery, were the opportunities most frequently identified for renovation, non-Act 250 facilities.

TABLE 8.33 - HEATING SYSTEM MISSED OPPORTUNITIES

MISSED OPPORTUNITES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
One or More Opportunities Found	42%	42%	36%	53%	55%
Insulate Pipes and Ducts	29%	33%	14%	7%	0%
Programmable Thermostat	4%	0%	7%	33%	0%
Educate on How to Use Programmable Thermostat	4%	0%	0%	0%	0%
Exhaust Heat Recovery	8%	17%	7%	20%	18%
Improved Equipment Efficiency/ System Design/ Zones	0%	8%	21%	7%	36%
Hotel Guest Room Fireplaces Dampers Often Open	4%	0%	0%	0%	0%
Outdoor Reset Needed	0%	0%	0%	7%	0%
Combustion Air Opening Outdoors	0%	0%	0%	7%	0%

Note that for some facilities pipe insulation was needed in a given area and not throughout the facility. Also note that all of the less efficient heating equipment shown in the heating equipment tables might be candidates for efficiency upgrades. For example, over one-quarter of the main heating

systems (26%) were observed to have had efficiency levels of 80% or lower. Thus, there is an opportunity for efficiency improvements as new systems are installed. However, since none of the systems inspected were rated as poor or not working and only 5% were viewed as fair, the opportunity for equipment replacement does not appear substantial. In addition, retro-commissioning is frequently an opportunity at these facilities. Table 8.33 presents the specific opportunities identified by the field engineers.

COOLING SYSTEMS

The findings regarding cooling systems are summarized in tables and text for each of the five project types. The section concludes with a discussion of potentially missed cooling system opportunities. The tables present findings on:

- Cooling system present
- Cooling system type and fuel used
- System sub-types and auxiliary equipment
- Proportion of space cooled and condition of system
- System maintenance activities
- System operational training and equipment conditioning
- System controls
- Cooling system energy efficiency features

Between half and three-quarters of the sites have cooling systems (Table 8.34).

TABLE 8.34 - COOLING SYSTEM PRESENT

COOLING SYSTEM	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Cooling System Present	54%	50%	71%	53%	64%

Of the observed projects using cooling systems, about two-thirds of the Act 250 projects combined heating with cooling (Table 8.35). Unitary air conditioning was employed in a majority of these facilities, and was used in all of the new construction and all Act 250 renovation projects. Central chillers or unitary heat pumps were each used in one-fifth or fewer of the facilities, with the

exception of non-Act 250 renovation projects, which employed central chillers 40% of the time. Other auxiliary features observed at one or two sites of the 76 visited were condenser water pumps, chilled water pumps and chilled water or ice storage. Concerning the energy sources used to power the systems, only Act 250 projects used a source other than electricity. These other sources were natural gas or propane.

TABLE 8.35 - COOLING SYSTEM: EQUIPMENT, AUXILIARIES, AND FUEL TYPE AMONG THOSE WITH COOLING SYSTEM PRESENT

COOLING SYSTEM TYPE, FUEL, AND CONDITION	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
System Combined with Heating	62%	0%	70%	13%	29%
Need for Winter Cooling	15%	0%	50%	38%	33%
Unitary Air Conditioning Present	100%	100%	100%	87%	86%
Central Chiller Equipment Present	14%	20%	12%	40%	14%
Unitary Heat Pump Present	11%	0%	17%	20%	0%
Condenser Water Pump Present	0%	0%	0%	1 obs.	0%
Chilled Water Pump Present	0%	0%	0%	1 obs.	0%
Chilled Water or Ice Storage Provided	1 obs.	0%	1 obs.	0%	0%
Fuel Type					
Electric	67%	100%	85%	100%	100%
Natural Gas	22%	0%	15%	0%	0%

Propane	11%	0%	0%	0%	0%

Three types of unitary air conditioning systems were employed in the facilities, namely, split, package or window units (Table 8.36). Of the Act 250 new construction projects, one-half used split systems and one-half used package systems. Half of the Act 250 renovation projects also used split systems, with the proportion of split system usage rising to two-thirds or more for non-Act 250 renovations and equipment upgrades. Window units were encountered least frequently, and were not used at all in Act 250 new construction projects, while being used in one-third of the non-Act 250 new construction projects. Window units were used in ten to twenty percent of the remaining projects. The frequency of observations of central chiller and unitary heat pump types was so low as to be inconclusive. Those observations are set forth in the Table. All of the heat-rejection systems used air-cooled condensers with the exception of one Act 250 new construction facility, which employed a cooling tower. All of the projects requiring winter cooling included air-side economizers.

TABLE 8.36 - SYSTEM SUB-TYPES AMONG THOSE WITH COOLING SYSTEM PRESENT

COOLING SYSTEM SUB-TYPE	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250	NON	ACT 250	NON	NON
Unitary Air Conditioning, Equipment Type					
Split	50%	50%	50%	70%	66%
Package	50%	17%	40%	15%	17%
Window Unit	0%	33%	10%	15%	17%
Central Chiller, Equipment Type					
Reciprocating	0	1 obs.	0	0	1 obs.
Centrifugal	1 obs.	0	1 obs.	1 obs.	0
Screw/Scroll	0	0	0	1 obs.	0
Unitary Heat Pump, Type					
Package	0	0	1 obs.	1 obs.	0
PTHP	1 obs.	0	0	0	0

Heat Rejection Equipment Type					
Air-cooled Condensers	92%	100%	100%	100%	100%
Cooling Tower	8%	0%	0%	0%	0%
If Winter Cooling, Type of Equipment					
Air-side Economizer	100%	0%	100%	100%	100%

More than half of the newly constructed and renovated facilities observed to have cooling systems are using their system to cool the entire building, with the highest percentage of such use in non-Act 250 renovations at 62% (Table 8.37). By comparison, where only equipment was replaced, it was used to cool the entire building in 29% of the facilities. The next most commonly cooled amount of space in Act 250 construction and renovation facilities was one-third or less, which occurred in just over one-quarter of these facilities. In 43% of the facilities where equipment was replaced, it was used to cool one-third of the building or less. The 40% of non-Act 250 facilities that did not cool their entire building space, were observed to cool between one third and two thirds of that space.

Also shown in Table 8.37, most of the observed cooling systems appear to be in excellent condition, with the highest percentage of systems in excellent condition found in Act 250 new construction and in equipment-replacement facilities at 85% and 86%, respectively. Renovated facilities had the lowest incidence of excellent cooling-system condition at 70% for Act 250 renovations and 63% for non-Act 250 renovations. The only systems observed to be in poor condition were found in facilities where equipment was replaced.

TABLE 8.37 - SPACE COOLED AND CONDITIONING OF SYSTEM AMONG THOSE WITH COOLING SYSTEM PRESENT

PROPORTION OF SPACE AND CONDITION OF COOLING SYSTEM	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
Proportion of Space Cooled					

Whole Building	55%	60%	58%	62%	29%
67% to 99%	9%	0%	0%	19%	14%
34% to 66%	9%	40%	14%	0%	14%
1% to 33%	27%	0%	28%	19%	43%
If Cooling, Condition of System					
Excellent	85%	83%	70%	63%	86%
Good	15%	17%	20%	25%	0%
Fair	0%	0%	10%	13%	0%
Poor	0%	0%	0%	0%	14%

The approach to scheduling maintenance of cooling system compressors in new facilities was observed to contrast between Act 250 and non-Act 250 facilities (Table 8.38). Fifty-eight percent of the Act 250 facilities scheduled annual maintenance compared to 33% of non-Act 250 facilities. Half of the latter rely on maintenance upon request, while only 8% of the new Act 250 facilities maintain their cooling system compressors upon request. Seventeen percent of both categories of new facilities scheduled maintenance on a quarterly basis.

About two-thirds of the renovated facilities scheduled regular maintenance of their cooling system compressors, with annual maintenance or maintenance at the beginning and end of each season being the most common schedules. About one-third of renovated facilities maintain their compressors on a per-request basis.

In facilities with replaced equipment, two-thirds of the cooling-system compressors were scheduled for annual maintenance, while compressor maintenance for the balance of these facilities was evenly split between maintenance at the beginning and end of each season and maintenance upon request.

In newly constructed Act 250 and non-Act 250 facilities, the frequency of maintenance scheduled on an annual basis for auxiliary cooling-system

equipment rises to 64% and 67%, respectively. An additional 18% of new Act 250 facilities schedule such maintenance semi-annually. No new facilities maintain this equipment on a per-request basis.

The maintenance schedule pattern for cooling-system auxiliary equipment in renovated Act 250 facilities exactly matches the maintenance schedule pattern for cooling-system compressors in these facilities. That is, one-third scheduled maintenance annually, one-third maintain the equipment on a per-request basis, and the balance of the facilities maintain the equipment at the beginning and end of the season, or quarterly. In non-Act 250 renovations the most common maintenance schedule for cooling-system auxiliary equipment is the beginning and end of the season (40% of applicable sites surveyed). Maintenance schedules for the balance of these facilities fell equally into three categories: annually, quarterly and per request.

TABLE 8.38 - COOLING SYSTEM—MAINTENANCE ACTIVITIES AMONG THOSE WITH COOLING SYSTEM PRESENT

MAINTENANCE ACTIVITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
Compressor Maintenance Frequency					
On Request	8%	50%	33%	29%	17%
Start/End Season	17%	0%	22%	29%	17%
Once a Year	58%	33%	33%	29%	66%
Quarterly	17%	17%	11%	13%	0%
Auxiliaries Maintenance Frequency					
On Request	0%	0%	33%	20%	20%
Start/End Season	18%	0%	22%	40%	20%
Once a Year	64%	67%	33%	20%	60%
Semi-annually	18%	0%	0%	0%	0%
Quarterly	0%	33%	11%	20%	0%

As shown in Table 8.39, cooling system operators were most likely to receive training upon installation, as reported occurring for about two-thirds to three-quarters of the operators of new construction Act 250 projects and all types of renovation projects. Roughly half of the new construction and renovation cooling systems were reported to have been commissioned. About half of these in new construction projects were noted as being done by an independent third-party commissioner. None of the renovation projects were commissioned by independent parties.

TABLE 8.39 - COOLING SYSTEM—OPERATIONAL TRAINING AND EQUIPMENT COMMISSIONING AMONG THOSE WITH COOLING SYSTEM PRESENT

COOLING SYSTEM COMMISSIONING	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
Operational Training					
Never	23%	67%	22%	38%	83%
Upon Installation	62%	33%	78%	63%	17%
Once per Year	8%	0%	0%	0%	0%
Less than Once per 3 Years	8%	0%	0%	0%	0%
Commissioning					
Cooling System Commissioned When Installed	45%	50%	44%	50%	20%
If Commissioned, Done by Independent 3rd Party	40%	50%	0%	0%	0%
Retro-commissioning					
Never	80%	67%	80%	86%	100%

Once per Year	10%	17%	20%	14%	0%
Once per 2 or 3 Years	10%	17%	0%	0%	0%

Programmable thermostats were found to be more common than energy management system (EMS) direct digital controls (Table 8.40). Together, these two types of controls were found at about three-quarters of the new construction and renovation Act 250 sites, and at 40% to 50% of the new construction and renovation non-Act 250 sites. Twenty percent of the equipment replacement facilities had programmable thermostats and none had EMS controls.

TABLE 8.40 - COOLING SYSTEM—CONTROLS AMONG THOSE WITH COOLING SYSTEM PRESENT

COOLING SYSTEM CONTROLS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
System Control Type					
Thermostat	23%	60%	30%	50%	80%
Programmable Thermostat	62%	20%	50%	25%	20%
EMS Direct Digital Control	15%	20%	20%	25%	0%
Control System Provides					
Chilled Water Reset	0%	100%	0%	25%	0%
Chiller Sequencing	0%	0%	0%	25%	100%
Scheduling of Auxiliaries	0%	0%	0%	25%	0%
Condenser Water Reset	0%	0%	0%	0%	0%
Other	0%	0%	0%	25%	0%

Table 8.41 identifies the various energy efficiency features observed among those sites where cooling systems were present. Economizers (dry-bulb type) were the energy-efficient equipment most commonly seen in use with the cooling systems.

TABLE 8.41 -COOLING ENERGY-EFFICIENCY FEATURES AMONG THOSE WITH COOLING SYSTEM PRESENT

AUXILLIARY EQUIPMENT	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=13)	NON (N=6)	ACT 250 (N=10)	NON (N=8)	NON (N=7)
Evaporative Pre-Cooler Present	0%	0%	100%	13%	0%
Desiccant Dehumidifier Present	8%	0%	10%	13%	0%
Steam Humidifier Present	8%	0%	0%	13%	0%
Heat Wheel/Heat Recovery Present	8%	17%	10%	0%	0%
Chilled Water Pipes Insulated	33%	100%	17%	0%	50%
Free Cooling (Economizer Cycle) Present	69%	17%	40%	50%	17%
Economizer is Dry-Bulb Type	100%	NA	100%	100%	100%

Missed Opportunities: Cooling Systems

Many of the missed opportunities for heating systems also apply to cooling systems. Field engineers noted the following additional potential opportunities for cooling system energy efficiency improvements:

- In one new construction, Act 250 facility, the outdoor lines to the cooling tower were ripped, exposing the pipe.

- There was an opportunity for free cooling in one renovation, Act 250 facility.

VENTILATION SYSTEMS

The findings regarding ventilation systems are summarized in tables and text for each of the five project types. The section concludes with a discussion of potentially missed ventilation system opportunities. The tables present findings on:

- Ventilation system equipment type and operation; and
- Ventilation system energy efficiency features.

About half of the new construction and renovation facilities had ventilation or air handling equipment (Table 8.42). Dual duct was the most common equipment encountered, in use at about half of the sites with ventilation equipment. Fifty to 60% of the new construction Act 250 and the renovation facilities had systems that handled outside air using a variable volume system.

TABLE 8.42 - VENTILATION AND AIR HANDLING UNIT SYSTEM TYPES AND OPERATION

QUERIED FEATURES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Ventilation or Air Handling Unit Present	52%	50%	57%	53%	27%
If Ventilation, Equipment Type					
Dual Duct	50%	60%	50%	50%	33%
Multiple Zone	33%	0%	0%	13%	33%
Variable Volume	8%	0%	0%	0%	0%
Single Zone	8%	40%	38%	38%	0%
Other	0%	0%	13%	0%	33%
If Ventilation, Fan System Use					

Heating and Cooling	75%	17%	63%	50%	0%
Heating Only	8%	0%	38%	0%	33%
Cooling Only	17%	33%	0%	38%	33%
Air Exchange	0	50%	0	13%	33%
Outside Air					
System Handles Outside Air	67%	60%	75%	50%	33%
If Outside Air, Air Volume Varied	60%	33%	50%	50%	0%
Air Volume Varied Based on Occupancy	1 obs.	0	2 obs.	0	NA
Air Volume Varied by temp or enthalpy (e.g. econ)	5 obs.	1 obs.	0	2 obs.	NA

As shown in Table 8.43, field engineers observed that ducts were insulated at three-quarters of the new construction Act 250 and renovation non-Act 250 sites with ventilation systems, as well as at two-thirds of the equipment replacement facilities with ventilation systems. New construction Act 250 facilities were the most likely to have variable air volume systems, which were most frequently controlled by inlet vanes.

TABLE 8.43 - VENTILATION ENERGY EFFICIENCY FEATURES AND CONTROLS

QUERIED FEATURES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Ductwork Insulated	73%	33%	25%	75%	67%
Duct Sealing Retrofit Ever conducted	0%	0%	0%	14%	0%
Pre-heat, Re-heat	25%	20%	13%	25%	67%

Coils Present					
If Pre/Re-heat Coils, Heat Source					
Electricity	1 obs.	1 obs.	NA	1 obs.	1 obs.
Hot Water	2 obs.	0	NA	2 obs.	0
Air Flow Control*					
Constant Volume	42%	80%	75%	57%	100%
Discharge Dampers	17%	20%	13%	29%	0%
Inlet Vane Control	33%	0%	13%	0%	0%
Variable Speed Drive	8%	0%	0%	14%	0%
Control Type					
Manual	0	20%	0	13%	0
Standard Thermostat	8%	60%	38%	25%	33%
Programmable Thermostat	75%	20%	62%	37%	0
EMS Direct Digital Control	17%	0	0	25%	33%
EMS-Electronic/Pneumatic	0	0	0	0	33%

** See previous table, Table 8.39, for data on variable air volume systems in use with outside air.*

The field engineers found two facilities that had duct problems. One renovation Act 250 facility reported condensation problems in the summer, while one renovation non-Act 250 facility reported that the ducts had been noisy in the past.

Missed Opportunities: Ventilation Systems

In addition to the opportunities for heating and cooling systems presented above, the field engineers noted the following potential opportunities for ventilation system improvements:

- Volume control could be based on CO_2 or temperature
- Incorporate better air control option

MOTORS AND COMPRESSED AIR SYSTEM

The findings regarding motors are summarized in tables and text for each of the five project types. The section concludes with a discussion of potential missed motor and air compressor opportunities. The tables present findings on:

- Number and average efficiency of motors by HP range (2 – 10 HP, 11 – 75 HP and 76 – 200 HP)
- Number and % of motors with efficiency levels >= 88.6% for 2 – 10 HP units, 92.0% for 11 – 75 HP units, and 94.3% for 76 – 500 HP units
- Estimated average hours of operation per year by HP range (2 – 10 HP, 11 – 75 HP and 76 – 200 HP)

Specific compressed air system elements addressed include:

- Compressor size and type and key system elements
    - HP & rotary screw, reciprocating, centrifugal, etc.
    - Primary compressed air storage
    - Compressed air dryer and/or heat recovery
- Operation and maintenance
    - Operational issues
    - Leak survey frequency
    - Compressed air energy audit or study & resulting actions

Findings of operational problems and leaks are presented in the section on missed opportunities.

Tables 8.44 through 8.46 present the characteristics of motors following in three size ranges: 2 to 10 horsepower, 11 to 75 horsepower, and over 75 horsepower. Motors of 2 to 10 horsepower are most common. Only one motor was found in excess of 75 horsepower. The renovation, non-Act 250 facilities

that had motors had more motors per site than any other group. This prevalence of motors no doubt reflects the business conducted at these sites. The motors operated by new construction, Act 250 facilities and renovation, non-Act 250 facilities were likely to be energy efficient. About 43% of the new construction, Act 250 motors (of all sizes) were energy efficient, as were 73% of the renovation, non-Act 250 motors (of all sizes). None of the motors of the other groups were energy efficient.

TABLE 8.44 - MOTOR CHARACTERISTICS: MOTORS 2 TO 10 HORSEPOWER (NUMBER OF OBSERVATIONS)

MOTORS 2 TO 10 HP	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Motors	9	1	3	2	1
Total Number of Motors	24	1	9	19	1
Average Number of Motors per Site	2.7	1	3	9.5	1
Number of Motors Used for Back-Up	2	0	1	1	0
Average HP	5.4	3	5.6	6.4	3
Efficiency Less than 88.6%	10	1	2	2	0
Efficiency 88,6% or Higher	6	0	0	0	0
Efficiency Data Not Available	8	0	7	17	1
ODP Motors	9	0	2	0	0
TECF Motors	13	1	5	19	0
ODP/TECF Not Available	2	0	2	0	1

Single-Phase Motors	7	0	0	2	0
Three-Phase Motors	13	3	4	2	1
Phases Not Available*	4	0	5	15	0
No Speed Control	9	1	2	0	0
Variable Speed Drive Control	2	0	3	14	0
Load/No Load Control	4	0	0	4	0
Switch Control	4	0	0	0	0
Control Not Available*	5	0	4	1	1
RPM: 1100-1200	0	0	0	2	0
RPM: 1725-1800	9	1	2	17	1
RPM: 3450-3500	5	0	0	0	0
RPM Not Available*	10	0	7	0	0
Annual Hours of Use: Under 1,000	4	0	0	1	0
Annual Hours of Use: 1,000-2,000	4	0	0	0	0
Annual Hours of Use: 8,000 or More	4	0	0	0	0
Annual Hours of Use Not Available*	12	1	9	18	1
Use: Compressors	3	0	0	0	0
Use: Conveyors	2	0	0	0	0

Use: Pumps	2	0	0	0	0
Use: Saws	1	0	2	1	0
Use: Molders	1	0	2	0	0
Use: Crane	0	0	0	14	0
Use: Polisher	0	0	0	2	0
Use: Other Specified	3	1	2	2	0
Use: Not Available*	12	0	3	0	1

**Field staff were unble to identify some characteristics of some motors.*

TABLE 8.45 - MOTOR CHARACTERISTICS: MOTORS 10 TO 75 HORSEPOWER (NUMBER OF OBSERVATIONS)*

MOTORS 10 TO 75 HP	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Motors	4	1	3	3	1
Total Number of Motors	16	1	10	18	3
Average Number of Motors per Site	4	1	3.3	6	3
Number of Motors Used for Back-Up	5	0	0	5	0
Average HP	38.6	20	26.5	22.7	2.7
Efficiency Less than 92.0%	6	0	0	2	0
Efficiency 92.0% or Higher	6	0	0	8	0

Efficiency Data Not Available	4	1	10	8	3
ODP Motors	11	0	0	10	1
TECF Motors	4	0	0	6	0
ODP/TECF Not Available*	0	0	10	2	2
Single-Phase Motors	0	0	0	0	0
Three-Phase Motors	11	0	1	10	3
Phases Not Available*	5	1	9	8	0
No Speed Control	0	0	3	4	2
Variable Speed Drive Control	6	0	0	2	0
Load/No Load Control	4	0	0	7	0
Switch Control	0	0	0	0	0
Control Not Available*	6	1	7	5	1
RPM: 1100-1500	4	0	0	3	1
RPM: 1725-1800	6	0	1	8	1
RPM: 3400-3600	5	0	0	2	0
RPM Not Available*	1	1	9	5	2
Annual Hours of Use: Under 1,000	0	0	0	2	0
Annual Hours of Use: 1,000-2,500	1	0	5	3	0
Annual Hours of Use: 8,000 or	0	0	0	0	0

More					
Annual Hours of Use Not Available*	15	1	5	13	3
Use: Pumps	4	0	0	0	0
Use: Cooling System	3	0	0	2	1
Use: Compressors	2	0	0	1	0
Use: Plant Application	2	0	2	2	0
Use: Air Cleaning	2	0	1	0	0
Use: Hydraulics	2	0	0	0	0
Use: Elevators	1	1	1	0	2
Use: Saws	0	0	3	2	0
Use: Polisher	0	0	1	1	0
Use: Other Specified	0	0	1	0	0
Use: Not Available*	0	0	1	10	0

**Field staff were unble to identify some characteristics of some motors.*

TABLE 8.46 - MOTOR CHARACTERISTICS: MOTORS 76 HORSEPOWER OR MORE (NUMBER OF OBSERVATIONS)*

MOTORS 100 HP OR MORE	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Motors	0	0	0	1	0
Total Number of Motors	NA	NA	NA	3	NA

Average Number of Motors per Site	NA	NA	NA	3	NA
Number of Motors Used for Back-Up	NA	NA	NA	0	NA
Average HP	NA	NA	NA	100	NA
Efficiency 94.3% or Higher	NA	NA	NA	3	NA
ODP Motors	NA	NA	NA	3	NA
ODP/TECF Not Available*	NA	NA	NA	0	NA
Three-Phase Motors	NA	NA	NA	3	NA
Phases Not Available*	NA	NA	NA	0	NA
Load/No Load Control	NA	NA	NA	3	NA
Control Not Available*	NA	NA	NA	0	NA
RPM: 3400-3600	NA	NA	NA	3	NA
RPM Not Available*	NA	NA	NA	0	NA
Annual Hours of Use: Under 1,000	NA	NA	NA	1	NA
Annual Hours of Use:6,570	NA	NA	NA	2	NA
Annual Hours of Use Not Available*	NA	NA	NA	0	NA
Use: Not Available*	NA	NA	NA	3	NA

**Field staff were unble to identify some characteristics of some motors.*

Tables 8.47 through 8.49 present information on air compressors, by size of unit. Table 8.47 addresses air compressors with motors under 5 horsepower; Table 8.48 addresses compressors with motors from 5 to 10 horsepower; and Table 8.49 addresses compressors with motors over 10 horsepower. Motors of 5 to 10 horsepower are the most common for the two new construction groups, while motors less than 5 horsepower are the most common for the other three groups of facilities.

TABLE 8.47 - AIR COMPRESSOR CHARACTERISTICS: MOTORS UNDER 5 HORSEPOWER (NUMBER OF OBSERVATIONS)

AIR COMPRESSOR CHARACTERISTICS (MOTOR < 5 HP)	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Compressors	1	0	2	4	2
Total Number of Motors	1	0	2	4	5
Average Number of Motors per Site	1	NA	1	1	2.5
Average HP	2	NA	2	2.25	1.15
Average Operating Pressure (PSI)	25	NA	90	112	82
Average Compressor CFM	NA	NA	NA	NA	NA
Number of Motors Reciprocating	1	NA	2	4	5
Number of Motors	0	NA	0	0	0

Centrifugal					
Number of Motors Load/No Load Control	1	NA	2	3	5
Number of Units Primary Compressed Air Storage	1	NA	2	4	5
Number of Units with No Operational Issues	1	NA	2	2	5
Number of Units with Refrigerant Compressed Air Dryer	1	NA	2	1	5
Number of Units with Heat Recovery	0	NA	0	0	0
Number of Units with No Leaks	0	NA	1	3	3
Number of Units with Audit Done	0	NA	1	0	0
Number of Units Auditor Missed Efficiency Opportunities	NA	NA	0	NA	NA

TABLE 8.48 - AIR COMPRESSOR CHARACTERISTICS: MOTORS 5 TO 10 HORSEPOWER (NUMBER OF OBSERVATIONS)

AIR COMPRESSOR CHARACTERISTICS (MOTOR 5-10 HP)	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Compressors	4	1	1	1	2

Total Number of Motors	5	1	1	1	3
Average Number of Motors per Site	1.25	1	1	1	1.5
Average HP	7.5	10	5	5	6.25
Average Operating Pressure (PSI)	143	150	100	175	150
Average Compressor CFM	16.6	22.9	NA	34.2	23.05
Number of Motors Reciprocating	4	NA	1	1	2
Number of Motors Centrifugal	1	NA	0	0	1
Number of Motors Load/No Load Control	5	1	1	1	3
Number of Units Primary Compressed Air Storage	5	1	1	1	3
Number of Units with No Operational Issues	4	1	0	NA	3
Number of Units with Refrigerant Compressed Air Dryer	2	0	0	1	0
Number of Units with Heat Recovery	1	0	0	0	0
Number of Units with No Leaks	0	0	0	0	0
Number of Units	2	0	0	0	0

with Audit Done					
Number of Units Auditor Missed Efficiency Opportunities	1	0	0	0	0

TABLE 8.49 - AIR COMPRESSOR CHARACTERISTICS: MOTORS OVER 10 HORSEPOWER (NUMBER OF OBSERVATIONS)

AIR COMPRESSOR CHARACTERISTICS (MOTOR >10 HP)	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Number of Sites with Compressors	1	1	1	1	1
Total Number of Motors	1	1	2	1	5
Average Number of Motors per Site	1	1	2	1	5
Average HP	15	30	258	30	15
Average Operating Pressure (PSI)	98	125	130	115	125
Average Compressor CFM	NA	NA	83	29	54
Number of Motors Rotary Screw	0	1	0	0	2
Number of Motors Reciprocating	1	0	1	1	3
Number of Motors Centrifugal	0	0	0	0	0
Number of Motors Load/No Load Control	NA	0	1	1	NA

Number of Units with Variable Speed Drive	0	1	0	0	0
Number of Units Primary Compressed Air Storage	1	0	1	1	1
Number of Units with No Operational Issues	1	1	1	0	5
Number of Units with Refrigerant Compressed Air Dryer	1	1	1	0	5
Number of Units with Dessicant Compressed Air Dryer	0	0	0	0	0
Number of Units with Heat Recovery	0	1	0	0	5
Number of Units with No Leaks	1	NA	0	1	5
Number of Units with Audit Done	0	0	0	0	0

Missed Opportunities: Motors and Air Compressors

Table 8.50 presents the missed opportunities identified for motors and air compressors. A few motors needed power factor improvements or VSDs. A few air compressors had pressure fluctuations. A few had leaks, which were reported to be occur about once a year and not more frequently. A few compressors were old and needed replacing and a few compressors needed annual maintenance.

TABLE 8.50 - MISSED OPPORTUNITIES FOR MOTORS AND AIR COMPRESSORS (NUMBER OF OBSERVATIONS)

	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Motors					
One or More Missed Opportunities Found	2	0	2	1	2
Inefficient Motor	1	0	0	0	0
Power Factor Improvements	2	0	0	0	0
VSD	0	0	1	1	0
Timer for Pump	0	0	0	0	1
Many Small HP Pumps Inefficient	0	0	0	0	1
Air Compressor Motors Under 5 HP					
Number of Units with Pressure Fluctuations	0	NA	0	2	0
Number of Units with Leaks Once per Year	1	NA	1	1	2
Number of Units Survey Identified Missed Opportunities	0	NA	0	3	3
Opportunities Missed	NA	NA	NA	Old units in need of replacing	Annual maintenance . Loose belt on Unit 2. Broken

					gauge on Unit 3
Air Compressor Motors 5 to 10 HP					
Number of Units with Pressure Fluctuations	1	0	1	NA	0
Number of Units with Leaks Once per Year	3	1	0	NA	3
Number of Units Survey Identified Missed Opportunities	1	1	NA	0	NA
Opportunities Missed	Very little usage for compressor	Old compressor	0	0	0
Air Compressor Motors Over 10 HP					
Number of Units with Moisture or Air Quality Issues	0	0	0	1	0
Number of Units with Pressure Fluctuations	0	0	0	0	0
Number of Units with Leaks Once per Year	0	0	1	0	0
Number of Units Survey Identified Missed Opportunities	0	0	0	0	0

DOMESTIC HOT WATER SYSTEMS

The findings regarding domestic hot water systems are summarized in tables and text for each of the five project types. The section concludes with a discussion of potential missed domestic hot water system opportunities. The tables present findings on:

- Hot water system characteristics
  - Type of system (standard storage type, heat exchanger, separate hat water tank, instantaneous, heat pump) and fuel source
  - Age of system and size of tank
  - Existence/use of circulating pump
- System usage and efficiency characteristics
  - Level of DHW demand and typical usages
  - Use of timer controls
  - Use of tank insulation
  - Use of pipe insulation

Domestic hot water (DHW) systems were present in over 80% of the new construction projects (both types), in 100% of the renovation, Act 250 facilities, and in about two-thirds to three-quarters of the renovation, non-Act 250 and equipment replacement facilities (Table 8.51). Standard storage tanks, heat exchanger from boiler inside the building, and separate tanks were equally common across the five groups of facilities. The fuel used most frequently varied by the type of equipment installed, as well as varying across the five groups of facilities.

TABLE 8.51 - DOMESTIC HOT WATER SYSTEM CHARACTERISTICS

DHW CHARACTERISTICS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
DHW Present	88%	83%	100%	67%	73%
DHW Type					
Standard Storage	33%	0%	43%	30%	38%
Heat Exchanger From Central Heating Plant	5%	0%	0%	10%	12%
Heat Exchanger from Boiler Inside Building	38%	60%	14%	30%	25%
Separate Tank	24%	30%	43%	30%	25%
Instantaneous Point-of-use	0%	10%	0%	0%	0%
If Standard Storage, Fuel Type					
Natural Gas	33%	NA	20%	33%	25%
Electric	17%	NA	40%	67%	50%
Oil	33%	NA	20%	0%	25%
Propane	17%	NA	20%	0%	0%
If Separate Tank, Fuel Type					
Natural Gas	0%	0%	43%	33%	33%
Electric	50%	100%	57%	33%	0%
Oil	0%	0%	0%	0	33%
Propane	50%	0%	0%	33%	33%
If Heat Exchanger from Boiler, Storage Tank Present					
Yes	64%	80%	100%	25%	100%
Circulating Pump Present					

Yes	52%	63%	31%	33%	50%

Most of the facilities had a low demand for hot water (Table 8.52). The new construction, Act 250 facilities were more likely than other facilities to have insulated pipes. Both types of new construction facilities were the most likely to have insulated storage tanks, when storage tanks were in use.

TABLE 8.52 - DOMESTIC HOT WATER SYSTEM USAGE AND EFFICIENCY CHARACTERISTICS

DHW USAGE AND EFFICIENCY FEATURES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Domestic Hot Water Demand					
High	5%	11%	8%	0	0
Medium	29%	0%	8%	11%	38%
Low	67%	89%	85%	89%	63%
If Circulating Pump, Timer Controlled					
Yes	0%	20%	25%	0%	0%
If Separate Storage Tank, Insulated					
Yes	93%	100%	91%	67%	60%
Pipes Insulated					
Yes	63%	13%	23%	30%	25%

Missed Opportunities: Domestic Hot Water

One key area for DHW energy efficiency improvements involves increasing the level of insulation of the pipes and, less so, of the tank (Table 8.53).

TABLE 8.53 - DOMESTIC HOT WATER SYSTEM MISSED OPPORTUNITIES

MISSED OPPORTUNITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=21)	NON (N=10)	ACT 250 (N=14)	NON (N=10)	NON (N=8)
One or More Missed Opportunities Found	29%	50%	36%	60%	75%
Pipe Insulation	29%	50%	36%	30%	75%
Tank Insulation	0%	0%	0%	0%	13%
Inefficient Unit	0%	0%	0%	30%	0%
Point-of-Use (On-Demand) Unit	0%	0%	7%	0%	0%

OTHER MAJOR LOADS

As part of our on-site surveys, information was collected on food and process refrigeration equipment and swimming pools and spas. These types of other major load-using equipment were encountered at only a small proportion of the sites visited. Summary information and key equipment characteristics are presented in the following sub sections.

Food & Process Refrigeration Equipment

Food and process refrigeration equipment was used in 9 out of the 76 sites surveyed (12%). These refrigeration systems varied greatly by site, ranging from a vending refrigerator to a cold room. The most prevalent type of refrigeration enclosure was a vertical closed cabinet (present at two new construction non-Act 250 facilities, one renovation Act 250 facilities, two renovation non-Act 250 facilities, and two equipment replacement facilities). Only one site, a new construction Act 250 facility, reported a different type of enclosure: a walk-in refrigeration unit.

Refrigeration systems were most often reported as “medium temperature,” with just over half of those sites with refrigeration equipment reporting this type. Linear size was only reported in three cases. Linear size of these three units was 16, 24 and 30 feet. Area size estimates varied from between 12 to 128 feet.

The compressors included reciprocating, sealed and screw types. The quantity of compressors at each site varied between one and six, and the horsepower also varied greatly with ranges between 2 and 125 hp reported. The six sites for which data are available have the following options: floating head pressure controls (5 sites), parallel unequal compressors (2 sites), and industrial refrigeration (1 site).

The refrigeration systems had the following types of defrost heaters: hot gas (3 sites), electric—timer controlled (2 sites), electric—demand controlled (1 site). For three sites the type of defrost heater was unknown.

None of the refrigeration systems had been commissioned.

Swimming Pools/Spas

Two of the 76 sites surveyed had indoor swimming pools. One of these pools was small—5,000 gallons, while the other was larger at 15,000 gallons. The latter pool was heated straight from the boiler. Both sites used a mechanical cooling system for dehumidification. A third site had an outside pool of 20,000 gallons. One site had an indoor whirlpool/bathtub, which held 34 gallons. No sites had an outdoor spa. None of the pools or spas had pool covers.

Other – Other Major Loads

Only a small number of sites had major loads outside of the categories previously mentioned in this report and these were very specific to the type of business occupying that site. Some of these site-specific unique loads included:

- Battery chargers for forklifts
- Fish tank water pumps
- Commercial ranges and ovens
- Air blowers for various processes

Missed Opportunities: Other Major Loads

Potential energy savings might result from retro-commissioning of refrigeration equipment and covers for heated pools and spas. One new construction, Act 250 facility had a pool that needed insulation on the pipes from the boiler that delivered hot water. One refrigerator and one freezer were described by the field engineers as old and in disrepair. The other large energy loads were unique to the site and would require customized approaches tailored firm.

ON-SITE GENERATION

In this section, findings regarding back-up/emergency generators and/or distributed/on-site generation systems are summarized for each of the five project types. Specific information addressed includes:

- Existence and type of on-site generation
  - Number of units encountered, sorted by geographic (Chittenden, Other Urban, and Rural) location and sorted by size of firm (small, medium and large)
  - Type of system (micro-turbine, natural gas engine, oil/diesel/gasoline engine, other) and size (kW) of unit
  - Heat recovery utilization
- General operating characteristics of on-site generator
  - Emergency only, emergency and peak shaving, other
  - Approximate annual operating hours

Over 40% of the new construction facilities (both types) had on-site generation (Table 8.54). Facilities with equipment replacement projects were the next most likely to have on-site generation (36%). Diesel engines are the most common type of generator. Most of the systems serve as an emergency supply of power. Only one group of facilities used heat recovery: new construction, non-Act 250.

TABLE 8.54 - ON-SITE GENERATION

ON-SITE GENERATION CHARACTERISTICS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Back-up or Distributed Generation Present	42%	42%	14%	27%	36%
Type of System					
Microturbine	0%	0%	0%	0%	0%
Natural Gas Engine	12%	0%	0%	0%	0%
Diesel Engine	50%	75%	50%	100%	33%
Other	38%	25%	50%	0%	67%
Size of System (Number of Observations)					
5 to 30 kW	3 obs.	1 obs.	1 obs.	0	1 obs.
50 to 150 kW	1 obs.	2 obs.	0	1 obs.	0
250 to 500 kW	1 obs.	0	1 obs.	2 obs.	0
Operation of Generator					
Emergency	63%	67%	50%	100%	75%
Standby	0%	0%	0%	0%	0%
Peak Shaving	0%	0%	0%	0%	0%
Other	37%	33%	50%	0%	25%
Heat Recovery Utilized					
Yes	0%	40%	0%	0%	0%

PARTICIPATION IN EFFICIENCY VERMONT

During on-sites, our field engineers asked their facility hosts two questions regarding participating with Efficiency Vermont (EVT). The first question assessed participation with EVT on the specific project for which the site visit was being conducted. The second questions attempted to determine any previous facility participation with EVT. Results are summarized in Table 8.55.

TABLE 8.55 - EFFICIENCY VERMONT PARTICIPATION

EFFICIENCY VERMONT PARTICIPATION	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Current Participation	15%	18%	33%	14%	14%
Past Participation	28%	25%	33%	21%	55%

SUMMARY OF ON-SITE FINDINGS AND MISSED OPPORTUNITIES

In the previous sections of this chapter, detailed findings were presented by equipment type/building system (e.g., building shell, lighting, heating, cooling, motors, etc.), in text and table format with breakouts by five separate C&I building activity categories (New Construction, Act 250; New Construction, non-Act 250; Renovation/Remodeling, Act 250; Renovation/Remodeling, Non-Act 250; and Equipment Replacement). In this section, the same information is summarized (sliced differently), to show key findings sorted by each of these same five construction activity categories. A summary of findings across the five areas is then presented.

Finally, this section ends with a tabulation of missed energy efficiency improvement opportunities, also sorted by the five building activities categories. For detailed information on these missed opportunities, please refer to the targeted write-ups included in the previous measure/system-specific sections.

VT C&I New Construction Activities Summary, Act 250 Projects

On-site surveys were conducted with 24 facilities having new construction, Act 250 projects. These facilities are characterized by the following proportions of equipment and efficiency measures (for more information, please refer to the appropriate detailed write-ups above):

Building Shell:

- 0% of facilities have single pane windows
- 87% have entirely double-pane windows and 13% have no windows
- 48% have entirely low-emissivity glass
- 25% have on/off photocells
- 33% have foundation insulation with R-values greater than 10
- 38% have wall insulation with R-values greater than 19

- 75% have roof insulation with R-values greater than 30

Indoor Lighting:

- 75% of facilities have T8 lamps with electronic ballasts
- 26% of floor space is lit by T8 lamps with electronic ballasts
- 30% of floor space is lit by HID lamps with pulse start ballasts
- 1,134 lamps are T8 with electronic ballasts, out of 2,422 lamps in the facilities
- 57% have LED exit signs

Outdoor Lighting:

- 96% of facilities have outdoor lighting
- 49% of those with outdoor lighting use metal halide fixtures, and 7 of 13 sites use photocell controls for the fixtures
- 35% use high pressure sodium fixtures, and 4 of 10 sites use photocell controls for the fixtures

Heating:

- 81% of facilities heat their entire space
- 67% heat with a boiler (water)
- 48% use propane for the primary heating fuel
- 85% conduct maintenance of their burners once a year, as do 89% for boilers, 73% for chimneys, and 85% for calibration or adjustment of controls
- 50% train operators upon installation of the system

- 50% commissioned the system when installed, 43% of whom used an independent, third party commissioning agent
- 74% have never retro-commissioned the equipment
- 61% have insulated heating hot water pipes
- 35% have programmable thermostats

Cooling:

- 54% of facilities have a cooling system
- 100% of those with cooling systems have a unitary air system
- 50% of the unitary air systems are split systems
- 14% of those with cooling systems have central chiller equipment present
- 58% of those with cooling systems conduct maintenance once a year
- 62% of those with cooling systems trained operators upon installation of the system
- 45% of those with cooling systems commissioned the system when installed, 40% of whom used an independent, third party commissioning agent
- 80% of those with cooling systems have never retro-commissioned the equipment
- 62% of those with cooling systems have programmable thermostats
- 69% of those with cooling systems have an economizer, 100% of whom use a dry-bulb type

Ventilation:

- 52% of facilities have a ventilation or air handling unit present

- 67% of those with ventilation systems handle outside air
- 60% of those handling outside air handle a variable air volume
- 75% of those with ventilation systems have programmable thermostats

Motors and Air Compressors:

- Nine facilities have a total of 24 motors 2 to 10 horsepower
- Six of the sixteen 2-10 hp motors with efficiency data have an efficiency of 88.6% or higher
- Two of the nineteen 2-10 hp motors with control data have variable speed drive control; 9 have no speed control of any sort
- Four facilities have a total of 16 motors 10 to 75 horsepower
- Six of the twelve 10-75 hp motors with efficiency data have an efficiency of 92.0% or higher
- Six of the ten 10-75 hp motors with control data have variable speed drive control; none have no speed control of any sort
- No facilities have motors 75 horsepower or greater
- One facility has one air compressor under 5 hp, a reciprocating motor with load/no load control
- Four facilities have a total of five air compressors 5-10 hp, 4 of which are reciprocating, all 5 have load/no load control
- One facility has one air compressor over 10 hp, a reciprocating motor

Domestic Hot Water:

- 88% of facilities have a domestic hot water (DHW) system
- 38% with a DHW system have a heat exchanger from boiler inside building

- 93% with separate storage tanks have insulated tanks
- 63% have insulated pipes

On-site Generation:

- 42% of facilities have on-site generation
- 50% of those with generation have diesel engines
- 63% of those with generation have it for emergencies

Participation in Efficiency Vermont (EVT):

- 15% of facilities were participating in EVT programs at the time of the on-site
- 28% had previously participated in EVT programs

VT C&I New Construction Activities Summary, Non-Act 250 Projects

On-site surveys were conducted with 12 facilities with new construction, non-Act 250 projects. These facilities are characterized by the following proportions of equipment and efficiency measures (for more information, please refer to the appropriate detailed write-ups above):

Building Shell:

- 17% of facilities have some single pane windows
- 75% have entirely double-pane windows and 8% have no windows
- 33% have entirely low-emissivity glass
- 25% have on/off photocells
- 14% have foundation insulation with R-values greater than 10
- 48% have wall insulation with R-values greater than 19

- 75% have roof insulation with R-values greater than 30

Indoor Lighting:

- 42% of facilities have T8 lamps with electronic ballasts
- 20% of floor space is lit by T8 lamps with electronic ballasts
- 55% of floor space is lit by HID lamps with non-pulse start ballasts
- 130 lamps are T8 with electronic ballasts, out of 269 lamps in the facilities
- 33% have LED exit signs

Outdoor Lighting:

- 92% of facilities have outdoor lighting
- 45% of those with outdoor lighting use metal halide fixtures; 7 of 12 sites control the fixtures by photocells
- 27% use high pressure sodium fixtures; 2 of 3 sites control the fixtures by photocells

Heating:

- 100% of facilities heat their entire space
- 50% heat with a boiler (water)
- 50% use propane for the primary heating fuel
- 80% conduct maintenance of their burners once a year, as do 100% for boilers, 62% for chimneys, and 74% for calibration or adjustment of controls
- 33% train operators upon installation of the system

- 36% commissioned the system when installed, 50% of whom used an independent, third party commissioning agent
- 83% have never retro-commissioned the equipment
- 29% have insulated heating hot water pipes
- 25% have programmable thermostats

Cooling:

- 50% of facilities have a cooling system
- 100% of those with cooling systems have a unitary air system
- 50% of the unitary air systems are split systems
- 20% of those with cooling systems have central chiller equipment present
- 33% of those with cooling systems conduct maintenance once a year
- 33% of those with cooling systems trained operators upon installation of the system
- 50% of those with cooling systems commissioned the system when installed, 50% of whom used an independent, third party commissioning agent
- 67% of those with cooling systems have never retro-commissioned the equipment
- 20% of those with cooling systems have programmable thermostats
- 17% of those with cooling systems have an economizer

Ventilation:

- 50% of facilities have a ventilation or air handling unit present

- 60% of those with ventilation systems handle outside air
- 33% of those handling outside air handle a variable air volume
- 20% of those with ventilation systems have programmable thermostats

Motors and Air Compressors:

- One facility has one motor 2 to 10 horsepower, with an efficiency less than 88.6%
- The motor does not have variable speed drive control, nor does it have speed control of any sort
- One facility has one motor 10 to 75 horsepower
- No facilities have motors 75 horsepower or greater
- No facilities have air compressors under 5 hp
- One facility has one air compressor 5-10 hp, which has load/no load control
- One facility has one air compressor over 10 hp

Domestic Hot Water:

- 83% of facilities have a domestic hot water (DHW) system
- 60% with a DHW system have a heat exchanger from boiler inside building
- 100% with separate storage tanks have insulated tanks
- 13% have insulated pipes

On-site Generation:

- 42% of facilities have on-site generation

- 75% of those with generation have diesel engines
- 67% of those with generation have it for emergencies

Participation in Efficiency Vermont (EVT):

- 18% of facilities were participating in EVT programs at the time of the on-site
- 25% had previously participated in EVT programs

VT C&I Renovation and Remodeling Activities Summary, Act 250 Projects

On-site surveys were conducted with 14 facilities with renovation, Act 250 projects. These facilities are characterized by the following proportions of equipment and efficiency measures (for more information, please refer to the appropriate detailed write-ups above):

Building Shell:

- 0% of facilities have single pane windows
- 86% have entirely double-pane windows and the remaining sites have no windows
- 31% have entirely low-emissivity glass
- 23% have on/off photocells
- 40% have foundation insulation with R-values greater than 10
- 24% have wall insulation with R-values greater than 19
- 40% have roof insulation with R-values greater than 30

Indoor Lighting:

- 71% of facilities have T8 lamps with electronic ballasts

- 33% of floor space is lit by T8 lamps with electronic ballasts
- 56% of floor space is lit by HID lamps with non-pulse start ballasts
- 475 lamps are T8 with electronic ballasts, out of 763 lamps in the facilities
- 42% have LED exit signs

Outdoor Lighting:

- 100% of facilities have outdoor lighting
- 29% of those with outdoor lighting use metal halide fixtures; 4 of 6 sites control the fixtures with photocells
- 29% use high pressure sodium fixtures; 3 of 4 sites control the fixtures with photocells

Heating:

- 79% of facilities heat their entire space
- 43% heat with a boiler (water)
- 36% use natural gas for the primary heating fuel
- 73% conduct maintenance of their burners once a year, as do 78% for boilers, 100% for chimneys, and 58% for calibration or adjustment of controls
- 54% train operators upon installation of the system
- 38% commissioned the system when installed, none of whom used an independent, third party commissioning agent
- 71% have never retro-commissioned the equipment
- 63% have insulated heating hot water pipes

- 29% have programmable thermostats

Cooling:

- 71% of facilities have a cooling system
- 100% of those with cooling systems have a unitary air system
- 50% of the unitary air systems are split systems
- 12% of those with cooling systems have central chiller equipment present
- 33% of those with cooling systems conduct maintenance once a year
- 78% of those with cooling systems trained operators upon installation of the system
- 44% of those with cooling systems commissioned the system when installed, none of whom used an independent, third party commissioning agent
- 80% of those with cooling systems have never retro-commissioned the equipment
- 50% of those with cooling systems have programmable thermostats
- 40% of those with cooling systems have an economizer, 100% of whom use a dry-bulb type

Ventilation:

- 57% of facilities have a ventilation or air handling unit present
- 75% of those with ventilation systems handle outside air
- 50% of those handling outside air handle a variable air volume
- 62% of those with ventilation systems have programmable thermostats

Motors and Air Compressors:

- Three facilities have a total of 9 motors 2 to 10 horsepower
- Both of the two 2-10 hp motors with efficiency data have an efficiency less than 88.6%
- Three of the five 2-10 hp motors with control data have variable speed drive control; the other two have no speed control of any sort
- Three facilities have a total of ten motors 10 to 75 horsepower
- All three of the 10-75 hp motors with control data have no speed control of any sort
- No facilities have motors 75 horsepower or greater
- Two facilities each have one air compressor under 5 hp, reciprocating motors with load/no load controls
- One facility has one air compressors 5-10 hp, a reciprocating motor with load/no load control
- One facility has two air compressors over 10 hp, one of which is a reciprocating motor and has load/no load control

Domestic Hot Water:

- 100% of facilities have a domestic hot water (DHW) system
- 14% with a DHW system have a heat exchanger from boiler inside building
- 91% with separate storage tanks have insulated tanks
- 23% have insulated pipes

On-site Generation:

- 14% of facilities have on-site generation

- 50% of those with generation have diesel engines
- 50% of those with generation have it for emergencies

Participation in Efficiency Vermont (EVT):

- 33% of facilities were participating in EVT programs at the time of the on-site
- 33% had previously participated in EVT programs

VT C&I Renovation and Remodeling Activities Summary, Non-Act 250 Projects

On-site surveys were conducted with 15 facilities with renovation, non-Act 250 projects. These facilities are characterized by the following proportions of equipment and efficiency measures (for more information, please refer to the appropriate detailed write-ups above):

Building Shell:

- 21% of facilities have some single pane windows
- 50% have entirely double-pane windows and 29% have no windows
- 29% have entirely low-emissivity glass
- 21% have on/off photocells
- 50% have foundation insulation with R-values greater than 10
- 58% have wall insulation with R-values greater than 19
- 17% have roof insulation with R-values greater than 30

Indoor Lighting:

- 66% of facilities have T8 lamps with electronic ballasts
- 22% of floor space is lit by T8 lamps with electronic ballasts

- 27% of floor space is lit by HID lamps with non-pulse start ballasts
- 125 lamps are T8 with electronic ballasts, out of 472 lamps in the facilities
- 75% have LED exit signs

Outdoor Lighting:

- 93% of facilities have outdoor lighting
- 29% of those with outdoor lighting use metal halide fixtures
- 29% use high pressure sodium fixtures

Heating:

- 73% of facilities heat their entire space
- 67% heat with a boiler (water)
- 53% use oil for the primary heating fuel
- 92% conduct maintenance of their burners once a year, as do 92% for boilers, 63% for chimneys, and 62% for calibration or adjustment of controls
- 53% train operators upon installation of the system
- 54% commissioned the system when installed, 33% of whom used an independent, third party commissioning agent
- 73% have never retrocommissioned the equipment
- 44% have insulated heating hot water pipes
- 20% have programmable thermostats

Cooling:

- 53% of facilities have a cooling system
- 87% of those with cooling systems have a unitary air system
- 70% of the unitary air systems are split systems
- 40% of those with cooling systems have central chiller equipment present
- 29% of those with cooling systems conduct maintenance once a year
- 63% of those with cooling systems trained operators upon installation of the system
- 50% of those with cooling systems commissioned the system when installed, none of whom used an independent, third party commissioning agent
- 86% of those with cooling systems have never retro-commissioned the equipment
- 25% of those with cooling systems have programmable thermostats
- 50% of those with cooling systems have an economizer, 100% of whom use a dry-bulb type

Ventilation:

- 53% of facilities have a ventilation or air handling unit present
- 50% of those with ventilation systems handle outside air
- 50% of those handling outside air handle a variable air volume
- 37% of those with ventilation systems have programmable thermostats

Motors and Air Compressors:

- Two facilities have motors 2 to 10 horsepower, 19 motors in all
- Fourteen of the eighteen 2-10 hp motors with control data have variable speed drive control; none have no speed control of any sort
- Three facilities have motors 10 to 75 horsepower, 18 motors in all
- Eight of the ten 10-75 hp motors have efficiencies 92.0% or higher
- Two of the fourteen motors with control data have variable speed drive control; four have no speed control of any sort
- One facility has three motors 75 horsepower or greater, all of which have 94.3% efficiency or greater and load/no load control
- Four facilities each have one air compressor under 5 hp, reciprocating motors, three with load/no load controls
- One facility has one air compressors 5-10 hp, a reciprocating motor with load/no load control
- One facility has one air compressor over 10 hp, one of which is a reciprocating motor and has load/no load control

Domestic Hot Water:

- 67% of facilities have a domestic hot water (DHW) system
- 30% with a DHW system have a heat exchanger from boiler inside building
- 67% with separate storage tanks have insulated tanks
- 30% have insulated pipes

On-site Generation:

- 27% of facilities have on-site generation

- 100% of those with generation have diesel engines
- 100% of those with generation have it for emergencies

Participation in Efficiency Vermont (EVT):

- 14% of facilities were participating in EVT programs at the time of the on-site
- 21% had previously participated in EVT programs

VT C&I Equipment Replacement Activities Summary

On-site surveys were conduced with eleven facilities with equipment replacement projects. Facilities with equipment replacement projects are characterized by the following proportions of equipment and efficiency measures (for more information, please refer to the appropriate detailed write-ups above):

Building Shell:

- 56% of facilities have some single pane windows
- 44% have entirely double-pane windows; all sites have windows
- 22% have entirely low-emissivity glass
- 11% have on/off photocells
- 0% have foundation insulation with R-values greater than 10
- 0% have wall insulation with R-values greater than 19
- 33% have roof insulation with R-values greater than 30

Indoor Lighting:

- 45% of facilities have T8 lamps with electronic ballasts

- 30% of floor space is lit by T8 lamps with electronic ballasts
- 0% of floor space is lit by HID lamps of any sort
- 118 lamps are T8 with electronic ballasts, out of 427 lamps in the facilities
- 11% have LED exit signs

Outdoor Lighting:

- 82% of facilities have outdoor lighting
- 22% of those with outdoor lighting use metal halide fixtures, all controlled by photocells
- 55% use high pressure sodium fixtures, five of the six sites controlling some or all of their lamps by photocells

Heating:

- 91% of facilities heat their entire space
- 75% heat with a boiler (water)
- 75% use oil for the primary heating fuel
- 86% conduct maintenance of their burners once a year, as do 75% for boilers, 33% for chimneys, and 63% for calibration or adjustment of controls
- 25% train operators upon installation of the system
- 25% commissioned the system when installed, 25% of whom used an independent, third party commissioning agent
- 100% have never retro-commissioned the equipment
- 75% have insulated heating hot water pipes

- 13% have programmable thermostats

Cooling:

- 64% of facilities have a cooling system
- 86% of those with cooling systems have a unitary air system
- 66% of the unitary air systems are split systems
- 14% of those with cooling systems have central chiller equipment present
- 66% of those with cooling systems conduct maintenance once a year
- 17% of those with cooling systems trained operators upon installation of the system
- 20% of those with cooling systems commissioned the system when installed, none of whom used an independent, third party commissioning agent
- 100% of those with cooling systems have never retro-commissioned the equipment
- 20% of those with cooling systems have programmable thermostats
- 17% of those with cooling systems have an economizer, 100% of whom use a dry-bulb type

Ventilation:

- 27% of facilities have a ventilation or air handling unit present
- 33% of those with ventilation systems handle outside air
- 0% of those handling outside air handle a variable air volume
- 0% of those with ventilation systems have programmable thermostats

Motors and Air Compressors:

- One facility has one motor 2 to 10 horsepower
- One facility has three motors 10 to 75 horsepower
- Two of the three motors with control data have no speed control of any sort
- No facilities have motors 75 horsepower or greater
- Two facilities have a total of five air compressor under 5 hp, reciprocating motors, with load/no load controls
- Two facilities have a total of three air compressors 5-10 hp, two are reciprocating motors, all three have load/no load control
- One facility has five air compressors over 10 hp, of which three are reciprocating motors and two are rotary screw

Domestic Hot Water:

- 73% of facilities have a domestic hot water (DHW) system
- 25% with a DHW system have a heat exchanger from boiler inside building
- 60% with separate storage tanks have insulated tanks
- 25% have insulated pipes

On-site Generation:

- 36% of facilities have on-site generation
- 33% of those with generation have diesel engines
- 75% of those with generation have it for emergencies

Participation in Efficiency Vermont (EVT):

- 14% of facilities were participating in EVT programs at the time of the on-site
- 55% had previously participated in EVT programs

Summary Across the VT C&I Market/Activity Categories

Table 8.56 provides a summary across the five commercial construction market/activity groups. Cells are designated with an "H" if the group had the highest proportion of facilities with the given efficiency item, or if the group's proportion was close to the highest proportion. One low-efficiency item is included in the table—T12 lamps with magnetic ballasts—to provide a contrast with the more efficient lighting types.

TABLE 8.56 - DESIGNATION OF GROUPS WITH HIGHEST PROPORTION OF FACILITIES HAVING EFFICIENCY ITEMS

HIGHEST PROPORTION OF FACILITIES HAVING EFFICIENCY ITEMS	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
Double-pane Windows	H	H	H		
Low-emissivity Windows	H				
On/Off Photocells	H	H	H	H	
Foundation Insulation High R-Value	H		H	H	
Wall Insulation High R-Value		H		H	
Roof Insulation High R-Value	H	H			
T8 Lamps, Electronic Ballasts	H		H	H	
T12 Lamps, Magnetic Ballasts					H
HID Lamps, Pulse Start	H				
HID Lamps, Non-pulse Start		H	H		

LED Exit Signs				H	
HID Outdoor Lamps					H
Metal Halide Outdoor Lamps	H	H			
Operator Training Upon Heating System Installation	H		H	H	
Heating System Commissioned by Independent Third Party	H			H	
Heating Pipes Insulated	H		H		H
Programmable Thermostat for Heating	H				
Programmable Thermostat for Cooling	H		H		
Economizer for Cooling	H			H	
Ventilation System with Variable Volume Outside Air	H		H	H	
2 to 10 HP Motors High Efficiency	H				
2 to 10 HP Motors Variable Speed Drive Control				H	
10 to 75 HP Motors High Efficiency	H			H	
10 to 75 HP Motors Variable Speed Drive Control	H				
Over 75 HP Motors High Efficiency				H	
Heat Exchanger from Boiler		H			
Instantaneous Point-of-Use Water Heater		H			
Insulated Water Heater Storage Tank	H	H	H		
Water Pipes Insulated	H				
Total Efficiency Items Designated "H"	20	9	10	12	2
Inefficient Item Designated "H"	0	0	0	0	1

As shown in the table, facilities with new construction, Act 250 projects had the most efficiency items installed by comparatively high proportions of the group. This group is followed by facilities with renovation, non-Act 250 projects. Facilities with new construction, non-Act 250 projects and with renovation, Act 250 projects were comparable in number of efficiency items installed by comparatively high proportions of firms. Facilities with equipment replacement projects had comparatively low proportions of facilities with the efficiency items, with the exception of insulated heating system pipes.

Missed Opportunities

Table 8.57 gives the proportion of facilities in each group for which field engineers identified one or more missed opportunities. Note that any given opportunity might be small; for example, a single inefficient lamp constitutes a lighting missed opportunity. The proportions in the table do not indicate that the missed opportunities were extensive, but simply that they were present, to whatever degree.

The renovation, Act 250 group had the fewest proportion of facilities with missed opportunities identified (57%). This was followed by the renovation, non-Act 250 group and the new construction, Act 250 group, whose proportions of facilities with missed opportunities are comparable (73% and 75%). The new construction, non-Act 250 group had 83% of its facilities with missed opportunities identified, and the equipment replacement group had 91% of its facilities with missed opportunities noted.

TABLE 8.57 - MISSED OPPORTUNITY SUMMARY

MISSED OPPORTUNITIES	NEW CONSTRUCTION		RENOVATION		EQUIPMENT
	ACT 250 (N=24)	NON (N=12)	ACT 250 (N=14)	NON (N=15)	NON (N=11)
One or More Opportunities Identified	75%	83%	57%	73%	91%
Indoor Lighting Opportunities Identified	46%	58%	36%	53%	64%

Outdoor Lighting Opps. identified	9%	9%	0%	29%	22%
Heating Opps. Identified	42%	42%	36%	53%	55%
DHW Opps. Identified as Percent of Those with DHW	29%	50%	36%	60%	75%

COMPARISON OF DATA FROM ON-SITE AND TELEPHONE SURVEYS

A critical element of this on-site data analysis effort involved a comparison of the data collected on-site with the self-reported data (obtained during the end-user telephone surveys). This comparison was made based on the assumption that the on-site data, collected by field engineers, would have a higher level of accuracy. In this section, we present our findings.

The on-site responses are more accurate than the phone responses due to the training of the field staff and their fewness in number, which led to standardized interpretations. In addition, for the on-site surveys, multiple questions involving each issue were addressed – giving the surveyor the opportunity to examine consistency within groups (*i.e.*, heating, cooling, etc). Nonetheless, throughout this comparison, the reader should bear in mind that while the site data are extensive and represent a high degree of accuracy, they are not irrefutable. The data analysis uncovered a few cases where questionable data existed among the on-site responses.

Identification and Discussion of Discrepancies

During our comparison, discrepancies were identified in the following areas:

- Building characteristics reported/observed
    - Principal business activity
    - Building age
    - Building size
- Project size reported/observed
- Efficiency measures reported/observed

Specific discrepancies within each of these areas are discussed below.

Among responses to *principal business activity* at the surveyed site, there were 25 (out of 76) discrepant cases. A close examination, however, shows that most of the differences were non-substantive and can be attributable to

interpretation. Matters of interpretation include whether an office is "truly" a public building or a public building is truly an office, or whether a building that the occupant described as an office or a public building might be more accurately considered as "other—nonspecified". Table 8.58 presents the discrepant building type descriptions.

TABLE 8.58 - DISCREPANT BUILDING USE REPORTS

SELF-REPORT	ON-SITE REPORT	NUMBER OF CASES
Office or Public Building	Public Building or Office or Other	11
Warehouse	Industrial	6
School	Public Building or Other	2
Industrial	Public Building or Other	2
Warehouse	Retail	2
Office	Industrial	1
Retail	Other	1

For six cases, there was a discrepancy between whether a site is a warehouse (via self-reports) or truly an industrial building (from the on-site). According to self-reports, 17 of the surveyed sites were warehouses and 16 were industrial, whereas the on-site findings indicate that 11 are warehouses and 22 are industrial facilities. However, the possibility remains that the designation of the facility is, again, open to interpretation. Follow-up analysis of the on-site data set could shed light on this issue by examining the equipment stock reported by the facilities in question and assessing whether "warehouse" is within the realm of interpretation or inaccurate with respect to the purposes of energy analysis.

As shown in 8.59, the comparison found 15 cases where the on-site and self-reported *age of facility* differed. For 13 of the 15 cases, the on-site survey identified a younger building age than was reported by the occupant.

TABLE 8.59 - DISCREPANT BUILDING AGE REPORTS

SELF-REPORT	ON-SITE REPORT	NUMBER OF CASES
More than 20 Years Old	Less than 5 years old	7
More than 20 Years Old	5 to 20 years old	2
5 to 20 Years Old	Less than 5 years old	4
5 to 20 Years Old	More than 20 years old	1
Less than 5 Years Old	More than 20 years old	1

Only one type of building characteristic discrepancy appears to have implications for an energy-related analysis, such as in the current study. The *size of the industrial stock* is potentially quite significant. Some occupants may have significantly underestimated the size of their facility. The comparison found 13 cases where the two sets of data differ; in nine of these cases, the field engineer found a larger establishment than the occupant reported. Three of the nine cases are offset by three discrepant cases in the opposite direction, for a net discrepancy of six cases where the occupant understated the building size (out of 76, or 8%) and one case where the occupant overstated it. Table 8.60 shows the discrepant responses that are not offset by a mirror discrepant response in the opposite direction.

TABLE 8.60 - DISCREPANT BUILDING SIZE REPORTS

SELF-REPORT	ON-SITE REPORT	NET NUMBER OF CASES
Less than 5,000 SF	5,000 to 10,000 SF	1
Less than 5,000 SF	10,000 to 25,000 SF	3
Less than 5,000 SF	25,000 to 50,000 SF	1
5,000 to 10,000 SF	75,000 to 100,000 SF	1
More than 75,000 SF	10,000 to 25,000 SF	1

Project size had fewer discrepancies than facility size. Discrepancies were found for six cases, two of which were mirror opposites and so offset each other. Table 8.61 gives the other discrepancies.

TABLE 8.61 - DISCREPANT PROJECT SIZE REPORTS

SELF-REPORT	ON-SITE REPORT	NET NUMBER OF CASES
Less than 5,000 SF	5,000 to 10,000 SF	2
Less than 5,000 SF	10,000 to 25,000 SF	1
25,000 to 75,000 SF	5,000 to 10,000 SF	1

For ten *efficiency measures* that were directly comparable in the two data sets, Table 8.62 identifies the incidence of discrepancies between the phone and on-site data.

TABLE 8.62 - DISCREPANT EFFICIENCY MEASURE REPORTS

EFFICIENCY MEASURE	PHONE: YES ON-SITE: NO	PHONE: NO ON-SITE: YES	NET NUMBER OF CASES
PHONE SURVEY OVER-REPORTED INCIDENCE OF MEASURE			
Programmable Thermostat	12	3	9
Low E Glass	9	0	9
Condensing Furnace	9	1	8
CFLs	9	5	4
LED Exit Signs	9	5	4
PHONE SURVEY UNDER-REPORTED INCIDENCE OF MEASURE			
Daylighting Features	0	25	25
T-8 Lamps	3	13	10
PHONE SURVEY APPROXIMATELY ACCURATE ON INCIDENCE OF MEASURE			
Electronic Ballasts	6	5	1
Economizer	3	3	0

Variable Frequency Drives	1	1	0

Twenty-five phone respondents—33% of the sample of 76 cases with on-site data—incorrectly identified whether they had daylighting features. We conclude that phone respondents have a very poor understanding of what constitutes "daylighting features". This is consistent with our findings from the end user phone survey: about 40% stated they were not aware of the measure.

Between 18% and 21% of the sample incorrectly identified whether they had T-8 lamps, programmable thermostats, CFLs, and LEDs. This level of misidentification—approximately 1 in 5—suggests some confusion about the terms (especially in the case of T-8 lamps, of which 47% of end users with permitted projects were aware), but does not have alarming implications for the phone survey findings. The figure might be higher than one would hope, but within the range that one might reasonably expect from respondents that, unlike those of us involved in the study, are not professionals in energy efficiency. (Consider the case of programmable thermostats, the most over-reported measure. Twelve respondents incorrectly said they had one. However, many of these respondents indeed had an energy management system with programmable features.)

Between 12% and 14% of the sample incorrectly identified whether they had electronic ballasts, Low-E glass, or condensing furnaces. The most accurate responses were for economizers (8% error) and variable frequency drives (3% error). The results for condensing furnace and economizers are unexpectedly low given the rate at which phone respondents were aware of these measures (about 50% awareness).

We conclude that it does not make sense to ask end users to report on whether or not they have daylighting features. For the other efficiency measures, end users are reasonably good reporters.

RECOMMENDATIONS FOR FURTHER RESEARCH

The on-site data set has a wealth of detailed information about equipment and building stock from a select, small sample of facilities that have recently been involved in new construction, renovation, and/or equipment replacement activities. We believe that the DPS and EVT should take advantage of this wealth and explore questions beyond the scope of this current evaluation effort. Given the large amount of data, we caution that the investigation should be carefully described at the outset of any further analysis. The analyst should approach the task with a clear understanding of the questions to be answered, how the answers will be used, and the level of detail desired.

Our second recommendation concerns additional data collection that might be of value to the DPS and EVT. Due to the small number of refrigeration units in the 76 on-site surveys and the variation found in types of systems, we were unable to draw any conclusions. However, since business types such as groceries and food service establishments have heavy refrigeration loads, it might be useful to collect on-site data from more of these facilities. Results could then be used to suggest energy efficiency opportunities for this end-use on a sector-by-sector basis.

9. CONCLUSIONS AND RECOMMENDATIONS

The Vermont building and construction professionals and the commercial and industrial (C&I) firms who use these professionals for their building and construction needs reflect the unique characteristics of Vermont's location and geographic environment. In total, there are about 20,000 C&I firms in the state; about 3,000 of these are large, occupying 25,000 square feet or more. To put Vermont's C&I stock in perspective, a nearby out-of-state utility serving an area about half the size of Vermont has approximately 4,000 large C&I accounts.

Large firms are scattered evenly about the state. Larger construction projects are more likely to occur in Chittenden County, primarily because the large firms in Chittenden County were more likely than large firms elsewhere to engage in construction projects, and their projects typically were large.

Vermont's building and construction designers, contractors, and suppliers seize the opportunities that present themselves: large or small projects, commercial or industrial or residential clients, nearby or farther away, new construction, renovation or remodeling. In Vermont's comparatively small C&I market, research through this study is showing word-of-mouth communication and social networks are particularly important.

We have found larger construction projects and larger firms are more likely than small and medium-size projects and firms to install energy efficiency measures. However, we have also found the interactions with professionals used on a project contributes on average at least as much as—and, in some cases, more than—size to the determination of the number of efficiency measures used.[76] Finally, using statistical regression analysis, we found use of EVT services makes a positive contribution to the number of energy efficiency

[76] C&I firms installed more efficiency measures, on average, when they discussed energy use with mechanical engineers, or with architects, and general contractors, than when such conversations did not take place. In addition, the more professionals consulted on a project, the greater the number of efficiency measures installed.

measures installed in projects. We expect the measured influence of EVT for a sample of projects that received permits after EVT's establishment would be even larger than the influence measured for the current sample, which received permits in 1998 and 1999.

The goals of the efficiency utility include achieving an equitable distribution of services to customers across the state, and EVT has been reaching out to large, medium and small firms throughout its first three years. However, small C&I firms are considered among the most hard to reach customers.[77]

We believe the following characteristics and conditions result in larger projects and firms installing more efficiency measures than smaller ones:

- Larger firms have more capital, and more access to capital, which enables them to cover higher initial costs of efficient equipment more easily than smaller firms can.
- Larger firms have more staff and thus more staff time available to oversee and make decisions about project and equipment specifications than smaller firms have.
- Larger firms have more staff and thus have more specialized staff; larger firms are more likely to have one or more staff members experienced in construction or knowledgeable about construction alternatives.
- Larger projects are more complex than smaller projects, and so bring together more professionals. The larger the number of professionals consulted, the more likely it is that one will encounter a professional that strongly encourages energy efficiency.
- Larger projects have more opportunity to install efficiency measures as they include more varieties of lighting, HVAC equipment, and so

[77] The California Public Utility Commission defined small businesses as an underserved community subsequent to a filing in 1998 by the California Board for Energy Efficiency. Advice Letter IG/IE in TecMRKT Works, July 2001.

on, and have a greater need for such measures as energy management systems.

- Larger firms have been targeted by the EVT business development group.

Although we found larger C&I firms and larger construction projects install more efficiency measures, we did not find evidence, either in these end user or the market actor surveys, that larger professional firms are more likely than smaller professional firms to encourage the use of energy efficiency. We do *not* see evidence to support a theory that in Vermont large professional firms work with large customers on large projects and promote energy efficiency nor do we see small professional firms working primarily with small customers on small projects.

We *do*, instead, see evidence of the use of social and professional networks for Vermont construction activities: people tend to work with the people they know or are familiar with, and this familiarity promotes a feeling of trust prior to the establishment of the working relationship.[78] It is our opinion that the small size of the construction market in Vermont makes it possible and indeed, highly likely, that most commercial construction professionals in good standing are qualified to work on most commercial construction projects done in the state. It is the exceptional project that would require more expertise than is available from the typical, competent local building and construction professional.

In Vermont, we hypothesize one's social network can extend through most of the state. Consistent with this, we did not find a relationship between location within the state and the number of energy efficiency measures installed in permitted construction projects.

[78] Personal communication on social and professional networks with John Reed and Nick Hall of TecMRKT works, a firm that has examined social networks operating in the California building and construction community. Their research suggests that social networks are significant in urban and suburban areas. However, they also found that social networks in urban areas were more likely to include similarly sized and skilled firms within a network; larger firms working together, medium sized firms working together, etc.

We also found the rate of discussion of efficiency measures between professionals and the C&I firm affect their installation in projects. That is, most efficiency measures that are discussed with a building and construction professional are implemented; there is *not* a lot of discussion in excess of implementation. We have also identified that the rate of awareness of efficiency measures among respondents does *not* affect their discussion in projects.[79]

Because of these findings, we hypothesize in many cases it is *the building and construction professional* that initiates effective discussions of efficiency options, rather than the building owner. We further hypothesize *the rate at which professionals initiate discussion of efficiency options affects the rate of installation of efficiency options*. We believe EVT can stimulate this process and encourage efficiency to penetrate more broadly into the market.

A theory of social networks was not incorporated in the design of this initial research and so we did not approach the study with this premise to be tested. Nonetheless, the findings from this research consistently point to benefits that will accrue to energy efficiency if EVT can increase communication with equipment contractors and distributors about energy efficiency solutions and help these market actors engage more effectively with C&I firms.

The architects and engineers have had a great deal of exposure to these new ideas. They have been the primary users of EVT educational efforts, attending the Better Buildings By Design conference and using EVT design support services. Architects and engineers typically respond they have experience and knowledge of efficient solutions.

The rest of the building and construction community in Vermont is just beginning to learn about energy efficiency solutions.

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[79] Clearly, *after the installation of an efficiency measure,* the respondent is aware of the measure. However, the respondent need not have been aware of a measure *prior* to a discussion with a professional. The respondent could have learned about the efficiency measure during the discussion of equipment options. Thus, a customer's *a priori* awareness does not need to limit *a posteriori* awareness and equipment installation. This is confirmed in data presented in the chapter on C&I firms, which shows that awareness of efficiency measures is higher among respondents with no permits that have installed equipment than those who have not installed equipment.

The conclusions and recommendations below are structured in two sets. The first set identifies opportunities for EVT to increase building and construction professionals' knowledge and communication skills so that the social networks in Vermont can further the effectiveness of EVT and expand EVTs reach to medium and smaller sized businesses. The second set of conclusions and recommendations concerns additional research that will enhance this first evaluative effort and ultimately will further EVT's opportunity for success.

PROGRAM CONCLUSIONS AND RECOMMENDATIONS

1. Impacts on C&I Firms' Energy-Efficiency Decisions

CONCLUSION: EVT is successfully reaching those who design and build new and existing building and construction projects throughout the State of Vermont and having a sound influence on the decision to invest in energy efficiency. Participation in the program has exceeded program goals and Vermont residents have responded positively to EVT efforts. We found evidence that the largest firms, which have been a target of EVT efforts, have responded and are installing more measures than other firms.

> ***Recommendation:*** **EVT should continue its incentives, promotion, and outreach efforts.** Clearly the approach has been effective and rebates as well as training and education are important tools for increasing the efficiency of Vermont buildings.

2. Statewide Services

CONCLUSION: EVT services appear to be reaching all areas of the state. However, technical assistance for non-Act 250 projects is one service that is having less reach to the rural and small urban areas.

> ***Recommendation:*** **EVT should increase technical assistance offerings in rural and small urban areas**. Options include holding technical assistance meetings in rural or small urban communities on an occasional basis or locating staff in other areas of the state who can facilitate access to EVT services.

3. Educating C&I Construction Service Providers

CONCLUSION: When C&I firms discuss energy use with their mechanical engineers, architects and general contractors they are more likely to install energy efficiency equipment than if they discuss energy use with other professionals or do not discuss energy use at all.

> ***Recommendation:*** **EVT should continue to work with mechanical engineers, architects and general contractors to expand their knowledge of and skills with energy efficiency solutions and their capability to discuss energy use and efficiency with their customers, C&I firms.** One option for doing this would be to continue to expand sessions at the Better Buildings by Design conference that are specifically focused on how to talk to the skeptical client or contractor about energy efficiency solutions.

CONCLUSION: We confirmed building professionals talk with customers about the project and influence customers' decisions. We also confirmed each project tends to have a different mix of professionals involved. Furthermore, efficiency measure installation is affected by the rate at which the measure is discussed with a professional. Since mechanical engineers and architects are among the least frequently used on a project (though most effective regarding energy efficiency), other building professionals need to become messengers for energy efficiency if efficiency is to reach more broadly into medium and small permitted and non-permitted construction projects in Vermont.

> ***Recommendation:*** **EVT should follow-through with plans to expand their educational efforts with electrical and mechanical contractors and with real estate developers.** One tool for doing this is to expand the offerings of the Better Buildings by Design conference to have sessions that target these professionals role in the construction process. The sessions should seek to motivate the professionals to pursue energy efficiency and should provide them with information on how they can effectively use energy efficiency solutions and talk to other professionals and C&I firms about energy efficient solutions.

4. Equipment Suppliers and Manufacturers

CONCLUSION: Engineers identified equipment suppliers as one of the two parties that most influence equipment decisions. Yet we found equipment suppliers to be among the least informed market actors in Vermont. This suggests suppliers are not being educated by the manufacturers and that designers, contractors and C&I firms are not demanding energy efficiency solutions from the suppliers.

> ***Recommendation:*** **EVT should continue and expand efforts to work with suppliers to increase their knowledge of energy efficient equipment, their motivation to provide it, and their awareness of EVT services so that they can more effectively work with other building and construction professionals and provide energy efficient equipment**. EVT's continued work with regional and national organizations that work with manufacturers will also further the upstream education of suppliers by manufacturers.

5. Lighting

CONCLUSION: Many C&I firms seek high "quality" lighting; while some interview respondents equate energy-efficient lighting with high quality, an equal proportion explicitly described it as being of low quality. We also found real estate developers to consider the efficient lighting equipment to be too costly.

> ***Recommendation:*** **EVT should continue to offer rebates to address cost concerns, and continue to actively promote the DesignLights Consortium's Knowhow™ educational lighting guidelines series.** In additional, EVT should go forward with plans to more aggressively promote comprehensive lighting efficiency services and incentives under its "comprehensive track", and consider creating a lighting design lab or demonstration site.

RESEARCH RECOMMENDATIONS

The current report documents an extensive data collection and analysis process designed to better understand the market characteristics and

structure in which EVT is providing energy efficiency services to C&I firms in Vermont. The research has successfully achieved this goal while at the same time obtaining initial assessments of EVT process from market actors and C&I firms. The following form our recommendations for next steps in the research process.

1. Process Evaluation 2003-04

CONCLUSION: In 2003 EVT plans to embark on a new effort to take a market focus and to reach out to trade allies. The value of this is likely to be quite high, given the market characteristics and structure identified in this study. At the same time, as the program seeks to accomplish a deeper reach into the construction and building market in Vermont, it will be important to ensure the program is maximally effective.

> ***Recommendation:*** **Throughout 2003 and 2004, it will be of great value to conduct a process evaluation to explore whether the program process is successfully reaching and influencing market participants to increase their use of energy efficiency technologies and practices.**

2. Opinion Leader Research

CONCLUSION: The role of social networks and word of mouth communication is not well understood for the Vermont market. We anticipate a better understanding of who the opinion leaders are for the building and construction community would provide EVT with a very effective tool for reaching out to and influencing the Vermont building and construction community.

> ***Recommendation:*** **Research should be conducted directly with market participants who have had contact with EVT.** This work should begin by reviewing the EVT database to determine how many unique market actors have used EVT services and where the market actors are located. Then a sample of interviews could be conducted to obtain more detailed information on program process issues, how they came to learn about EVT, how they worked with others on their team, and how they believe EVT can reach other firms in Vermont.

3. Supplier Research

CONCLUSION: EVT and DPS may want a better estimate of baseline market conditions for key products offered by suppliers. Phase I data about suppliers are weak because the suppliers were particularly hard to reach and sample sizes were small.

> ***Recommendation:*** **Future supplier research should focus on the measures actively being promoted by EVT or expected to have good potential.** Experience elsewhere has shown suppliers and manufacturers rarely cooperate with studies seeking detailed information on their inventories in the absence of monetary compensation. For a research strategy focused solely on Vermont suppliers to be cost effective the inquiry should focus on a limited number of equipment options; thus an investigation of the items most relevant to EVT's activities would be recommended. Alternatively, EVT or the DPS should participate in various regional and national efforts being considered to track product market shares by state. This would provide economies of scale that cannot be achieved in a single state study.

4. Market Indicator Study

CONCLUSION: The current, comprehensive study provides a market assessment and baseline assessment of EVT's initial C&I program efforts including identification of key market progress tracking indicators. In 2004 or 2005, a second study will need to determine, in comparison with the baseline results, if EVT has helped the market expand its knowledge, awareness, and use of energy efficient solutions.

> ***Recommendation:*** **The next market study should focus on market indicators of energy efficiency improvements and include samples of designers contractors, suppliers, C&I firms, and real estate professionals, as interviewed for the current study.**

5. Act 250 Impacts Study

CONCLUSION: Of the professionals and C&I firms that had engaged in the Act 250 process for at least one project, we found about as many who felt Act 250

had improved the energy efficiency of the project as felt that the project had not been affected. There are a variety of possible explanations for this, which could not be sorted out in this study. Act 250 has been in place since 1970. Understanding the effects of Act 250 on energy efficiency would require a study focused on Act 250, perhaps longitudinal and possibly comparing the efficiency of buildings in Vermont with a similar state, such as New Hampshire, that does not have a similar law. Nonetheless, there are interactions between Act 250, the new design guidelines for Act 250 projects and the efforts of EVT to work with Act 250 projects teams.

> ***Recommendation:*** **Additional effort to understand the effects of Act 250 on energy efficiency should be conducted in separate studies from this evaluation of EVT.** The evaluation should include an examination of the effect of EVT efforts with Act 250 projects.

6. Other Recommended Evaluation Priorities for 2003-04

CONCLUSION: In addition to the recommendations noted above a number of other research activities are planned for the 2003-2004 time period. These include a strategic impact and realization rate assessment and an informal and ad hoc utilization of data gathered through this evaluation to further assess market sectors, barriers, EVT services and opportunities on an ongoing basis to improve energy efficiency knowledge, infrastructure and services within Vermont.

> ***Recommendation:*** **Conduct these ancillary research activities.**

BASELINE MEASUREMENTS FOR MARKET INDICATORS

This section describes the market indicators that we consider viable to track and the baseline measures obtained in this research. We identify these measures as viable because they demonstrate significant opportunity for change as they are generally occurring at a low level. In addition, the

measures are those that can be tracked at a reasonable cost and relate to behaviors targeted by EVT programs.[80]

There are very few differences that can be discerned from the practices of market actors or real estate professionals between existing buildings and new construction. However, responses at the C&I firm level did show distinctions between new construction and existing buildings, largely owing to the large samples we had available. Therefore, the market indicators given below for market actors and real estate professionals do not distinguish between the two submarkets, while those for C&I firms differentiate between new construction and existing buildings.

The market indicators are given in Tables 9.1 through 9.4.[81, 82] In addition, one other market indicator should be considered: awareness of the ASHRAE standards. The fact that we found limited awareness of the ASHRAE standards outside of engineers and architects suggests tracking the awareness of ASHRAE standards could be useful. On the other hand, with the advent of the 2001 Vermont Guidelines for Energy Efficient Commercial Construction, we suspect those currently unaware of ASHRAE may become aware of the guidelines without realizing the role of the ASHRAE standards. If awareness of the guidelines is accepted as a market indicator for engineers, architects, general contractors, and electrical and mechanical contractors, we believe for each market group the baseline measure is less than 5%.

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80 The DPS may choose to modify this list if some measures are not to be targeted by EVT. Additions to the list might be warranted if additional data are collected, such as tracking the actual product sales of suppliers. The indicators recommended herein for suppliers focus on availability and awareness.

81 These market indicators will be augmented as warranted with information obtained from the on-site surveys.

82 One might seek to improve the accuracy of the market indicators by using sales data instead of self-reported data. However, experience elsewhere has shown that suppliers and manufacturers rarely cooperate with studies seeking detailed information on their inventories in the absence of monetary compensation.

Table 9.1

INDICATORS FOR DESIGNERS

MARKET PARTICIPANT	INDICATOR	BASELINE MEASURE: PERCENT OF DESIGNERS	COMMENT
Architects	Awareness of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%	These guidelines are based on ASHRAE 90.1, 1999 and were just adopted at the end of 2001
	Use of day lighting strategy in design practice	35% of architects on at least 5% of projects a year	Expect to also see number of projects increase
	Specify photo dimming to enhance day lighting	30% of architects on at least 5% of projects a year	Expect to also see number of projects increase
	Know SHGF rating generally specified for glazing	10% of architects for all projects	
	Use of lighting modeling for 75% of projects	23%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Use of third party agent for commissioning	23% of architects for at least one project a year	Expect to also see number of projects increase
Engineers	Awareness of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%	These guidelines are based on ASHRAE 90.1, 1999 and were just adopted at the end of 2001
	Specify photo dimming to enhance day lighting	10% of engineers on at least 5% of projects a year	Less than 40% of engineers are involved in day lighting design
	Specify efficient lighting controls, switching strategies, staging sequences, stepped controls	32%	About 60% of the engineers are involved in specifying lighting

	Specify variable air volume HVAC systems	13% of engineers on more than 35% of projects a year	75% of engineers specify HVAC equipment
	Use of energy use modeling for 25% of projects	25%	56% of engineers reported doing any modeling
	Use of third party agent for commissioning	12% of engineers on at least one project a year	Expect to also see number of projects increase

Table 9.2

INDICATORS FOR CONTRACTORS

MARKET PARTICIPANT	INDICATOR	BASELINE MEASURE: PERCENT OF CONTRACTORS	COMMENT
General Contractors	Awareness of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%	These guidelines are based on ASHRAE 90.1, 1999 and were just adopted at the end of 2001
	At least one project /year with day lighting components	15%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	At least one project/year using third party agent commissioning	26%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Percent of projects include specification for SHGF for glazing	38%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
Electrical Contractors	Awareness of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%	These guidelines are based on ASHRAE 90.1, 1999 and were just adopted at the end of 2001
	Energy management system	9%	Percent very experienced with technology on 5 point scale
	On-site generation	9%	Percent very experienced with technology on 5 point scale

MARKET PARTICIPANT	INDICATOR	BASELINE MEASURE: PERCENT OF CONTRACTORS	COMMENT
	Life-cycle costing	0%	Percent very experienced with technology on 5 point scale
	Third party agent commissioning	9%	Percent very experienced with technology on 5 point scale
	Automatic photo dimming	4%	Percent very experienced with technology on 5 point scale
	Building-wide lighting controls	13%	Percent very experienced with technology on 5 point scale
	T-5 lighting	13%	Percent very experienced with technology on 5 point scale
			Continued
Mechanical Contractors	Awareness of 2001 Vermont Guidelines for Energy Efficient Commercial Construction	< 5%	These guidelines are based on ASHRAE 90.1, 1999 and were just adopted at the end of 2001
	Experience with variable air volume systems	28%	Percent very experienced with technology on 5 point scale
	Onsite generation	5%	Percent very experienced with technology on 5 point scale
	Life cycle costing	13%	Percent very experienced with technology on 5 point scale
	Third party agent commissioning	13%	Percent very experienced with technology on 5 point scale

Table 9.3

INDICATORS FOR SUPPLIERS

MARKET PARTICIPANT	INDICATOR	BASELINE MEASURE: PERCENT OF SUPPLIERS	COMMENT
Electrical Equipment Suppliers	Photo-cells with dimming ballasts	43% of suppliers sell; equipment about 2% of sales	
	Controls with staged sequencing	57% of suppliers sell; equipment about 3% of sales	
	T-8 fixtures	100% of suppliers sell; equipment about 24% of sales	85% of suppliers sell T-12 fixtures; T-12 fixtures are 6.4% of sales.
	T-5 fixtures	57% of suppliers sell; equipment about 1% of total sales	
			Continued
HVAC Suppliers	Packaged or split system heat pumps 5.4 tons, SEER>13	Unknown	Insufficient sample to obtain measure
	Packaged or split system heat pumps or AC, 5.4-11.25 tons, EER>11	Unknown	Insufficient sample to obtain measure
	Dual enthalpy economizers	Unknown	Insufficient sample to obtain measure
Window Suppliers	Awareness of SHGF rating on products sold	Less than 10%	
Motor and VFD Suppliers	Knowledge of VFDs	80% below "4" on scale	Ten point scale, 1 is lowest, 10 highest

Table 9.4

INDICATORS FOR C&I FIRMS

TYPE OF PROJECT	INDICATOR	BASELINE MEASURE: PERCENT OF FIRMS	COMMENT
Permitted Projects	Discussed energy use with one or more professionals	55%	Would be important to also ask about energy efficiency discussions
	Occupancy sensors installed	19%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Programmable thermostats installed	52%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Economizer installed	25%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Energy Management System installed	18%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
			Continued
Non Permitted Projects	Discussed energy use with one or more professionals	Not measured	Would be important to ask about energy use and energy efficiency discussions
	Occupancy sensors installed	14%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Programmable thermostats installed	31%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Economizer installed	8%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Energy Management System installed	13%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.

TYPE OF PROJECT	INDICATOR	BASELINE MEASURE: PERCENT OF FIRMS	COMMENT
Real Estate Firms	Discussed energy use with one or more professionals	Not measured	Would be important to ask about energy use and energy efficiency discussions
	Low-E glass installed	60%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Occupancy sensors installed	38%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.
	Economizer installed	60%	Modify the question in the follow-up to provide way to estimate sq. ft. affected.