Another Link in the Chain: Characterizing the Wisconsin C&I HVAC Supply Market

Michael Rufo, Quantum Consulting, Inc.
Michael Sedmak, Quantum Consulting, Inc.
Philippus Willems, Quantum Consulting, Inc.

ABSTRACT

This paper presents result from market research on suppliers of equipment and services to the commercial and industrial (C/I) HVAC market for Wisconsin. The overall goal of the project is to help improve the effectiveness of Wisconsin Focus on Energy (WFOE) Business Programs activities by providing a better understanding of supply chain structures, product flows, and market actor practices, attitudes and information sources with regard to energy efficiency.

The paper summarizes findings from 66 HVAC supply chain interviews. Research issues include: (1) the relationships among supply chain actors and their relative importance to equipment selection and system specification, (2) identification of key business practices for product development, marketing, service and the extent to which energy efficiency is part of those practices, (3) assessment of the attitudes and perceptions of supply chain actors regarding the relative importance assigned to energy efficiency by their customers (either end users or downstream suppliers), (4) investigation of suppliers perceptions of the barriers to energy efficiency in HVAC systems, and (5) recommendations for further influencing the supply chain to increase the penetration of energy efficient products and services.

INTRODUCTION

Objectives and Scope

The overall goal of the project reported on in this paper is to help improve the Wisconsin Focus on Energy business programs by providing a better understanding of supply chain market structure and product flows; market actor roles; key business drivers and market actor practices; the role of energy efficiency; and market barriers. The project scope is limited to the supply-side of selected nonresidential markets. The in-scope end use markets for the project are HVAC, compressed air, and pumps. There are two industry segments being characterized as well: food and pulp and paper. In this paper, we present results from only the HVAC supply-side characterization.

Overview of Approach

The primary research conducted for this nonresidential HVAC supply-side market characterization consisted of in-depth interviews with industry experts, manufacturers, distributors, contractors, and designers. A careful review of the available literature also was conducted at the beginning of the project to develop a storyboard for the assessment and formulate research topics. As shown in Table 1, 66 in-depth interviews that were conducted during the Fall of 2002. The interviews were conducted in a step-wise fashion, beginning with the industry associations and manufacturers to refine the Project Team's understanding of the HVAC industry structure, and then moving through the distributor, contractor and design engineer interviews. Survey results were then analyzed and integrated

across market actors to produce an overall supply-side characterization for Wisconsin's nonresidential HVAC market.

Table 1. Breakdown of Nonresidential HVAC Industry Interviews

Market Actor	Number of Surveys
Industry Experts	6
Manufacturers	10
Distributors	10
Contractors	30
Designers	10
Total	66

Key C/I HVAC Supply Chain Characteristics

In this section we present our summaries of market structure, market size, product flow, and other key market characteristics. A critical objective of this study is to identify, quantify, and assess the importance of those aspects of the supply-side of the C/I market that affect and influence HVAC equipment and systems installed in Wisconsin. These results provide a necessary context for understanding and utilizing the subsequent findings on attitudes, practices, key business drivers, the role of energy efficiency, and market obstacles. Our results indicate that the following aspects of the C/I HVAC supply market are of critical importance:

- Market size and product flow among market actors through the supply chain
- Type of equipment (boilers, furnaces, chillers, and DX)
- Market event (new construction/major renovation, planned and emergency replacement)
- Bid structure (Plan and Specify versus Design/Build, direct award versus competitive bid)
- Importance and role of each market actor in HVAC decision-making

Estimates of Total Market Size, Equipment Breakdown, and Product Flow

Five manufacturers, Carrier, Trane, York, Lennox, and McQuay, account for virtually the entire commercial/industrial market for chillers, packaged A/C, and furnaces. Unlike the other C/I HVAC technologies, the manufacturer of boilers is relatively fragmented among over a dozen firms. For the Wisconsin market, we estimate that boilers and chillers represent roughly a combined 5,000 units per year (85 percent boilers) while furnaces and DX units represent roughly 25,000 units per year (split fairly evenly between both). Although boilers and chillers represent only 16 percent of the units sold, their fraction of heating and cooling capacity (and sales revenue) is much larger (on the order of 50 percent) because boilers and chillers are many times larger than furnaces and DX units per unit. The total size of the nonresidential HVAC equipment sales market in Wisconsin, in terms of revenue, is on the order of $125 to $175 million per year for the four types of units analyzed.

In Figure 1, we show the breakdown of major HVAC equipment shares by market actor. Note that the basis for the breakdowns shown is units for distributors and contractors and projects for designers. Units, in particular, is not a good proxy for revenue sales because boilers and chillers are typically at least an order of magnitude or more larger than furnaces and boilers (though the larger

equipment does cost less per unit of heating or cooling capacity). Distributors deal least often with chillers and boilers, which account for less than 10 percent of their units sold; while designers are involved with these equipment most often (roughly 40 percent of their projects on a relative basis). However, depending on how heavily one were to weight chillers and boilers from a revenue perspective as compared with furnaces and DX units, the share of revenues (from boilers and chillers combined) for distributors and contractors would be much higher than the fraction of units (likely in the range of 20 to 40 percent for distributors and 60 to 75 percent for contractors).

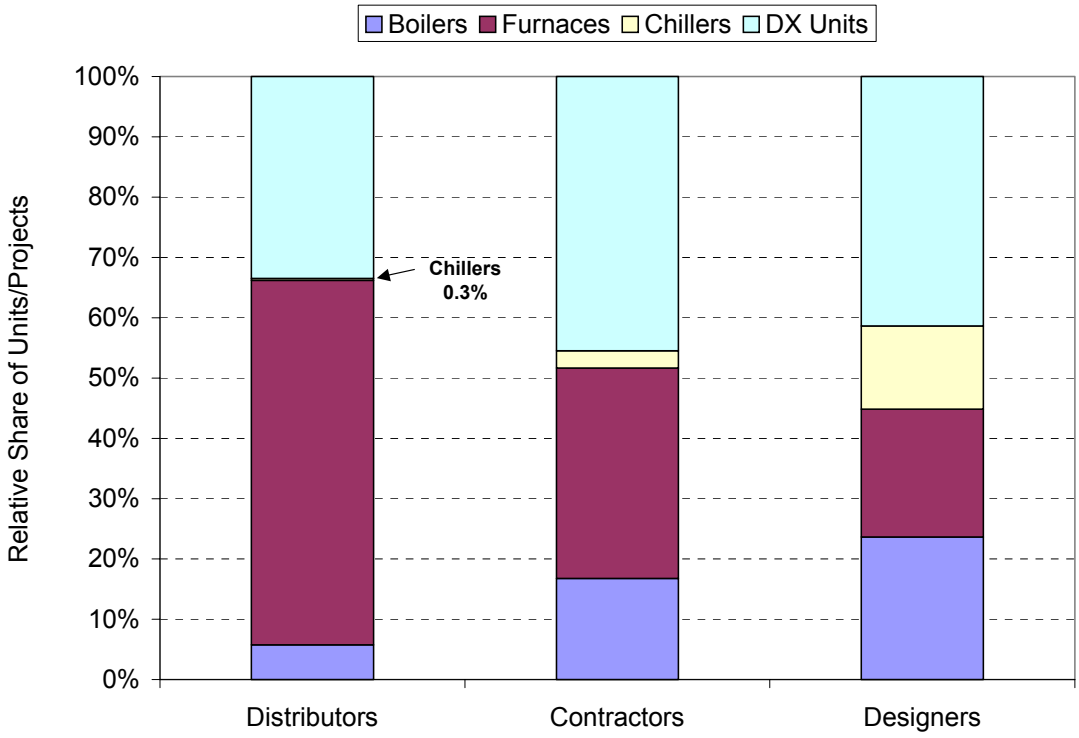
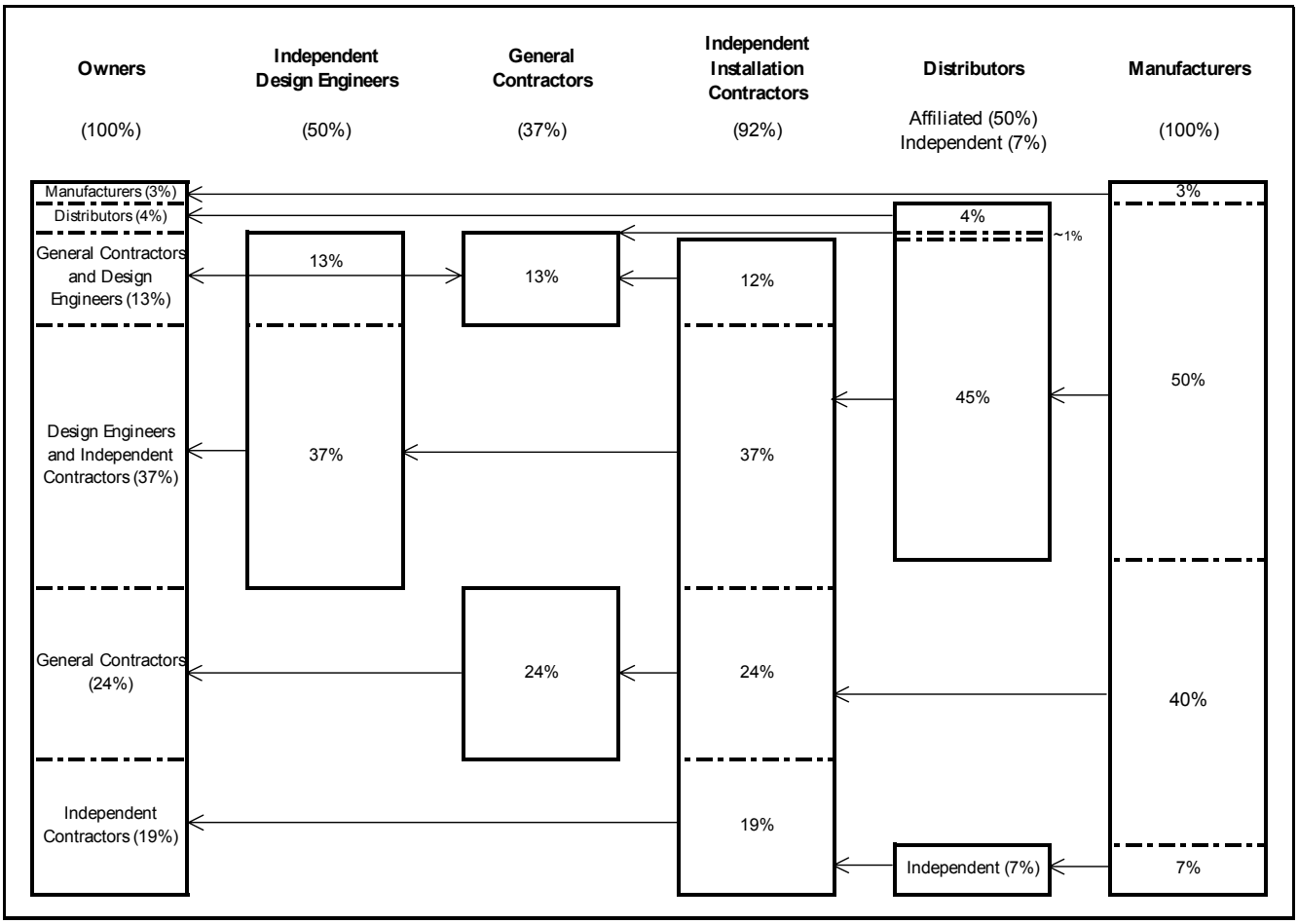


Figure 1. Relative Wisconsin C/I HVAC Equipment Shares by Market Actor
(Distributors and Contractors by Number of Units; Designers by Number of Projects)

Interviewee information was integrated to construct the overview of C/I HVAC industry product flow presented in Figure 2. While the level of involvement of each market actor group in HVAC delivery and installation varies by the type of project (e.g., new construction versus replacement), this overview provides a foundation for understanding (and influencing) the actions of firms operating in the HVAC industry.

We estimate that approximately 57 percent of the manufacturers' sales are to distributors, 40 percent directly to contractors, and 3 percent directly to facility owners. Over 90 percent of distributors' sales are to HVAC contractors, the remainder are direct to customers. HVAC Contractors account for over 90 percent of the equipment installed. HVAC Contractors work directly for the facility owner almost 45 percent of the time, and with developers 10 percent of the time. General contractors are involved in about 40 percent of the projects (primarily for new construction/major renovation and planned replacements). General contractors normally work directly with the facility owner. Designers are involved in approximately half of the nonresidential HVAC projects. Two-thirds of these projects are new construction; the remainder is planned replacement. Designers work for the facility owner 75 percent of the time and general contractors in their other projects.



Source: Analysis of market actor interview data. The method used to calculate these percentages is presented at the end of the report.

Figure 2. Wisconsin Nonresidential HVAC Product Flow

Market Event and Bid Structure

As we show in Figure 3, overall C/I HVAC sales for contractors in Wisconsin are roughly evenly split between new construction/renovation/remodeling and retrofit/replacements (contractors are a good proxy for the overall market since 92 percent of units pass through them). For the half of the market that is retrofit/replacement, emergency replacements make up 40 percent of the total and planned replacements 60 percent (thus, emergency replacements are 20 percent and planned replacements 30 percent of the total contractor market, respectively). The retrofit/replacement versus new construction/renovation/remodeling splits are fairly similar across major technology types, though boilers were reported to be more likely to be retrofit replacement and furnaces, chillers, and DX systems were more likely to be new construction/renovation/remodeling.

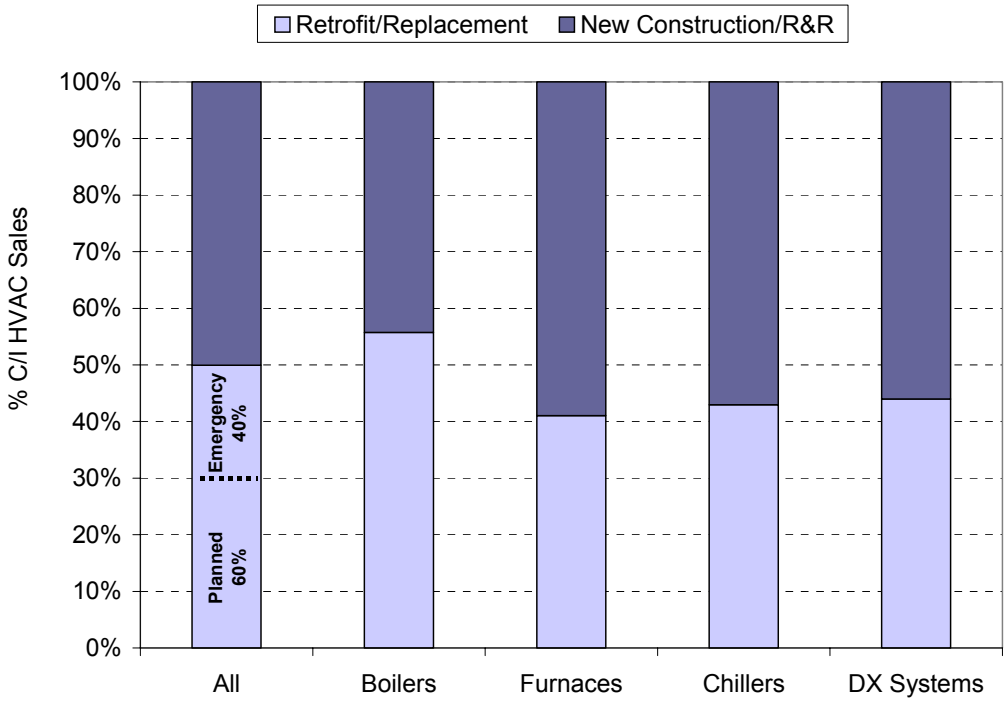


Figure 3. Breakdown of Wisconsin Contractor C/I HVAC Sales by Market Event

In addition to market event, bid structure can significantly affect the design process. For new construction and major renovation situations, the two most common bid structures are design-build (DB) and plan-specify. Under this DB model, the owner contracts with a design-build firm for all design and construction services. The DB contractor is then responsible for hiring and managing architects, mechanical engineers, contractors, and advisors as needed. With the plan-specify model, the owner contracts with an architectural or architectural/engineering (A/E) firm for all design services. The architect is then responsible for hiring and managing mechanical engineers and advisors as needed. A second contract is made between the owner and the general contractor for all construction services. Designers report that roughly half of new construction and 40 percent of major renovation projects are design-build.

Contractors typically obtain their work through either competitive bids or through direct awards. Directed contracts typically come from engineering firms or established relationships with customers. As shown in Figure 4, contractors reported competitively bidding for work half the time in retrofit situations and about 70 percent of the time in new construction.

The importance of both market event and bid structure to energy efficiency receptivity is summarized in Figure 5.

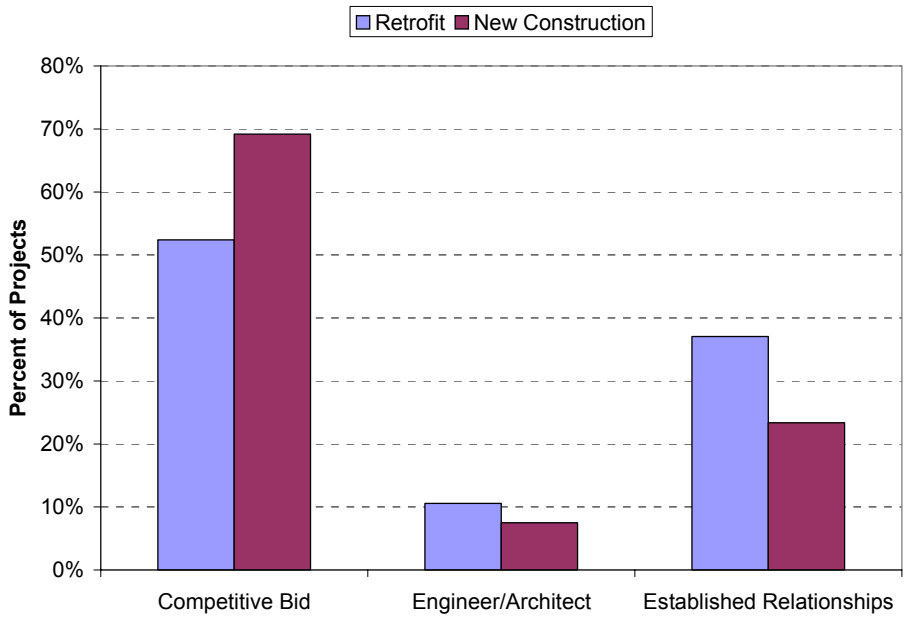


Figure 4. Contractors' Projects by Bid Versus Direct Award

Attribute	Competition In		Likelihood of EE HVAC Investment	Notes on Receptivity to Energy Efficient Investment
	Design	Install		
Market Event				
New Construction/Renovation	4	4	4	Longest planning horizon and greatest flexibility in design, incremental costs can be reduced via good design
Retrofit				
Planned Replacement	2	2	2	Longer planning horizon and more flexibility in design than emergency replacement
Emergency Replacement	1	2	1	No opportunity for design, competition is usually price only
Bid Structure				
"Plan and Spec"				
Bid/Design/Bid/Build	4	4	1	Most competitive, but most disjointed bid structure
Design/Bid/Build		4	2	Designers have more leeway here, get job on repeat business or referral
Bid Build		4	1 / 2	Primarily small planned or emergency replacement, depends on relationship
"Design/Build"				
Bid/Design/Build	4	--	2	Integrated bid by design/installation team
Design/Build	--	--	4	Noncompetive to design/build team, usually a preferred contractor
Build	--	--	1	Noncompetitive, no design; Small planned replacement, emergency replacement

4	High
2	Moderate
1	Low

Figure 5. Importance of Market Event and Bid Structure to Efficiency Receptivity

Decision-making Importance

The relative importance of each of the supply-side actors in influencing customers' choices of HVAC equipment and systems varies primarily by market event and project size. In Figure 6, we present a simplified summary of the relative importance of each of these market actors in providing equipment-related information and in directly influencing the equipment selection process. This summary of relative importance in determining equipment selection was developed from a set of questions in which each of the market actors was asked about the importance of each of the other members of the supply chain. Relative importance varies by market event, bid structure, and equipment size and system type.

Design engineers are most influential in large new construction and major renovation projects, less influential in planned replacements, and uninvolved in emergency replacements. Distributors generally are the least influential except when it comes to emergency replacement of equipment (in these cases, what the distributor has in stock often drives what is installed). Contractors are often influential across market events and even project size since they install the vast majority of systems and specify equipment when other market actors are uninvolved or default this responsibility to them. Nonetheless, they are generally not influential in large new construction/major renovation projects and can be very influential in small, emergency replacements.

The primary influence of HVAC manufacturers is on the other supply-side market actors, rather than the customer directly. The importance of this role should not be overlooked, however, since manufacturers are often the most knowledgeable and forward looking of the supply-side HVAC actors and influence end users through the other suppliers. Manufacturer interactions with all supply-side actors provide them with the channels needed to influence attitudes and actions.

		Supply-Side Market Actor				
Characteristic		Manufacturers	Distributors	Designers	General Contractors	HVAC Contractors
Market Event	New Construction/ Renovation	Low-Med	Low	**High**	**Med**	Low
	Planned Replacement	Low	Low	Low-Med	Low	**High**
	Emergency Replacement	Low-Med	**High**	Low	Low	**High**
Bid Structure	Plan and Specify	Low	Low	**High**	**Med**	Low
	Design Build	Low	Low	**Med**	**High**	**Med**
Tech/System	Large Projects & Boilers/Chillers	**Med**	Low	**High**	Low	**Med**
	Small Projects & Furnaces/DX	Low	Low	Low-Med	Low	**High**

Figure 6. Relative Importance Among Market Actors by Market Characteristic

Of course, customers, typically the owner, have the ultimate say in specifying certain aspects of equipment such as energy efficiency levels if they are active in the decision-making process; however, in many cases they rely on the recommendations of contractors or designers.

Key Business Drivers, Practices, and Role of Energy Efficiency

Drivers and Practices

Manufacturers and distributors were asked to discuss what they thought were the key issues driving the commercial/industrial HVAC market. The key issues identified were:

- downward pressure on prices because of a buyer's market economy;
- topping out of equipment-based efficiency improvements (with the exception of boilers);
- increasing interest in enhanced controls and systems approach to increasing HVAC efficiency;
- the slow economy leading customers to overhaul existing boilers rather than replace them;
- the significant effects of ASHRAE 90.1 on product lines;
- the importance of new refrigerants (though not significantly impacting efficiency); and
- demand for low NOx boilers in some markets (not Wisconsin).

In addition, each of the supply-side market actors were asked to identify the key factors that they believe differentiate themselves from their competitors, which are shown in Table 2.

Table 2. Distinguishing Business Features (Self-Reports, Unaided)

Manufacturers	Distributors	Contractors	Designers
• Energy efficiency • Reliability • Comfort • Serviceability • Noise level	For Firm: • Customer service • Long-term relationships • Quality of products • Tech support For Products: • Reliability • Energy efficiency • Noise level • Manufacturer's brand	For Firm: • Quality of work • Expertise of staff • Reputation of firm For Product Features: • Reliability/Serviceability • Controllability • Energy efficiency	For Firm: • Comprehensiveness of service • Quality of work • Use of customized approach For Equipment specs: • Reliability • Energy efficiency

HVAC manufacturers all stress energy efficiency, reliability, and serviceability, but to different degrees. All feel they have energy efficient products, and they distinguish themselves from each other through attributes like emphasis on full service solutions and depth and breadth of equipment offered. Manufacturers adjust their product offerings to the key decision-makers in different situations.

Distributors tend to emphasize the same key product features as manufacturers, while also emphasizing customer service and their ability to respond quickly to order requests. Establishing long-term reputations with their customers, through high-quality, reliable equipment and excellent customer service, was mentioned as the most important aspect of business success by all of the distributors. The

distributors are evenly divided between offering standard products and custom solutions, with four of the distributors offering mostly standard products, four offering mostly custom and/or complete solutions, and two offering a relatively even mix of standard and custom solutions.

For contractors, quality of work, expertise of staff in offering things such as creative design solutions, and the reputation of the firm were mentioned most as features that distinguish their firm. While all of the contractors mentioned service in some form, only two specifically mentioned customer value, and only one contractor volunteered that the long-term benefit of energy efficiency was stressed in their promotional efforts (another indicated they stress energy efficiency or low cost, depending on the customer's desires). Contractors most often stress the reliability and serviceability of their equipment when marketing commercial HVAC equipment (14 respondents). Contractors also tend to emphasize the controllability of the HVAC equipment, and long-term energy savings (6 each). Similarly, contractors say that customers ask for reliable products (14); timely, high-quality installations (5 and 4, respectively); performed by reputable firms with the expertise needed to complete a professional job (8); at a competitive price (4). Only three contractors volunteered that customers ask for energy efficient products.

In addition to providing excellent customer service, designers differentiate themselves from their competitors by providing individual attention to their clients, high technical quality, and integrated design and installation services. One of the ten designers interviewers stated that their focus on energy conservation was a distinguishing feature of their firm. When asked what equipment characteristics they considered most important when specifying HVAC equipment, reliability was mentioned by all of the designers, while half mentioned energy efficiency. Designers also reported that reliability was the attribute clients most often request in an HVAC system design (7 designers), followed by first cost (3), efficiency (2) and comfort (1). Designers prefer to specify reliable (not state-of-the-art) equipment (4) that is energy efficient if possible (3). Two also mentioned they use gas over electric whenever possible, because of lower operating costs.

Role of Energy Efficiency

As shown in Figure 7, when asked how often they promote/specify energy efficient equipment, almost all of the market actors reported that they did so at least half of the time. The majority (7 of the 10 distributors) indicated that they "almost always" take steps to promote energy efficient equipment, while the others indicated they promote energy efficient equipment "more than half of the time" (2) or "about half of the time" (1). Similarly, seven of the designers report they "almost always" specify HVAC equipment that is more efficient than code, with the other 3 specifying above-code equipment more than half the time. Contractors report promoting efficient equipment less often than distributors and designers but still report doing so in the majority (60 percent) of cases. As is often the case in this type of research, the responses to the energy efficiency promotion probe present a somewhat more positive impression of the role of efficiency in the market actors' practices than does their responses to the open-ended question on key business drivers and product attributes. This is most pronounced in the case of contractors.

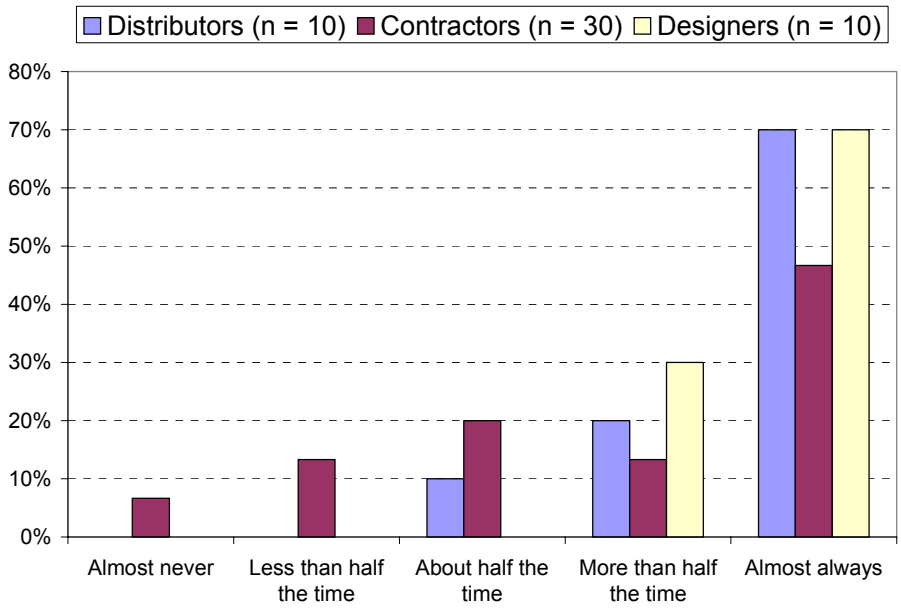


Figure 7. Frequency of Promoting/Specifying Energy Efficient Equipment
(Phrased as "How often do you promote energy efficiency?" for Distributors and Contractors; and "How often do you specify equipment more efficient than code?" for Designers)

Suppliers' Perceived Obstacles to C/I Efficiency and Suggested Solutions

Supply-side actors consistently perceive first-cost orientation to be the greatest end user obstacle to increased adoption of energy efficiency HVAC systems in Wisconsin's C/I sector. Lack of knowledge, lack of capital, reliability, and bidding and design process structures were also mentioned as significant barriers. The cost barrier is especially significant in competitive bid situations that involve multiple supply-side actors. As one contractor noted, when they bid through general contractors or architects they do not get the opportunity to provide the owner with the right information to make an educated decision about efficient products and services. In these situations, the general contractor controls the process and often looks, literally, only at price, with no recognition of the fact that higher cost systems provide owners with lower operating costs. Some suppliers also noted that cooling paybacks were often moderately high in Wisconsin (3 to 5 years) because of the low number of full-load cooling hours.

Suppliers believe that the keys to reducing end user barriers to adoption of efficient C/I HVAC systems are to improve and extend communication of payback and return-on-investment information to owners on a job-specific basis, generally improve customer education with respect to understanding the financial benefits of efficiency investments, buy-down initial costs with incentives, and achieve upstream price reductions by manufacturers. A few suppliers mentioned providing financing and case studies/demonstration projects.

When asked about obstacles to increased adoption of high efficiency HVAC on the supply-side of the market, many suppliers stated that they did not believe there were any. However, while most supply side actors say they promote energy efficient equipment, they state that their need to compete on first cost limits their ability to do so. In addition, some see barriers to efficiency in lack of knowledge (among contractors and designers), limited sales skills (among contractors), and worries about the reliability of unproven new technologies, particularly for boilers. Manufacturers and several other

suppliers emphasized that a major supply side barrier is the price-driven nature of spec and bid projects. Furthermore, in addition to lack of knowledge, they perceive that there are too few incentives to use the knowledge that each market actor has. For example, designers often have a clear disincentive to invest extra time in designing efficient systems since they are on de facto fixed price/fixed hours constraints, resulting in standard efficiency, cookie cutter designs.

Most of the suppliers' suggestions for addressing supply-side barriers focused on education for contractors and designers. A few suppliers mentioned efforts to change the structure of bidding and design process to both allow more information on efficiency options to make its way to the owners and create incentives (or eliminate disincentives) to designers to invest more time in efficient system designs (that pay for themselves in energy cost reductions). Many suppliers mentioned the same end user barrier solutions as supply side barrier solutions under the assumption that any supply-side barriers are simply reflections of lack of customer demand for efficient products and services.

Implications and Suggestions for Programs

The overall goal of this project is to provide Focus on Energy with a better understanding of supply chain actor practices, attitudes and information sources with regard to energy efficiency in order to improve the effectiveness of Business Programs activities. This study is not an evaluation of the existing FOE programs. Our intent is to help identify areas and aspects of the supply chain that are leverage points for current or refined program activities. Our recommendations should not be taken to imply that FOE is not already engaged in the suggested activity; indeed many of them are part of current program approaches. Suggestions from our research are summarized below.

Market Event

- ***Large new construction and renovation projects should be identified and tracked at their earliest stages*** to ensure and influence appropriate consideration of efficiency options. These projects offer the greatest potential for influencing designers and contractors and capturing the most cost-effective savings, which are often design related. The trend toward green buildings (LEED certified) presents a growing opportunity to capture increased energy efficiency through early, integrated design activities.

- ***For planned replacements, supply-side intervention efforts should focus on contractors***. Contractors are most likely to identify these projects in their earlier stages and have the greatest influence. ***Emergency replacement efforts should be directed toward distributors*** and contractors, as available stocking often drives equipment choice.

Bid Structure

- ***Efforts to influence the importance of efficiency in project bid structures should be considered.*** Because of their importance in design/build, ***General contractors need to be educated on the value of energy efficiency. Efforts to improve coordination and remove disincentives*** to efficiency are also important.

System Type

- ***Interventions for larger projects and*** those with ***central plants should focus on designers,*** while those for ***smaller*** jobs featuring packaged units ***should target contractors.*** In addition, efforts

should be made to ***encourage*** more efficient ***boiler and chiller systems*** (as opposed to less efficient packaged systems) where appropriate. ***System optimization and controls should be reinforced*** for both types of systems.

Other

- ***Tools and services that help contractors and, to a lesser extent, distributors sell high efficiency may be needed*** (for example, simple tools to accurately estimate paybacks and financial returns), particularly in emergency and some planned replacement situations.

- ***Identifying and addressing supplier concerns about the reliability of specific types of efficient products and services is critical,*** particularly in cases where perceptions may be based on unrepresentative anecdotal experiences or information.

- ***Case studies and demonstration projects can be particularly useful and effective education tools for high-efficiency products and services that are relatively new*** or may be recovering from a previously poor track record.

- ***Working with manufacturers*** to promote and disseminate energy efficiency information and leveraging training activities ***may be an effective way to influence the large population of smaller contractors***.

- ***Efforts to work with suppliers should be personalized and sustained over time***. Virtually a trade ally's value committed, long-term business relationships.

- Where appropriate, ***program efforts should support linkages between efficient products and services and*** distinguishing ***business characteristics of greatest import to suppliers*** (e.g., quality of work, reputation of firm, product reliability, etc.).

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