Non-Energy Benefits (NEBs) in Offices and Schools: Do They Influence Building Design and Decision-making?[1]

Lisa A. Skumatz, Ph.D., Skumatz Economic Research Associates, Inc., Superior, CO
Ingo Bensch, Energy Center of Wisconsin, Madison, WI
Blake Bear, Skumatz Economic Research Associates, Inc., Superior, CO
Stuart Schare, Summit Blue Consulting, LLC, Boulder, CO

Abstract

This project used detailed interviews and telephone surveys to explore the degree to which NEBs affect decision-making in new construction in the non-residential sector. The analysis measured the NEBs recognized by architects, engineers, owners, and developers. It also explored similarities and differences in the perception of NEBs for specifiers vs. their clients – and showed that architect and engineer (A&E) specifiers responsible for selecting building features had fairly inaccurate assessments of the importance of NEBs to their clients, likely resulting in under-specification of efficient measures and designs.

The project found that a number of NEBs (and negatives) were associated with efficient design compared to standard design and construction practices. The most important positive NEBs that were recognized included: improved tenant satisfaction, better quality of light, better comfort, and increased productivity of workers / students. Two key negatives were mentioned: initial cost (as expected) and concerns about increased maintenance (an especially large concern for A&E decision-makers). These results provided guidance for issues may be counteracted (or clarified) in training sessions.

There were also response patterns based on decision-maker and building type. The results point out perceptions about non-energy strengths and weaknesses and present a variety of lessons for program marketing and training topics – where reliable evidence can be developed and presented. This will be useful in transforming the opinions of important decision-makers – and consequently increasing the percentage of new construction using efficient designs. These results provide guidance for issues that need to be counteracted or clarified in training sessions targeted to appropriate actors, or overcome by well-designed program interventions and marketing.

Project Background and Methodology

The Energy Center of Wisconsin (ECW) and Focus on Energy (FOE) are interested in maintaining and "growing" consideration of energy efficiency and high performance design in commercial-sector buildings constructed in the State. The program hired Summit Blue Consultants and Skumatz Economic Research Associates, Inc. (SERA) of Boulder, Colorado to conduct interviews and surveys to analyze program needs. As part of the program efforts, the consultants investigated a host of questions related to energy-related decision making in offices and education facilities in the State. The first stage of the work was to conduct detailed in-person interviews with a small sample of owners, architects, and engineers involved in new office or school construction over the last few years. The detailed interviews

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were designed to provide information to guide a second-stage larger sample phone survey that followed (Bensch, et.al., 2003). The two phases of the project were designed to provide fast turnaround feedback on training issues – preferred venues, topics, and outreach methods – that were on a critical path for a related project.

Sample and Questionnaire Issues

The consultants contacted staff from the state, and the Cities of Janesville, Milwaukee, and Madison to obtain permit and plan submittal data for the last few years. However, the data were not available in a timely manner, so we used a similar database assembled by ECW staff in 2000.

The in-person interview sample was not intended to be a statistically representative sample. Instead, we clustered the interviews by geographic area, and selected a distribution of architects, engineers, and owners active in offices and schools in those areas, and called to arrange interviews. We focused on the following geographic areas for our recruitment because they had the highest activity (square footage and numbers of projects) for plan submitters – Madison, Green Bay, Appleton, Milwaukee, Fond du Lac, La Crosse, Oshkosh, Pewaukee, and Waukesha. Ultimately, 30 interviews were completed, with an average length of 65 minutes. They included: 3 developers, 5 owners, 12 architects, and 10 engineers, with 18 primarily associated with offices and 12 with schools.

The project also included a second phase telephone survey. We conducted 148 telephone interviews. The distribution of these interviews by type is shown in the tables below. We had a quota of a minimum of 35 interviews for each of four categories of actors: developers, owner-occupants, architects, and engineers. The original project plan did not include developers, but the in-person interviews made it clear this was a very distinct group from the others – with its own set of criteria, practices, attitudes, and needs.

Over one-third of the interviews addressed school buildings. This distribution provides a reasonable sample for planning for both schools and office programs. Over 90 interviews addressed new construction, and over 50 addressed remodels and/or additions. The interviews took an average of 24 minutes to complete, with 80% of them lasting between 10 and 40 minutes.

Table 1. About the Telephone Respondents
(telephone results)

		Actor Type				Building Type	
	Overall	**Developers**	**Owners**	**Architects**	**Engineers**	**Office**	**School**
Number	148	37	40	36	35	91	57
Office	91	37	22	13	19		
Schools	57	0	18	23	16		
Average Employees in Company	89.2	20.6	227.0	54.3	59.1	76.1	110.4
Average Buildings/year	55.9	12.9	2.7	87.1	173.5	57.4	53.3
Average Square-footage	51,322	42,282	56,634	54,213	51,579	44,938	61,403

Table 2. About the Telephone Respondents
(telephone results)

	Construction Type		Firm Size (Employees)			Bldg. Size (sq. ft.)	
	New	Add. / Remod.	<=8	9 to 49	>=50	<50,000	>50,000
Number	93	55	24	33	40	91	56
Office	79	12	16	24	21	65	25
Schools	14	43	8	9	19	26	31
Average Employees in Company	72.0	118.9	3.7	23.0	88.4	51.2	150.8
Average Buildings/year	48.9	68.2	10.0	51.5	157.2	67.7	37.0
Average Square-footage	50,709	52,349	38,681	53,915	57,969	29,655	86,532

The telephone survey topics were based on issues raised by the ECW in the initial project scope, with some additions and modifications based on a review of issues in the literature. The in-person surveys were also used to guide development of the telephone instrument. The questionnaire asked a number of questions about a specific building the actor had been involved with, and also asked questions about more general practices. The structured interview guide addressed the following topic areas:

- Decision-making and criteria
- Barriers to new design ideas and equipment
- Understanding of "high performance" concepts
- Recognition of non-energy benefits
- Program needs and preferences
- Information sources
- Training needs and preferences.

Perceived Non-Energy Benefits / Problems Associated with High Performance (HP) Design

We asked respondents whether there were perceived benefits (or problems) associated with HP or efficient buildings and equipment beyond energy savings. The results are summarized below.

In-Person Interview Results

Respondents were asked about benefits (or problems) other than energy savings that may be associated with HP buildings or specification of HP equipment. There were seven key non-energy (NEB) benefit categories that elicited the most comments by respondents: comfort, productivity, aesthetics, quality of light, tenant comments/complaints, equipment maintenance and equipment lifetimes. The first four received the highest number of positive comments, and were recognized as benefits by more than 14 of the respondents. The only one receiving more than one "negative" benefit comment was equipment maintenance, which was mentioned by four respondents as a concern. The percentage of total mentions by comment type is shown in the table below.

Table 3. Non-Energy Benefit Mentions
(in-person results)

	Total mentions	Positive benefit	No change	Negative	Depends on equipment	Percent of all respondents reporting positive benefit
Comfort	24	79%	21%			79%
Productivity	23	65%	17%	4%	13%	62%
Aesthetics	23	61%	34%	4%		58%
Quality of light	22	91%	9%			83%
Tenant complaints	19	53%	26%	5%	16%	42%
Equipment maintenance	18	33%	28%	22%	17%	25%
Equipment lifetimes	17	35%	35%	6%	24%	25%
Easier to sell or lease	12	58%	25%	17%		29%
Environmental considerations	12	75%	25%			37%
Safer for occupants	8	38%	62%			12%

We also attempted to determine the importance of NEBs to these actors. Both comfort and light quality received seven "highly important" rankings. Productivity was ranked as highly important by 3, medium by 1, and low by 3 respondents. Similar rankings were found for aesthetics. Few others received many relative ranking scores.

Respondents had difficulty when asked to suggest ways that one could get other market actors to recognize the benefits of HP buildings. Some suggested that owners care more about the long term than others; and some suggested making information about energy cost per square foot more available. They noted that some owners are more interested in these topics, but they tend to be schools and religious clients.

Telephone Interview Results

Respondents were asked about benefits and problems beyond energy savings that might be associated with HP buildings or equipment. We call these "non-energy benefits" (NEBs), and the concept incorporates both positive and negative "benefits." Tables 4-6 below show the results both overall and by sub-group. We asked respondents to rank whether or not there were any NEB effects from HP buildings, and for those noting a positive or negative effect, how important this factor was in influencing whether HP features were included in buildings they had worked on.

First, we asked whether HP design led to a positive effect, negative effect, or no effect (or "it depends") on a variety of possible non-energy benefit categories (compared to standard construction). We assigned positive values to answers where there was a positive effect and negative values to answers where there was a negative effect. For example, a response indicating a higher initial cost yielded a negative value, whereas a response indicating a lower initial cost yielded a positive value. The NEB categories were identified from previous work by the author (Pearson and Skumatz 2002, Skumatz 2002, and others) and the results of the in-person interviews. The overall results are shown in Table 4 below.

The results show that a majority of the responding decision-makers view the following to be positive impacts from HP / efficient equipment:

- Comfort
- Quality of light
- Tenant satisfaction
- Equipment performance (e.g., pushing air through the building more effectively, etc.), and
- Productivity.

Table 4. Percent Recognizing NEBs Associated with HP / Efficient Design (response to question "what would you say the impact of HP Design is on comfort – increased, decreased, no effect, or it depends.") (telephone results)

	NEB is Positive factor	No effect	NEB is Negative factor	Depends	Number not responding
Operating cost	46%	29%	21%	4%	36
Initial cost	3%	2%	93%	2%	18
Equipment maintenance	11%	33%	51%	5%	24
Equipment performance	61%	24%	8%	8%	29
Productivity	56%	36%	0%	8%	43
Tenant satisfaction	70%	23%	2%	5%	30
Comfort	73%	15%	3%	9%	20
Appearance	38%	51%	0%	11%	20
Quality of light	71%	17%	3%	9%	24
Ease of selling / leasing	49%	38%	4%	9%	43

HP / efficient equipment was perceived to have a negative impact on several categories – particularly initial cost and equipment maintenance. Negative impact on initial cost is a logical result because first costs are commonly perceived to be higher for HP equipment. Equipment maintenance results are discussed below.

The tables below show the percentages of each of the actor and building subgroups that thought of each factor as positive or negative. The results show that the negatives associated with first cost are mentioned less frequently by owners than other decision makers. Owners and architects are also more likely to associate productivity benefits with HP buildings and design. Architects more frequently attribute a variety of "soft" benefits to HP equipment, including tenant satisfaction, comfort, and light quality. However, they are split as to whether high performance equipment / design would have a positive or negative effect on operating costs. School decision makers are considerably more likely to consider student productivity and quality of light issues benefits from HP design than are office decision makers.

Table 5. Non-Energy Benefits – Percent Positive and Negative by Decisionmaker Subgroups (telephone results)

		Actor Type				Building Type	
Positive% /negative%	Overall	Developers	Owners	Architects	Engineers	Office	School
Operating cost	46%/21%	50%/14%	60%/16%	36%/29%	44%/24%	51%/16%	41%/29%
Initial cost	3%/93%	3%/93%	10%/81%	0%/100%	0%/97%	1%/95%	6%/90%
Equip't maintenance	11%/51%	20%/36%	16%/48%	12%/59%	0%/56%	13%/47%	10%/56%
Equip't performance	61%/8%	92%/0%	82%/6%	43%/18%	30%/6%	68%/4%	49%/13%
Productivity	56%/0%	50%/0%	61%/0%	80%/0%	26%/0%	49%/0%	70%/0%
Tenant satisfaction	70%/2%	62%/7%	62%/0%	91%/0%	64%/0%	63%/3%	80%/0%
Comfort	73%/3%	74%/4%	76%/0%	91%/0%	53%/9%	73%/5%	74%/19%
Appearance	38%/0%	30%/0%	56%/0%	41%/0%	26%/0%	33%/0%	45%/0%
Quality of light	71%/3%	64%/11%	76%/0%	86%/3%	54%/0%	67%/4%	77%/2%
Ease of selling/leasing	49%/4%	48%/7%	14%/0%	54%/7%	69%/0%	50%/6%	46%/0%
Number of respondents	130	30	31	34	35	79	51

Interviewees contacted about additions / remodels indicated that high performance features have a positive effect on operating cost and tenant satisfaction more often than respondents contacted about new buildings. Employees of smaller and larger firms also thought more often that high performance features had a positive effect, when compared with employees of mid-sized firms.

Table 6. Non-Energy Benefits – Percent Positive and Negative by Building/Business Subgroups (telephone results)

	Construction Type		Firm Size (Employees)			Bldg. Size (sq. ft.)	
Positive% /negative%	**New**	**Add./ Remod.**	**<=8**	**9 to 49**	**>=50**	**<50,000**	**>50,000**
Operating cost	47%/30%	65%/15%	71%/13%	42%/30%	65%/15%	56%/22%	52%/29%
Initial cost	88%/11%	84%/15%	92%/8%	82%/15%	98%/3%	88%/11%	84%/14%
Equipment maintenance	58%/19%	53%/11%	71% 8%	48%/24%	63%/10%	57%/15%	55%/18%
Equipment performance	62%/19%	58%/20%	54%/21%	48%/27%	65%/15%	60%/21%	61%/18%
Productivity	44%/25%	47%/36%	50%/33%	36%/52%	45%/23%	43%/29%	48%/30%
Tenant satisfaction	55%/25%	73%/13%	71%/13%	52%/27%	75%/13%	59%/20%	64%/21%
Comfort	71%/17%	78%/7%	79%/8%	61%/24%	88%/5%	75%/13%	71%/14%
Appearance	40%/15%	47%/11%	46%/42%	36%/27%	38%/3%	41%/12%	45%/16%
Quality of light	66%/19%	76%/11%	83%/42%	63%/33 %	65%/13%	70% /18%	68%/14%
Ease of selling/leasing	46%/27%	38%/35%	71%/21%	52%/39%	53%/13%	44%/30%	41%/30%
Number of respondents	93	55	24	33	40	91	56

We felt that simple percentages did not tell the entire story. To gather information about how important these associated benefits and negatives were, we followed up with a question asking "how important is this factor in influencing whether HP features were employed in buildings you've worked on." We used a 5-point scale, where 1 meant the factor was not important, 5 meant it was very important, and the responses counted for either direction – positive or negative. We weighted the positive results with a +1, and negative influences using a –1. The follow-up question was not asked of those stating no effect or "it depends." The results are interpreted as follows:

- +5=very important positive factor influencing installation of HP equipment / design.
- -5=very important negative factor influencing installation of HP equipment / design.

This factor provides an indication of both the direction and relative size of the relationship with the NEB categories.

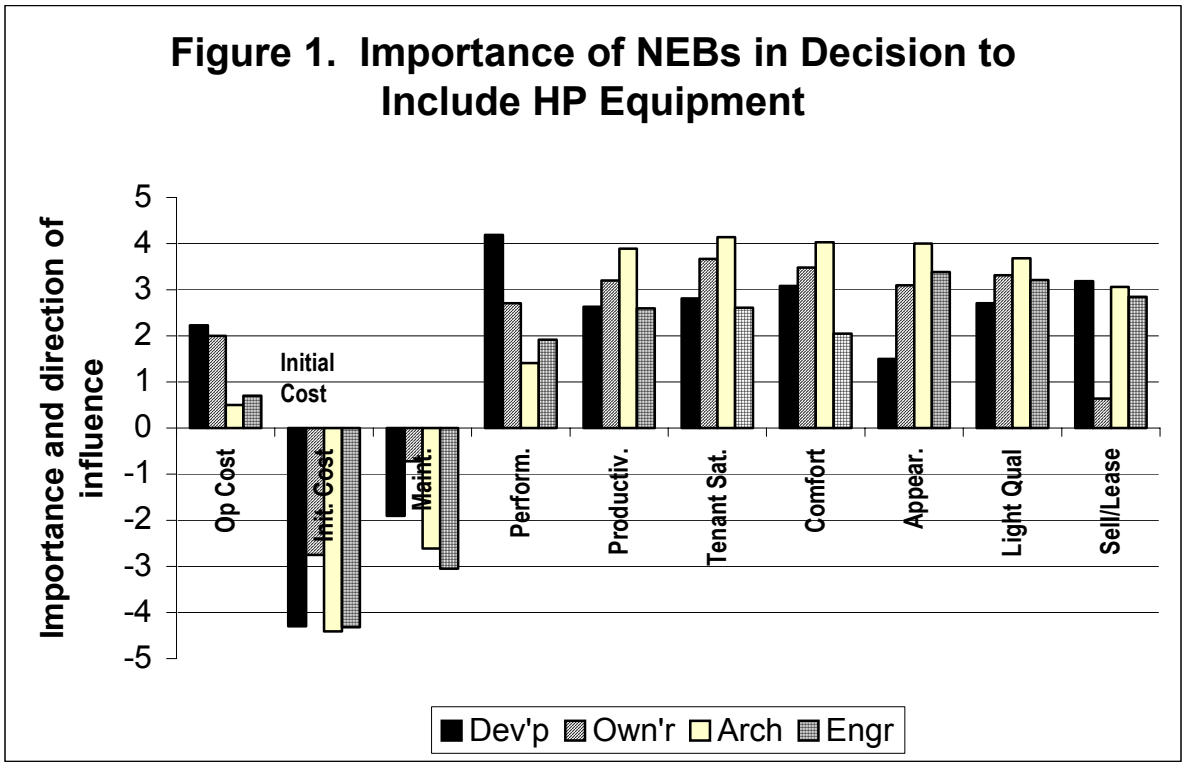
Table 7. Indicator of Influence of Non-Energy Benefit on Decision to Include HP Equipment by Decisionmaker Subgroups (telephone results)
(+5=very important positive factor influencing installation; -5=very important negative factor influencing installation)

		Actor Type				Building Type	
	Overall	**Developers**	**Owners**	**Architects**	**Engineers**	**Office**	**School**
Operating cost	1.23	2.23	2.00	0.50	0.70	1.88	0.32
Initial cost	-4.00	-4.30	-2.75	-4.41	-4.32	-4.22	-3.66
Equipment maintenance	-2.01	-1.90	-0.72	-2.61	-3.05	-1.95	-2.08
Equipment performance	2.60	4.19	2.71	1.41	1.92	1.13	1.75
Productivity	3.23	2.63	3.20	3.89	2.60	2.83	3.73
Tenant satisfaction	3.38	2.81	3.67	4.14	2.61	3.03	3.79
Comfort	3.26	3.08	3.48	4.03	2.05	2.96	3.73
Appearance	2.95	1.50	3.10	4.00	3.38	2.39	3.77
Quality of light	3.31	2.71	3.31	3.68	3.21	3.19	3.45
Ease of selling / leasing	2.58	3.19	0.64	3.06	2.85	2.53	2.68
Number of respondents	117	23	26	34	34	70	47

Table 8. Indicator of Influence of Non-Energy Benefit on Decision to Include HP Equipment by Building / Business Subgroups(telephone results)
(+5=very important positive factor influencing installation; -5=very important negative factor influencing installation)

	Construction Type		Firm Size (Employees)			Bldg. Size (sq. ft.)	
	New	Add./ Remod.	<=8	9 to 49	>=50	<50,000	>50,000
Operating cost	1.73	0.61	0.47	1.60	1.00	1.45	0.85
Initial cost	-4.10	-3.82	-3.90	-4.35	-4.49	-3.86	-4.21
Equipment maintenance	-2.21	-1.69	-3.04	-2.53	-2.28	-1.73	-2.48
Equipment performance	2.55	2.69	3.30	3.00	1.60	2.64	2.55
Productivity	2.90	3.71	2.75	2.78	3.64	2.88	3.78
Tenant satisfaction	3.15	3.67	3.13	3.33	3.46	3.04	3.90
Comfort	3.03	3.59	2.65	3.53	3.36	2.91	3.86
Appearance	2.43	3.85	2.00	3.00	3.14	2.75	3.23
Quality of light	3.13	3.56	3.12	3.50	3.38	3.35	3.24
Ease of selling / leasing	2.60	2.55	2.69	3.25	2.91	2.47	3.14
Number of respondents	73	44	20	23	39	59	35

The results show that all actors see initial cost as a very significant negative factor affecting whether or not high performance (HP) or efficient equipment (EE) is installed in a building – the indicator is –4 out of a maximum negative score of –5. Note that the indicator for operating cost is small and positive. This seems to indicate that there is a recognition that operating costs may be somewhat lower, but the factor may not rank highly for decision makers. The other major negative factor is equipment maintenance (with a score of –2). The respondents seem to feel that maintenance or risk of poor reliability is a problem with HP or EE equipment. This reflects some of the concerns we heard during in-person interviews.



Overall, the NEBs that positively influence consideration of HP / EE equipment, ranked from highest to lowest, include:

- Tenant satisfaction (3.38)
- Quality of light (3.31)
- Comfort (3.26)
- Productivity (3.23)
- Appearance (2.95)
- Equipment performance (2.60)
- Ease of selling / leasing (2.58)
- Operating cost (1.23)

There is a cluster of factors that rank fairly highly (3.2 or higher of a maximum of 5). These factors are similar to those found in other work (Skumatz, Dickerson, and Coates, 2000, Pearson and Skumatz, 2002). However, that work relied on interviews with owners or occupants; in this study, we can also examine the perception of NEBs by a variety of other actors (A&E) involved in decision-making regarding new buildings. Examining the findings by subgroup shows the following:

- Engineers (and architects) were especially negative about equipment maintenance issues associated with HP / EE equipment. This may be an important barrier in attempting to increase the integration of efficient technologies into buildings in the state.
- Owners view the initial cost and operating cost tradeoffs more favorably than others. They ranked the negatives associated with first cost at only –2.75 (compared to scores exceeding –4 provide for the other decision makers). They (and developers) also gave operating cost an indicator of +2.0, which was considerably higher than the A&E respondents.
- Productivity was perceived positively and highly by both owners and architects. School decision makers found (student) productivity benefits more important in influencing the adoption of HP / EE equipment than did office designers (3.73 compared to 2.83).
- Architects were more likely than others to view tenant satisfaction, comfort, appearance, and quality of light features as important influencing factors in adoption of HP / EE equipment. Given the critical role of architects in basic building design, this can be a favorable factor.
- Developers were most positive about equipment performance, comfort, and perceived ease of selling / leasing the building.
- School-related decision makers were more likely (than office decision makers) to consider productivity, tenant satisfaction, comfort, and appearance as important factors influencing the adoption of HP / EE equipment.
- Respondents contacted about additions / remodels were more positive in general about high performance features / design than respondents contacted about new buildings.
- Larger firms tended to be slightly more concerned about initial cost that their smaller counterparts.
- Interviewees contacted about larger buildings were more positive about high performance features in general, though they thought the initial cost would be more prohibitive than did respondents contacted about smaller buildings.

The responses indicate that non-energy benefits (NEBs) influence building design; in addition, there are highly recognized NEBs that apparently result from the incorporation of HP design into new buildings. Disseminating information about the NEBs may provide opportunities to influence design. The NEB research also points out perceived non-energy costs (and benefits) associated with HP design, which may be useful to address in training key actors in this market.

Conclusions

Generally, although the research from other parts of this study demonstrated that high performance (HP) is not a commonly used concept or familiar term among building decision-makers, the research demonstrates that decision-makers care about high performance features – or at least are familiar with key concepts. The bad news is that this means the program will need to further develop the high performance "brand", and clearly associate the "brand" with the range of NEBs that decision-makers have reported they realize from HP building features. Further, the program needs to sell high performance and its components based on what the decision-makers care about: energy benefits and non-energy benefits.

Attitudes / awareness of efficiency and non-energy benefits

The in-person interviews highlighted some concerns, given Focus on Energy's and ECW's interest in efficiency. For instance, there were several (very busy) firms that were not as focused on efficiency as other firms. Summarizing the practical side of things, there were several respondents that expressed the following sentiments.

- You can get 90-95% of the way using good informed decision making from good standard design practices.
- Some decision makers think that engineering can overcome poor design / architecture.
- Economics are a big issue – you can "get points in green heaven but it costs money now."

We also examined the perceptions about the NEBs with respect to High Performance (HP) building features and energy efficient design. The results showed that tenant satisfaction, quality of light, comfort, and productivity are important positive outcomes associated with HP / efficient equipment. Negative factors were initial cost and equipment maintenance issues.

We found that there were several patterns based on decision maker and building type. A&E respondents were very concerned about equipment maintenance and first cost issues – more so than the ultimate building owners. Developers and owner-occupants were much more likely to believe that equipment performance would be much better for efficient or high-performance equipment than architect and engineer respondents. Engineers were generally even more negative or skeptical about performance and NEB issues than architects.

There were several implications from the research. It will be important for training and outreach efforts to address the (perceived or real) maintenance and cost concerns with A&E decision-makers. It may also be useful to inform A&E decision-makers that their concerns about first cost and maintenance are higher than their owner/developer clients, and they may be being more cautious than the client's preferences. Another useful approach may be to emphasize the soft, but apparently recognized, positive non-energy benefits associated with HP features to owners, developers, and design professionals when promoting program services and when educating decision-makers about HP design and equipment.

Summary

In practice, high performance design is most commonly pursued for reasons of improved work environment, as opposed to lower energy bills or greener buildings. The top four reasons for implementing HP were tenant satisfaction, comfort, quality of light, and productivity. This implies that perhaps high-performance design can best be promoted by marketing its non-energy benefits—in particular, the "people" issues such as improved comfort level and quality of light, increased worker

productivity, and better building aesthetics. As with previous research (Pearson and Skumatz 2002, Skumatz *et.al*. 2000), the results indicate that there may be a powerful benefit to marketing energy efficiency using terms the participant values, rather than selling on efficiency grounds, in order to help achieve efficiency objectives.

In addition, however, different groups of building actors and decision-makers recognized different values and priorities associated with the NEB categories – with patterns related to their perspective or areas of expertise in many cases. The results indicate there is a difference in training and marketing needs between different groups of actors – providing information that emphasizes benefits they value, and addressing negative NEBs they hold as concerns. In addition, tailoring in intervention design between owners, developers, and submitting professionals may also improve the impact of the program.

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