Transforming Modular Classrooms in California and Elsewhere

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ABSTRACT

This paper discusses a market-transformation program to reduce energy use in modular school classrooms, a large part of new construction activities in California's schools. Today's modular classrooms cost more to operate than is necessary to provide effective, comfortable learning conditions for students and teachers. Although past resource acquisition programs have created a demand for efficient products and services, modular classrooms remain poorly differentiated in this respect.

The cost-effectiveness of a range of potential energy efficiency measures (EEM's) were evaluated including lighting, alternative HVAC options, and improved envelope features. Viable EEM's were combined in two separate packages. The first includes measures that can easily be implemented and are projected to reduce operating costs by 30%. The second implements a daylighting system, a two-stage evaporative cooler, and radiant heating, resulting in projected annual energy cost savings over 60%.

Transforming the market for modular classrooms is accomplished using natural market forces, rather than financial incentives directed at an entire industry. Proactive efforts are focused on the manufacturing industry's change leaders to commercialize energy-efficient products. Lost market share and peer pressure do the "heavy lifting" of convincing market followers to upgrade their products. Demand for efficient classrooms is increased by educating schools about the new products' financial advantages, comfort enhancements, and environmental benefits. As new products become established in the marketplace, support will be gradually withdrawn.

The relevance of this work extends beyond California, given other States' programs to reduce class size, and the Presidents initiative to reduce class size nationally.

Introduction

Background work for the program began in September of 1997, when market transformation had become a hot topic in California and elsewhere. Although the idea for improving modular classrooms had been simmering within PG&E for more than a year, the mandates for resource acquisition programs did not "fit" the opportunity. Different premises for market transformation, however, provided the flexibility required to design an appropriate program. In September, PG&E commissioned Davis Energy Group to evaluate the potential for saving energy in modular classrooms.

The defining work by Eto, Prahl and Schlegel clearly outlined a broad concept for market transformation, yet left many questions unanswered with respect to its implementation. Additionally, there were few other sources of information to draw upon for direct answers. As agents for public purpose funding, the mission was to design programs for 1998 which both reflected the new paradigm and "worked in the real world."

Most modular classrooms in California are rectangular with an area of 960 SF, composed of two 12X40 "floors" that are transported on trucks and bolted together on site. A typical installation cost of $75,000 would include the building for $45,000 and site work for $30,000. The motivation to build a program around modular classrooms was based initially on anecdotal information. We knew that thousands of manufactured classrooms were being placed in K-12 schools every year, and they were commonly referred to as "energy hogs" by facilities managers. This assertion was supported by evident application of inefficient lighting fixtures and air conditioning package units to most classrooms. But these observations seemed peculiar since, historically, schools had participated aggressively in energy efficiency programs for permanent structures.

Preliminary investigation revealed a market structure favorable to market intervention. While there were 999 public school districts in California, and roughly 7,000 schools, there were only eight or ten active manufacturers of modular classrooms. We could therefore work through a small number of companies to influence a large market.

This paper is formatted to reveal both results and process. It is a step-by-step account of technical and economic analysis, followed by market analysis and program development. We conclude by summarizing how the program is working.

Technical and Economic Analysis

Technical and economic analyses were employed to evaluate the opportunity for an energy-efficient modular classroom program as a "market transformation" activity. We reviewed the classroom manufacturing industry, selected candidate energy-efficiency measures (EEM's), assessed potential EEM cost-effectiveness and, based on the industry review, assessed potential technical and market hurdles to be overcome in working with manufacturers to implement selected EEM's.

Methodology

In Task 1, we visited seven California manufacturers to gain a detailed understanding of current products, practices, and the state of the industry. We asked manufacturers a series of questions about the energy features in their products. We also asked for drawings and Title-24 energy compliance data necessary to complete reliable energy performance simulations of their products in typical California applications. We visited four typical installations, and completed a blower door air leakage test at one of the three. To identify typical thermostat settings in modular classrooms, we contacted 8 school districts, and twice interviewed one school district facilities manager.

In Task 2, we used a MICROPAS4 research version to develop base case energy performance models for typical California classroom installations based on data acquired in Task 1. We established a single base case model with five parametric variations to cover the range of possible conventional modular classroom designs. We also developed and used a spreadsheet program to integrate heating/cooling results with lighting energy use estimates.

In Task 3, we selected potential energy efficiency measures (EEM's) and organized them into envelope, lighting, and HVAC categories. We then modeled each measure applied to both the nine month and full year schedules in three climate zones. In Task 5, we estimated incremental installed costs for all combinations analyzed in Task 4. Working with product manufacturers and installers, we researched both base case and EEM cost details for all cases. We estimated EEM costs to be lower for modular classrooms than for typical residential new construction because of the high and continuous purchase volumes, and because of the labor efficiencies we observed in production facilities. We added a 25% factory overhead and profit margin to the materials and labor costs for each EEM.

We combined cost and performance results in a spreadsheet to compute simple pay-back values for all cases. We then assembled two energy efficiency packages, and computed pay-backs under 9-month and 12-month operating schedules in three climate zones. We selected EEM's for the first package based on their potential for immediate integration into the modular classroom industry, reserving more advanced measures, which may require prototyping and testing, for Package 2.

Results

While we observed differences in manufacturer's products, we also found remarkable similarities, and found the industry to be very accessible for information. Several of those interviewed commented that "There are no secrets in this industry." Key findings from the interviews were:

- Architectural designs are quite standardized, with 24' x 40' "2 module" classrooms the most popular; 30' x 32' "3 module" designs are also common.
- There is a strong trend toward steel "rigid frame" construction which relies on strong welded corner joints for strength, rather than wood "shear wall" design. Only one of the seven manufacturers produces all wood units, and another produces about half rigid frame and half wood shear wall units; the others build almost exclusively rigid frame units.
- Almost all units have metal roofs with standing seams oriented lengthwise on the modular unit; roofs slope either from a center ridge or one way toward the back.
- Most manufacturers do not insulate the full length roof beams (see Figure 2) and end beams.
- Window types are specified by the districts. The most common specification is for two 4' x 8' double-glazed gray tint windows per classroom.
- Approximately 95% of the units produced use heat pumps rather than gas heating, due apparently to lower heat pump costs and higher costs associated with bringing gas service to the modular classroom locations.
- All manufacturers use T-bar suspended grid ceilings. About half install the ceiling panels before shipping, and the other half install them on site.
- Most manufacturers install T12 light fixtures rather than more efficient T8's; most install 12 fixtures per classroom, although several typically install only 10.
- All manufacturers are currently using a single manufacturer's heat pumps, in sizes ranging from 3.5 to 5 tons; most install two 12" flex ducts to ceiling diffusers.
- Hot water is rarely supplied in the modular classrooms. 20 to 50% of modular classrooms are provided with cold water at sinks.
- All manufacturers also produce limited numbers of specialty modular units for assembly rooms, rest rooms, and labs. These units sometimes include up to six 12' wide modules, making rooms as large as 40' x 72'.

Base Case Energy Use

Table 1 summarizes the base case features used in the simulations, and Figure 1 shows the base case end use projection for Climate Zone 12 (Sacramento) for both 9 and 12 month operating scenarios. Not shown in Table 1 is infiltration during non-use hours, which was set at 0.23 ACH based on results of the blower door test. Projected annual energy use per classroom ranges from \$865 (\$0.90/ft^2-year) for 9 month occupancy to \$1,168 (\$1.22/ft^2-year) for full year occupancy. In both scenarios, lighting is the largest energy user at 42% of the total on both 9 and 12 month schedules. Heating, at 31% of the total, is the next largest energy user on the nine month schedule, while cooling at 24% is the second highest projected energy user on the full year schedule.

Table 1: Base Case Simulation Assumptions

Envelope	Base Case	Systems	Base Case
frame type	steel	lighting type	T12
roof beams	uninsulated	#/fixtures	12
walls	R11	heat source	heat pump
roof insulation	R19	outdoor air	15 cfm/person
roof surface	metal	economizer option	none
glazing	double	cooling SEER	10
glazing tint	grey	morning heat recovery	ramped
floor insulation	R11	**Schedules**	**Base Case**
Site	**Base Case**	annual	9 & 12 month
location	CZ 12	weekly	5 day
orientation	South	daily	7 to 4
#/occupants	20	summer/winter thermostats	70/76
occupant age	K-3	summer/winter demand($)	6.7/kW/1.65/kW
		summer/winter energy($)	.089/kWh/.073/kWh

Figure 1: Projected Annual Base Case End Use (9 & 12 month schedules)

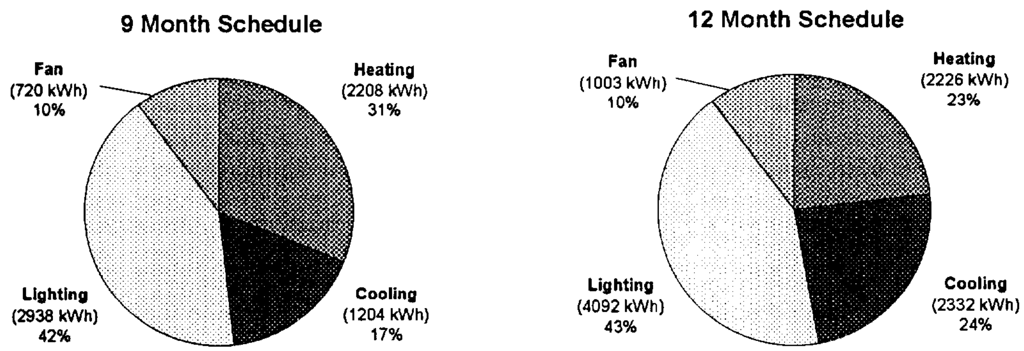


Table 2 shows the variance in projected annual base case energy cost by climate zone. Climate Zone 11 (Red Bluff), with the highest heating loads and cooling loads shows the highest projected annual energy cost among the zones. Climate Zone 4 (San Jose) has lower loads due to the mild San Francisco Bay Area climate. Based on the three climate zones evaluated in this study, annual utility bills are projected to vary approximately 15-20% from the average due to climate impacts.

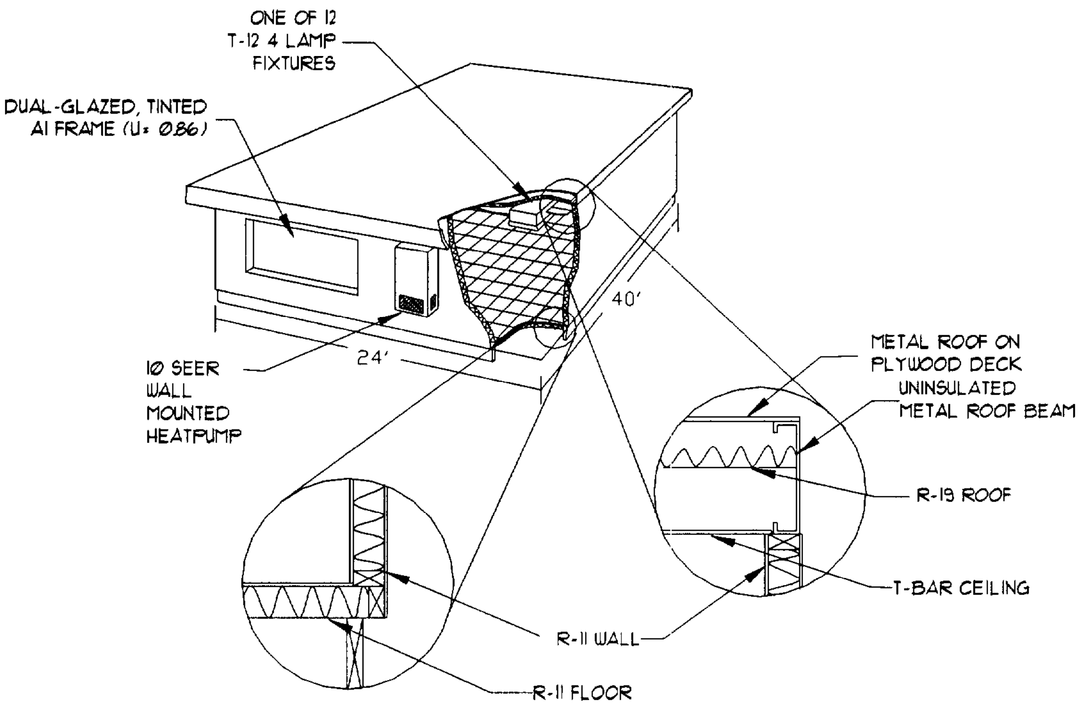
Table 2: Base Case Annual Costs by Climate

		Schedule	
CZ	City	9 Month	Full Year
4	San Jose	$704	$931
11	Red Bluff	$977	$1,310
12	Sacramento	$865	$1,168

Individual Energy Efficiency Measures

Figure 2 presents typical modular classroom "base case" construction.

Figure 2. "Typical" Modular Classroom Construction



A list of potential energy efficiency measures (EEM's) was developed for detailed analysis, organized into envelope, lighting, and HVAC. Table 3 presents energy efficiency measures (EEMs) that met the 10 year simple pay-back criteria selected for evaluation. Measures 1-11 are ordered with respect to the 9-month operating schedule, with Measure 1 the most cost effective and Measure 11, the least.

Table 3. Energy Efficiency Measure Descriptions

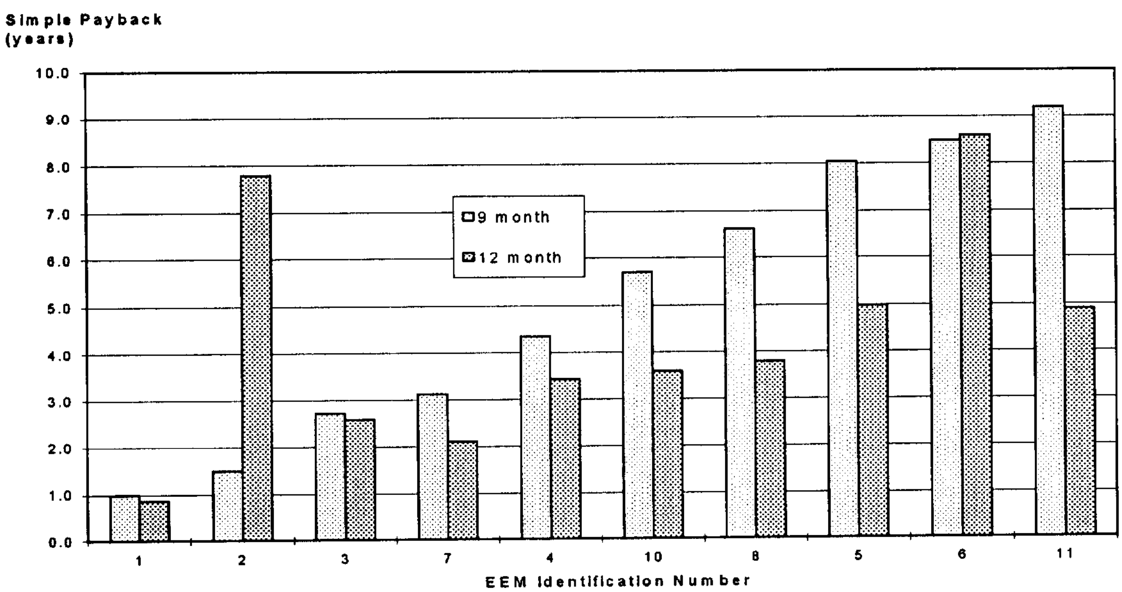
ID	Energy Efficiency Measure	Description
1	R11 insulated roof beam	Add R11 batts to perimeter roof beams
2	low-E glazing	Replace base case tinted glazing with low-E
3	R13 wall insulation	Upgrade wall insulation in 2x4 construction
4	insulated ceiling panels (3" rigid)	Replace existing T-bar ceiling grid with rigid 3" polyisocyanurate panels. Panel provides reflective top surface and eliminates thermal short circuit of roof beam
5	attic radiant barrier (ARB)	Laminate low emissivity foil to underside of roof plywood to reduce roof heat gains
6	R19 floor	Upgrade floor insulation from R11 to R19

7	improved light fixtures	Replace standard 4 lamp T12 fixtures with 2 lamp T8's with electronic ballasts and parabolic reflectors
8	skylights, dimmable T8 ballasts	Add 20" x 48" strip skylights (which fit between roof standing seams) with electronic ballasts & controls
9	improved seals at heat pump unit	Reduce duct leakage from HVAC unit by installing a gasketed seal at wall penetration
10	2-stage evaporative cooler & electric radiant ceiling panels	Replace base case heat pump with evaporative cooling and ten 400 Watt radiant ceiling panels (2' x 4')
11	12 SEER heat pump	Replace base case heat pump with high efficiency heat pump and CO_2 sensor

Figure 3 presents simple pay-backs for individual EEM's added to the base case in Climate Zone 12 (Sacramento). The EEM's are arranged in order of decreasing cost-effectiveness for the more common 9-month school schedule. EEM's are identified by the "ID number" listed in Table 4.

The general trend in Figure 3 is improved EEM cost-effectiveness with the longer 12 month schedule. This trend is logical as the longer school year results in higher loads, especially cooling. Two EEM's which are projected to have longer pay-backs under the 12 month schedule are the R19 floor and the low-E windows. Both of these measures reduce the ability of the modular classroom to reject heat during summer evenings. The low-E glazing also has a higher shading coefficient (and visible light transmittance) than the base case gray-tint glazing units. As is typical for new construction, the most cost-effective opportunities are in the thermal envelope category.

Figure 3. Projected Energy Efficiency Measure Simple Pay-backs (years)



Energy Efficiency Measure Packages

Table 4 identifies the EEM's selected for each package. Tables 5 and 6 show projected energy cost savings and economics, respectively, for the packages for both 9-month and full-year schedules in three climate zones. While the value of savings by package varies with climate, savings percentages remain relatively constant. Package 2, which includes the more advanced daylighting system and 2-stage evaporative cooling, is projected to have higher annual cost savings than Package 1. The incremental pay-back, however, is higher due to the cost associated with the daylighting system.

Assuming that favorable school financing opportunities justify pay-backs up to 10 years, both packages appear to be cost-effective in all climate zones on both 9 month and full year schedules.

Table 4. Package Summary of Measures

Measure	Base Case	Package 1	Package 2
Wall insulation	R-11	R-13	R-13
Ceiling insulation	R-19	R-19 + attic radiant barrier	R-19 + attic radiant barrier
Floor insulation	R-11	R-19	R-19
Roof beam insulation	R-0	R-11	R-11
Glazing type	U=0.86, bronze	U=0.75, low-E	U=0.75, low-E^2
Lighting	12 T-12 fixtures	12 T-8 fixtures	Package 1 + daylight
HVAC	10 SEER HP	12 SEER HP	IDAC* + radiant heating panels

*IDAC: 2-stage evaporative cooler

Table 5. Projected Package Annual Cost Savings

	Annual Cost Savings			
	Package 1		Package 2	
	9 Month	Full Year	9 Month	Full Year
San Jose	$192	$326	$422	$612
Red Bluff	$268	$374	$573	$856
Sacramento	$241	$342	$513	$767
Average %Savings	28%	31%	59%	66%

Table 6. Package Economics

	Package 1		Package 2	
Incremental Cost	$881		$4,246	
	Simple Pay-back (yrs)		Simple Pay-back (yrs)	
Climate City	9 Month	Full Year	9 Month	Full Year
San Jose	4.6	2.7	10.1	6.9
Red Bluff	3.3	2.4	7.4	5.0
Sacramento	3.7	2.6	8.3	5.5

Table 7 presents a 20-year life-cycle cost projection. Life cycle cost components include initial incremental cost (zero for the base case), annual operating costs discounted to present value, and incremental maintenance costs. The only incremental maintenance cost was based on minimal annual maintenance of the 2-stage evaporative cooler (sump and evaporative media cleaning), and periodic media replacement. The replacement interval was assumed to be 5 years for the mild San Jose climate and 4 years for the hotter Central Valley locations. All HVAC system types were assumed to have a 20 year life. Lighting was assumed to be a "wash" with fewer, more expensive lamps to be replaced in Packages 1 and 2. An 8% nominal discount rate was assumed.

Table 7. Projected Life Cycle Costs (1998$)

	Base Case		Package 1		Package 2	
	9 Month	Full Year	9 Month	Full Year	9 Month	Full Year
San Jose	$6,912	$9,141	$5,908	$6,831	$7,271	$7,635
Red Bluff	$9,592	$12,682	$7,832	$10,071	$8,497	$8,998
Sacramento	$8,493	$11,467	$7,007	$8,981	$7,997	$8,478

Implementation Issues

Table 8 identifies anticipated implementation issues by EEM, based on discussions and observations during the plant visits. In all cases, cost-effectiveness and desirability to the school district is an issue, since each purchase is typically customized per the school district's specifications.

Table 8. Implementation Issues

Energy Efficiency Measures	Issues
R19 floor	none
R11 insulated roof beam	in use by some; requires holding system
attic radiant barrier	purchase or laminate in plant
R13 wall insulation	none
low-E glazing	economical soft coat low-E 9-12 months away
T8 lamps, 10 fixtures	requires ceiling & wiring redesign
duct seals at wall mounting	must develop opposed flange gasket seal
skylights + dimming fixtures	requires design development & prototyping
12 SEER wall-mount heat pump	available as prototypes and lead times
2-stage evaporative cooler + radiant heating panels	require design development & prototyping

The Package 1 lighting strategy is to provide daylighting via clear glass for the modular units, allowing reduction to 10 fixtures instead of 12. "Hard coat" low-E glazing will be replaced with a higher quality, soft-coat low-E at comparable costs, so we assumed soft-coat low-E performance.

The Package 2 lighting strategy is similar to that of Package 1, but adds skylights to light the center 24' x 24' zone during daylight hours. Prototyping of this configuration is necessary to verify viability and acceptability. The IDAC cooling unit is a two-stage (indirect-direct) evaporative unit that has been tested and demonstrated in many residential applications but has not yet been applied to schools. The unit uses 100% outdoor air, and typically reduces cooling energy use by 70-80%. Since it is not currently available with an integrated heating system, radiant panels are used for heating.

Conclusions of Technical and Economic Analyses

1. Despite rapid recent production rate increases, classroom construction is of high quality.
2. Designs are relatively standardized despite the manufacturers' ability to fabricate many design variations.
3. Manufacturers have failed to standardize on cost-effective features common in other building categories; examples of omitted features include R13 wall insulation and T8 light fixtures.
4. A package of EEM's which are relatively easy to implement should reduce annual energy costs by approximately 30% and have a pay-back of 2-5 years.
5. A package of seven measures including daylighting, 2-stage evaporative cooling, and radiant heating should reduce annual energy costs by 60% and have a pay-back of 5-10 years.

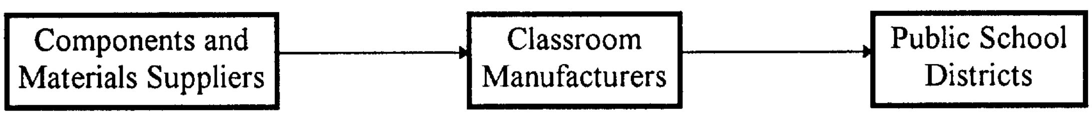
Market Analysis and Program Development

The market transformation program was designed to assist manufacturers in developing a business for energy efficient modular classrooms. Given the right technical and financial support, manufacturers would develop an efficient product. Strategic marketing support and economic analyses would show how adopting energy conservation as a business strategy could lead to greater profits and market share. Support of sales and advertising would help create demand for efficient classrooms and, as they became established in the marketplace, support would be gradually withdrawn.

Characterization of Market and Industry

Figure 4 shows a simple market structure with only three market actors. Since expected market barriers originate from these organizations, the model turns out not to be too simplistic.

Figure 4. Market Structure



Public School Market. The California market for modular classrooms has 999 public school districts, of which 17% have year-round educational programs. The K-12 student population is expected to increase by 1 million students over the next decade, and roughly one-half of public school districts participate in the State School Building Program. Participating districts are required to spend 30% of new construction capital on relocatable classrooms. Although this requirement may be eliminated by new legislation, pressure from increasing student population and California's class-size reduction activities are expected to maintain demand at about 10,000 classrooms per year, for at least the next few years.

School district representatives are, in general, knowledgeable about the economic importance of energy conservation due to the educational activities of past resource acquisition programs. Additionally, environmental issues, noise, and comfort are important to administrators and teachers. There is a willingness to spend more money on products differentiated by energy efficiency and, in the past, schools have participated more aggressively in energy efficiency programs than other market sectors. In general, teachers like modular classrooms. They are new and always conditioned, unlike some older permanent structures.

Manufacturing Industry. The manufacturing industry has approximately 10 modular classroom manufacturers and, due to requirements to meet California's Title 24 Energy Standards and obvious transportation limitations, there are no imports from other states. It is a clearly defined industry which permits competitive analysis.

Modular classrooms are manufactured in small companies with few resources for research and development, so the emphasis is on manufacturing rather than energy-efficient design. Not surprisingly, products are poorly differentiated with respect to energy efficiency. With few exceptions, current designs include minimum State requirements to meet Title 24 Energy Standards. Since high-volume manufacturers generally do not vary from minimum standards, overwhelmingly, today's modular classrooms are standard-efficiency units.

Since the manufacturing industry is months behind in filling orders, demand exceeds supply, and manufacturers operate in a competitive, but friendly, environment. Although manufacturers occupy a strong negotiating position, negotiations with schools are friendly since long-standing relationships between manufacturers and school districts are the norm. Additionally, "piggybacking" on existing contracts is the channel through which most classrooms are sold.

Component Suppliers. Competition among component suppliers appears to be adequate except for air conditioning equipment for which there is only one manufacturer. The typical wall-mount unit has an efficiency rating of 10-10.5 SEER and is well-suited to manufacturing operations, but the supplier does not offer efficient alternatives in the 12-13 SEER range. This issue is important since modular classrooms are almost never supplied with natural gas for heating, so heat pumps are the only commercial cooling option.

Market Barriers

Market barriers were identified primarily through discussion with manufacturers and school facilities managers. Table 9 shows potential market barriers, those which we believe exist for schools and manufacturers respectively, and barriers selected for market intervention through program activities. Since unlike energy efficiency measures are associated with different barriers, Table 9 necessarily represents an aggregation of measures for individual barriers.

One can see from Table 9 that there is no intent to address all barriers through program activities. This is part of a broader strategy, discussed under implementation strategy below. Market barriers to be addressed through program activities are as follows.

Information and search costs for manufacturers include gathering information about new EEM's and understanding their impact on classrooms. For schools, it is simply the value of time required to understand new products.

Performance uncertainty refers to the EEM's performing as expected for both manufacturers and schools, and directly influences technology acceptance.

Asymmetric information pertains to the accuracy of claims by manufacturers about building performance.

Product unavailability simply means that efficient models do not yet exist. It therefor includes the time and effort required to integrate new EEM's into plans, inventory, manufacturing, etc.

Unawareness of opportunity refers to manufactures' lack of knowledge of market potential and related opportunities.

Table 9. Market Barriers

Potential Market Barriers	Manufacturers		Schools	
	Existing	Program	Existing	Program
1. Information or Search Costs	x	x	x	x
2. Performance Uncertainty	x	x	x	x
3. Asymmetric Information or Opportunism			x	x
4. Hassle or Transaction Costs				
5. Hidden Costs	x	x	x	x
6. Access to Financing			x	
7. Bounded Rationality	x		x	
8. Organizational Practices or Customs	x		x	
9. Misplaced or Split Incentives			x	
10. Product or Service Unavailability	x	x	x	x
11. Externalities (environmental)				
12. Non-Externality Pricing				
13. Inseparability of Product Features	x		x	
13. Unawareness of Opportunity	x	x	x	

Strategies and Sustainability

In the private sector, only profitable product lines survive in a manufacturing company, so the principal strategy for sustainability is based on efficient modular classrooms becoming a profitable line of business for manufacturers. If so, manufacturers will make a business decision to include energy efficiency as a business strategy. This is the only meaningful measure of success.

How one accomplishes this is central to the program. A broad campaign to further educate schools and manufacturers about the benefits of energy efficiency would be prohibitively expensive. The benefit would be questionable anyway, since the simple message that "energy efficiency is good", has been delivered several times already to those who will listen. Lowering market barriers requires working closely with market actors to solve complex problems.

A private sector approach to solving problems must use competition, rather than oppose it, allowing natural market forces to do the "heavy lifting." Underlying this approach is the intent to transform only part an industry by helping the change leaders, not necessarily current market leaders, build a sustainable business for efficient modular classrooms. As new products are purchased, market share will grow. Lost market share or peer pressure will, in turn, influence market followers to upgrade their products. Assuming success, this approach should be cost-effective, compared to broad educational campaigns.

Markets naturally segment with respect to competitive parameters, and some parts of the classroom manufacturing industry will be more predisposed towards energy efficiency than others. Working with individuals and organizations with favorable views towards energy efficiency will be cost effective, since they demand less than do disinterested parties. Since serious "buy-in" requires personal investment, program support will be limited to approximately one-half the total cost of development and promotion. Manufacturers will self-select base on an industry-wide offer. Additionally, it is important that the utility maintain a support role and that manufacturers lead and make final decisions.

The market transformation effort can also be drastically simplified by working with manufacturing and school organizations that do not have internal organizational barriers. In Table 9, most barriers not selected for intervention fall in this category: bounded rationality, organizational practices and customers, and misplaced or split incentives.

The discussions above give rise to the following implementation strategies.

- Efforts should be concentrated on individuals already predisposed towards energy efficiency.
- The financial self interest of market actors should be the focus of our work.
- Market actors should be an integral part of designing interventions.
- All attributes related to using less energy, including increased comfort, improved health, and environmental benefits, should be part of educational activities.

Market Interventions and Effects

Product unavailability is the most basic barrier and this will be eliminated by helping manufacturers design and fabricate energy efficient classrooms for demonstration. Technical and economic analyses discussed above are the starting point, and meetins will be held to discuss implementation issues, make changes, and resolve problems. Design engineering support will be provided to support this process.

Although the program will pay for incremental material costs for demonstration units, integrated design techniques will be employed to control incremental material and labor costs. To increase the potential value to participants, assistance will be limited to two or three manufacturing companies. These actions increase a manufacturer's willingness to include changes in their designs and manufacturing processes.

The absence of cooling alternatives for inefficient wall-mount heat pumps is another aspect of product unavailability. It is especially important since ventilation, heating and cooling comprise more than 50% of the energy use in modular classrooms. Supplier competition is important to promote efficiency in the industry so special attention will be given to promoting an alternative.

Hidden costs and performance uncertainties will be reduced through demonstration projects that prove the performance and operational reliability of new energy efficiency measures, to both manufacturers and school facilities managers. These projects also serve to showcase new products for participating manufacturers. Energy-efficient classrooms will be monitored and the results will presented to both schools and manufacturers. Additionally, teachers will be interviewed to determine product satisfaction. These actions will begin to achieve technology and product acceptance.

Asymmetric information and opportunism, and information and search costs will be reduced, in part, through interventions already discussed, however, education will hasten product introduction.

This support will be provided by helping promote efficient modular classrooms through advertising and presentations at conferences and workshops. Since schools have been the target of many previous educational efforts, product introduction will be the focus more than education. Promotional materials will include case studies of demonstration projects, and include information on energy cost savings and life cycle costs, comfort and productivity, health and environmental benefits. A product excellence award will be awarded to help differentiate efficient classrooms, and a manufacturers brochure will be developed which clearly shows energy efficiency features to potential buyers. These actions will increase demand for efficient classrooms.

Awareness of opportunity will be eliminated through market information that shows the potential of increased market share and profitability. In small companies, starting a new product line represents a significant financial risk that must be offset by potential reward. Market information will be supplied to manufacturers to justify the risk of building investing in energy efficiency and, if necessary, a market analysis will be conducted to help identify the long-term market potential, and to direct sales. These actions will decrease company resistance and financial risk.

Program Update

The program was initiated in January, 1998. The results of technical and economic analyses were presented to all interested classroom manufacturers, and offers to assist were made individually, and to the industry as a group, at a conference for the School Facilities Manufacturers Association. Three manufacturers distinguished themselves by agreeing to participate in the program, their primary motivation to expand market share. Others showed interest, but were not willing to invest time in new product development.

The need for flexibility to do market transformation is even greater than expected. Three rounds of detailed discussions with manufacturers produced numerous changes. Packages of measures were defined, evaluated and redefined. Some measures were dropped while others were added.

Some significant technical issues deserve comment here. When the program began, distributors of wall-mount heat-pumps indicated that efficient units were not available. News of our investigating other options and competitors, however, prompted one manufacturer to produce prototypes for the program, and to declare its intentions to bring more efficient heat pumps into production. Although we have dedicated numerous hours of effort to the skylight design to ensure that it will not leak, achieving product acceptance by both schools and manufacturers will require time and experience. To a lessor degree, this is true for the 2-stage evaporative cooler.

We expect the program to be successful. School districts are interested in the new energy-efficient classrooms, and progress continues with manufacturers. We expect to place approximately 20 demonstration units before the new school year begins in September. In addition to saving energy, energy-efficient modular classrooms will be quieter, be more pleasant and productive due to enhanced lighting, and be more healthful due to greater outside air supply and better control of outside air.

References

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