A Tale of Two States: A Case Study Analysis of the Effects of Market Transformation

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In the past few years, there has been increasing interest in the concept of market transformation as a mechanism to increase end-use energy efficiency. Recent trends toward restructuring of the utility industry, and the accompanying decline in traditional utility-sponsored DSM programs, have accelerated that growth in interest.

Unfortunately, there has been very little empirical data available to document the effects of market transformation. That is partially because market transformation to achieve energy efficiency is a relatively new concept and there have been few structured attempts to implement that concept; and partially because estimating the effects of market transformation is a difficult task.

The purpose of this paper is to provide a case study example of where intervention in the energy efficiency market has produced a rather striking demonstration of market transformation. Specifically, a series of government and utility actions to encourage installations of high-efficiency natural gas furnaces in Wisconsin has almost completely transformed the market (i.e., 90 percent of new furnaces purchased in 1994 were high efficiency), whereas a neighboring state (Michigan) that did not pursue most of those initiatives has experienced a much lower level of market penetration (i.e., only 37 percent of 1994 sales were high efficiency).

This paper provides some background on the activities that produced the market transformation, and describes the methodology used to obtain the market penetration data for the two states. In addition, the paper offers estimates of the resulting energy savings and economic benefits associated with having transformed the market for natural gas furnaces in Wisconsin.

INTRODUCTION

Market transformation has often been at least an implicit objective of government and utility energy efficiency programs. Many policy advocates increasingly embrace the concept of market transformation because successful market transformation initiatives should achieve more savings and provide larger benefits to society, at lower total lifecycle costs (though not necessarily at lower first-year costs), compared to traditional utility rebate programs. In the current era of lower avoided costs, impending industry restructuring, and increased competition many individuals and organizations are looking to market transformation initiatives as preferred, or at least viable options for increasing energy efficiency in society.

Unfortunately, there is a paucity of real-world examples of situations where market transformation has been successfully implemented and its effects reliably documented. Market transformation as an explicit efficiency strategy is a fairly recent phenomenon and real market transformation can be both difficult to accomplish and very challenging to document.

This paper attempts to contribute to the literature regarding market transformation by documenting the existence of a transformed energy efficiency market (for gas furnaces in Wisconsin) and estimating the benefits being captured as a result. Although the market transformation itself was a somewhat serendipitous outcome rather than a primary program objective, it is hoped that it will be useful to demonstrate the existence of a transformed market and illustrate the magnitude of the benefits available from such an accomplishment.

What is Market Transformation?

In the context of this paper, market transformation occurs when conservation and energy efficiency programs induce lasting structural or behavioral changes in the market that result in increases in the adoption and penetration of energy efficient products, services, and practices. While lasting is a relative term, in this definition it means ‘‘persists once the program is modified or terminated.’’ This is in contrast to direct program impacts, which may be taken to be the result of a temporary behavioral change—e.g., a customer buys an efficient appliance instead of an inefficient one, simply because the customer has been given a one-time incentive to do so.

Many proposed or recently implemented market transformation efforts are planned, strategic initiatives (for some examples of strategic initiatives, see Geller and Nadel 1994, Gordon and Tumidaj 1995, and Keating 1996). In the case of the Wisconsin furnace market, the market was transformed even though the utility and government programs were not part of an explicit, coordinated strategy designed to achieve this transformation.

Origin of The Current Study

Michigan and Wisconsin are two neighboring states in the northern tier of what is generally regarded as the north-central United States. While not a perfect match, they are relatively similar in climate, geography and economic factors, and each is heavily dependent on natural gas for residential space heating.

Over the years, through anecdotal information as well as such documentation as utility saturation surveys, it became apparent that the natural gas furnace markets had evolved quite differently in the two states. Specifically, Wisconsin seemed to have a much higher penetration of high efficiency furnaces, i.e., furnaces with an annual fuel utilization efficiency (AFUE) rating of 90% or greater.

In late 1994 the Michigan Public Service Commission staff was having some market baseline research conducted regarding various residential appliances. This was recognized as an excellent opportunity to study issues related to market transformation. Here we had a distinct and readily identifiable technological innovation (high efficiency versus standard efficiency furnaces) and two neighboring markets (conveniently separated by Lake Michigan) that had apparently evolved down two very different paths. Given that opportunity, it was decided to have a portion of that market baseline research focus on attempting to document the similarities and differences in the residential natural gas furnace markets in Michigan and Wisconsin.

That market assessment was the first step in the exploration of the market transformation issues. This paper summarizes the results of that effort (HBRS 1995) and takes the additional steps of (1) examining some of the historical factors which may have helped ‘‘transform’’ the Wisconsin market, and (2) attempting to quantify some of the economic benefits being reaped by Wisconsin as a result of having a ‘‘transformed’’ market for residential natural gas furnaces. Hopefully this information will contribute to the debate regarding the feasibility and desirability of pursuing market transformation as an energy efficiency strategy.

METHOD

Conducting an assessment of the retail market for a given appliance is not an easy task. That is likely one reason why so few actual empirical studies of market transformation have been completed. Although the methodology available for this study is less than what one might optimally design with an unlimited budget, it should be sufficient to provide a single point in time comparison of the residential gas furnace market in two neighboring states. For this purpose, telephone survey responses and written sales record data were obtained from furnace contractors in each of those two states. The following material briefly presents information about the samples and the data collection methodology employed (HBRS 1995).

Sample

The sample pool for this study was the listing of boiler and furnace contractors and heating and air conditioning contractors in Wisconsin and Michigan available from Dun & Bradstreet’s Direct Access Service. From that sample pool, a random sample of approximately 100 contractors was selected for each state. Surveys were randomly conducted from those samples until 40 completed interviews were accomplished in each state.

A large number of sample points (approximately 40 percent) from the original Dun & Bradstreet’s listings were determined to be ineligible (e.g., no longer in business, work only in large commercial market, not in furnace business, etc.). The survey completion rate for eligible contractors actually reached by phone was 85 percent. When contractors believed eligible but unable to be contacted are included, the overall response rate was 55% (Michigan) to 68% (Wisconsin).

Interview participants were also asked to compile data on their actual 1994 natural gas furnace and boiler sales. In Wisconsin, 25 of the 36 contractors with natural gas furnace sales in 1994 provided the data (representing 1,989 furnace sales) and in Michigan 15 of the 37 contractors with furnace sales in 1994 provided that data (representing 1,415 furnace sales). For both Wisconsin and Michigan, participating contractors were well distributed over a broad cross section of communities within the states.

Data Collection

Telephone surveys of approximately 20 minutes in length were conducted by a professional survey organization experienced in energy program evaluation. At the end of the telephone interview, respondents were recruited to provide data on their natural gas furnace sales for the preceding year (1994). Those who agreed were mailed prepared forms requesting data on the brands, models and efficiency levels of all the natural gas furnaces they had sold during that year.

At the time of recruitment, respondents were offered reimbursement for their costs to complete the data collection. Roughly three-fourths of the contractors who sent in sales data requested reimbursement. The average amount requested by those who did ask for reimbursement was $57.

RESULTS

Below we present results on furnace efficiencies, penetration of high-efficiency furnaces, furnace prices, and other market characteristics (HBRS 1995).

Furnace Efficiencies

The data regarding furnace efficiencies which were obtained in this study strongly confirm that there are two very distinct categories of natural gas forced air furnaces being sold: (1) ''standard" efficiency furnaces that just meet existing federal minimum standards (i.e., in the 78-80% AFUE range) and (2) ''high-efficiency'' furnaces (i.e., with an AFUE of 90% or better).

Penetration of High Efficiency Furnaces

Two different methods were used to collect data to estimate the proportion of furnace sales in Michigan and Wisconsin which were high efficiency. Each has its own relative advantages and disadvantages.

First, respondents to the telephone survey were asked to estimate what percentage of the furnaces they sold in 1994 were in each of four efficiency categories (less than 70% AFUE, 70-79%, 80-89%, and 90% or greater). The advantage of this method is that it provided a 100 percent response rate from all contractors surveyed. There are two main disadvantages. The first is that it was an ''off the top of the head'' survey response and therefore of less certain validity than other methods. The second is that it weights each contractor's response equally and does not take into consideration the number of furnaces each contractor sold.

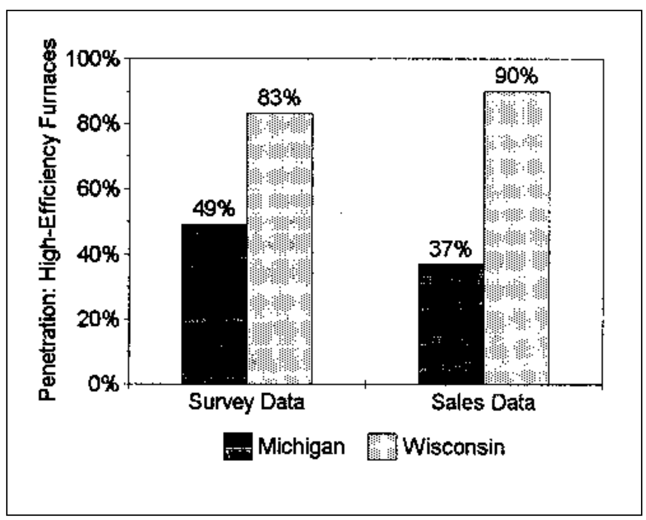
The second method was to ask survey respondents to take a prepared form and compile actual furnace sales numbers, by brand, model, and efficiency level, for all of 1994. The advantages and disadvantages of this method are the converse of the first method. This method has the advantage of a much more valid estimate of actual sales, and appropriately weights the number of units sold in the overall average. However, it has the disadvantage of a much lower response rate from contractors.

The results of each method, with the data collapsed into the ''standard'' and ''high efficiency" categories described above, are presented in Figure 1. The survey self-report data suggests that 83% of furnaces sold in Wisconsin were high efficiency, versus 49% for Michigan. The data based on actual sales records, however, shows an even wider gap, with 90% of Wisconsin furnace sales being high efficiency versus 37% for Michigan. The difference between the states is statistically significant ($p < .001$) using either method of estimation.

It is not possible to completely reconcile the two different estimates. However, a comparison of the survey responses to the sales data was performed for just those contractors who provided both types of data. This comparison revealed that the simple average proportion of high efficiency furnaces from the survey of Michigan contractors tended to over-estimate the proportion of furnaces those contractors actually sold which were 90% AFUE or better (i.e., the survey based average was 46%, but sales records indicate 37%). In contrast, the Wisconsin contractors' survey estimate slightly under-estimated their high efficiency sales (83% survey vs. 90% from sales records).

This would tend to confirm the initial presumption that compiling actual sales data would produce a more valid estimate

Figure 1. *Penetration of high-efficiency furnaces purchased in 1994 in Michigan and Wisconsin, based on survey and sales data.*



of the proportion of high efficiency furnaces being sold. The only remaining question is whether the sub-samples of contractors who sent in the sales data were representative of the full survey samples. That issue was investigated by comparing contractors who sent in sales data with those who did not, on a number of variables from the survey data set. The only significant difference detected, which was found in each state, was that sales data providers had a significantly higher average number of furnaces sold. There were no significant differences on any of the other 16 variables examined, including the contractors' own survey estimate of their percent of sales which were high efficiency. On that basis, it can be reasonably concluded that the sales data set should be representative of the full survey sample for the purposes of this study.

These results suggest that the furnace sales data set provides the preferred numerical estimate of the proportion of high efficiency gas furnaces sold in each state. From a conceptual standpoint, the choice of data sets is inconsequential. Each method of data collection clearly demonstrates that the Wisconsin residential gas furnace market has been ''transformed'' to a market where high efficiency furnaces are the dominant furnace type, whereas no such transformation has occurred in Michigan.

Furnace Prices

An additional important aspect of the residential natural gas furnace market which was examined in this study was the retail price of standard versus high efficiency furnaces. Contractors were asked in the telephone survey to provide their retail price for a standard efficiency furnace (i.e., 80-85% AFUE) that would heat a 1600 square foot house. They were then asked what the retail price would be for a high efficiency (i.e., 90% AFUE) and very high efficiency (95% AFUE) furnace for that same house. Their responses provide two somewhat different pieces of useful information.

First, the data provide an estimate of the typical retail price of natural gas furnaces of various efficiency levels in each state. As can be seen in Table 1, retail furnace prices tend to be lower in Wisconsin, with the relative price advantage growing wider for higher efficiency furnaces. The difference between the states in average price is not statistically significant for standard efficiency furnaces, but is statistically significant for both categories of high efficiency furnaces. The average reported retail price for a 90% AFUE furnace was $228 less in Wisconsin. For 95% AFUE furnaces, the price difference advantage for Wisconsin was $386. This could be evidence of benefits from a transformed market (e.g., high efficiency furnaces are more plentiful and widely stocked in Wisconsin, which tends to drive down prices, thus benefitting consumers.)

While the data in Table 1 represent the best estimates of retail furnace prices in the respective states (i.e., ''How much would a consumer have to pay for a high efficiency furnace in each state?"), a second issue concerns the *relative price differential* between standard and high efficiency furnaces *within* each state (i.e., ''How much more than a standard efficiency furnace does it cost to purchase a high efficiency furnace in each state?"). For that analysis, a subset of the previous data must be selected in order to restrict the mean price comparisons to just those contractors who sell each of the various efficiency levels (not all contractors sell all three of the efficiency levels). This approach eliminates the possibly confounding effects of other cost factors that may differ between contractors in the two states. The data from this comparison are presented graphically in Figure 2.

The results indicate that the average increase in retail price from a standard furnace to a 90% AFUE furnace is $391 in Wisconsin versus $486 in Michigan. For a standard to a 95% AFUE furnace, the increase is $560 in Wisconsin versus $771 in Michigan. Once again, these results could be evidence of benefits from a transformed market (e.g., contractors more familiar with and comfortable with high efficiency furnaces charge less of a price mark-up and/or more competitors selling high efficiency furnaces forces prices down).

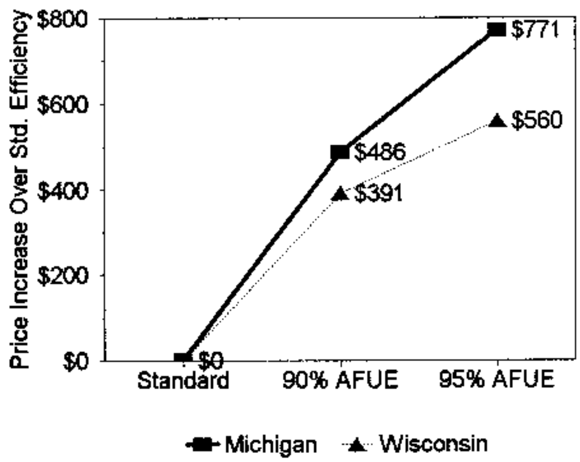
Other Market Characteristics

A variety of other characteristics of the residential natural gas furnace market were also examined in this study. In

Table 1. *Retail prices and differences in prices for furnaces in Michigan and Wisconsin*

Furnace Efficiency	Michigan	Wisconsin	Price Difference	Percent Difference	Sign.	Adjusted Difference
80%	$966	$849	$117	12.1%	NS	—
90%	$1,452	$1,224	$228	15.7%	.03	$111
95%	$1,819	$1,433	$386	21.2%	.05	$269

Figure 2. Average increase in price for a high-efficiency furnace.



general, the results reveal that other than the efficiency level and price characteristics noted previously, the residential natural gas furnace markets in the two states are quite similar.

The most notable differences were that Wisconsin contractors were more likely to obtain their furnaces from a distributor (90 percent for Wisconsin vs. 69 percent for Michigan) and were more likely to keep some furnaces in stock (56% of Wisconsin contractors report purchasing very few or no furnaces prior to the sale versus 78 percent for Michigan).

On the other hand, contractors in the two states were very similar in their rating of the importance of various criteria in their decision process for choosing which furnaces to sell. Out of a lengthy list of possible criteria, their top four choices were almost identical (Michigan: (1)reliability of equipment, (2) features/customer preferences, (3) energy efficiency levels, (4) cost; Wisconsin: the same except energy efficiency ranked second and features/customer preference ranked third).

Perhaps most importantly, all of the surveyed contractors in both Wisconsin and Michigan reported that 90% AFUE gas furnaces were readily available from distributors and/or manufacturers, and that 90% AFUE furnaces could be obtained in the ‘‘same amount of time’’ or "less time’’ than units with efficiency rating below 90 percent. This suggests that the differences in proportion of sales of high efficiency furnaces between the two states are not due to market barriers in the availability of high efficiency furnaces to contractors.

HOW WAS THE MARKET TRANSFORMED IN WISCONSIN?

To understand how the market in Wisconsin was transformed, it is helpful first to understand how the market for new and replacement furnaces operates. The market for heating systems is largely an equipment replacement market, driven primarily by replace-on-failure or replace-on-age situations, with some additional sales associated with new construction and renovation. In this market customers often are forced to make quick decisions with very little time to become educated consumers (unless they want to go without heat). Most customers rely on their heating contractor for recommendations, since that individual is perceived as an expert. In new construction, architects and general contractors often consult the heating contractor for an expert opinion.

Given the central role of the heating contractor in furnace purchase decisions, consider what would happen in a transformed market versus a market where substantial market barriers to high-efficiency furnaces still exist. If the heating contractor is experienced and familiar with high-efficiency equipment, prefers high-efficiency equipment, and if high-efficiency furnaces are standard practice (so that the contractor is fully aware that other contractors will be specifying equipment with the same efficiency level, at competitive prices), then the contractor will recommend and promote a high-efficiency heating system.

However, if the contractor does not have experience with high-efficiency systems, is worried about reliability and frequent call-backs, and works in a market where moderate efficiency systems are standard practice (where the contractor could easily lose a higher-priced high-efficiency sale to a contractor quoting a lower-priced and less efficient system), then the contractor will recommend the moderate-efficiency system over the high-efficiency one. In fact, even if a customer asks for a high-efficiency system, the contractor may try to talk the customer out of it.

It appears that the substantial replacement and new furnace activity in the Wisconsin utility and government low-income weatherization programs, utility rebate programs, audit and informational programs, and new construction programs, combined with the efficiency standards for new and replacement systems within those programs, led to contractors having early (and mostly positive) experiences with high-efficiency systems. For example, the Wisconsin utility low-income weatherization programs started installing high-efficiency systems in their programs in 1982 and 1983. Contractors had to be willing to work with the utilities and install high-efficiency systems, or lose those sales to their competitors. While most contractors approached high-efficiency systems with substantial concerns about reliability and call-backs (and did not believe that customers would pay for them), the contractors who installed high-efficiency systems in the early weatherization and utility rebate programs reported that they found the systems to actually be more reliable on average than the moderate-efficiency systems. In addition to better reliability (and fewer call-backs), the high-efficiency systems provided a larger profit per sale due to the mark-up on higher wholesale equipment costs. Plus contractors reported that they found customers were willing to pay the extra cost for the more efficient systems if they were informed of the benefits.

Over time, more Wisconsin contractors became familiar with high-efficiency systems and the related advantages for their businesses. By the late 1980's quoting and installing high-efficiency systems had become the standard practice in many areas of Wisconsin, resulting in the penetration of high-efficiency furnaces in at least some areas reaching 90% by 1991 (Schlegel et al. 1992, Schlegel and Prahl 1994). This transformation of the Wisconsin market led several utilities to discontinue their furnace rebate programs in the late 1980's. The Public Service Commission of Wisconsin directed all the other utilities to eliminate rebates for high-efficiency furnaces in 1991 because of the high penetration observed. (Some financing, fuel switching, and low-income programs in Wisconsin continued to provide incentives for high-efficiency furnace purchases beyond 1991, but these programs had lower funding levels in limited market segments compared to the much larger amount of government and utility market intervention in the 1982 through 1991 period.)

Not only had the penetration of high-efficiency systems increased dramatically in Wisconsin compared to other states, but the costs had decreased. In a study of one area of Wisconsin, contractors reported that the average installed cost for a high-efficiency furnace in 1991 was about $1,650, compared to $2,000 to $2,250 in nearby states (Schlegel et al. 1992, Schlegel and Prahl 1994).

ESTIMATING THE BENEFITS OF A TRANSFORMED MARKET

Two analyses of the energy savings and economic benefits of the transformed market for high-efficiency furnaces in Wisconsin are presented in this section. First, the benefits due to the higher penetration of high-efficiency furnaces purchased in 1994 in Wisconsin compared to Michigan were estimated, based on the results of the Michigan/Wisconsin market assessment study described above. Second, the cumulative benefits over a ten-year period (1985-1994) due to the transformed market in Wisconsin were estimated, based on the Michigan/Wisconsin market assessment and prior studies of the Wisconsin furnace market.

Five types of benefits and net benefits were estimated in the analyses: (1) energy savings due to the higher penetration of high-efficiency furnaces in Wisconsin; (2) the economic value of the energy savings, calculated using either retail or wholesale natural gas prices; (3) cost savings to customers in Wisconsin due to the lower prices of high-efficiency furnaces; (4) the net present value of benefits to customers in Wisconsin due to the energy savings and lower prices; and (5) the benefits to the economy of Wisconsin, including funds retained in the state because of reduced imports of natural gas and the wholesale equipment portion of lower incremental furnace costs.

Table 2 documents the key inputs and assumptions used in the analyses.

Benefits From Higher Penetration in 1994

The higher penetration of high-efficiency furnaces purchased in 1994 in Wisconsin (90%) compared to Michigan (37%) resulted in almost 32,000 additional high-efficiency furnaces purchases that year (53% higher penetration x 60,349 natural gas furnaces sold annually in Wisconsin). These additional purchases have provided substantial energy savings and economic benefits to Wisconsin customers and the state economy. The key energy savings and cost benefits, the present value of the benefits, and the net present value of benefits (i.e., present value of benefits minus costs) are described below. Because this analysis uses the market in Michigan as the baseline, all estimates of benefits are assumed to be ''net'' of what would have happened in the absence of the specific government and utility efforts in Wisconsin.

The higher penetration of high-efficiency furnaces purchased in 1994 in Wisconsin led to almost 4.7 million therms of annual energy savings (32,000 additional high-efficiency furnaces purchased x 146 therms per furnace)—enough to heat over 4,000 homes. These energy savings provide $2.9 million of savings annually to customers at a retail cost of $.62/therm. Lifecycle savings using a life of 21 years (based on a 4.8% replacement rate) are 98 million therms. The present value of the energy savings benefits to customers over the life of 21 years is $42.4 million (using a consumer discount rate of 6%; all values are in 1994$).

In addition to energy savings, the transformation of the Wisconsin market resulted in cost savings to Wisconsin customers due to lower prices for high-efficiency furnaces. Based on the survey results in Table 1 and interpolation, the average price for a 92% AFUE furnace in 1994 was $291 lower in Wisconsin than in Michigan. Since Wisconsin appears to have lower furnace prices than Michigan in gen-

Table 2. *Inputs and Assumptions Used in the Energy Savings and Economic Benefits Analysis*

Input or Assumption	Value
Total number of Wisconsin households	1,822,118
Percent of households buying a new forced air furnace each year	4.8%
Percent of new furnaces that use natural gas	69.0%
Percent of all households buying a new gas forced air furnace each year (4.8% * 69%)	3.3%
Total annual purchases of gas forced air furnaces in Wisconsin	60,349
Average increase in AFUE of furnace, from 80% to 92%	12%
Average space heating usage per space heating customer (therms)	1,117
Average savings per high-efficiency furnace (therms)	146
Lifetime of high-efficiency furnace (based on 4.8% replacement rate) (years)	21
Consumer discount rate (real)	6%
Social discount rate (real)	4%
Fuel escalation rate (above inflation)	2%
Retail cost of natural gas, 1994 (per therm)	$.620
Wholesale cost of natural gas, 1994 (per therm)	$.255
Incremental cost for a 92% AFUE furnace in Wisconsin (interpolated from Table 1)	$459
Adjusted difference in the average price for a 92% AFUE furnace, Michigan vs. Wisconsin	$174

Sources: HBRS 1994, WCDSR 1994, WEB 1993 and 1995

eral, as evidenced by the $117 difference for standard efficiency models (Table 1), the difference in average price for a 92% AFUE furnace due to the transformed market was assumed to be $174 ($291—$117). This $117 adjustment to the difference between average prices for high-efficiency furnaces was made even though that difference between the states for standard-efficiency furnaces was not statistically significant.

How much did customers save in 1994 because of this difference in average prices? It can be argued that some of the Wisconsin customers who purchased high-efficiency furnaces would not have done so at the higher prices seen in Michigan. Therefore, no cost savings are claimed in this paper for the 53% increment of higher penetration in Wisconsin. However, the baseline customers in Wisconsin (equivalent to the 37% penetration in Michigan) did experience cost savings due to the transformed market. The savings for these customers were estimated to be almost $3.9 million in 1994 alone.

Combining the present value of the energy savings to customers ($42.4 million), and the cost savings to baseline customers due to lower furnace prices in 1994 ($3.9 million), the present value of benefits to Wisconsin customers (net of the Michigan baseline) from the 1994 higher penetration is $46.3 million. The net present value of benefits (i.e., present value of benefits minus costs) to Wisconsin customers is about $31.6 million, based on $14.7 million of incremental costs using an average incremental cost of $459 for a 92% AFUE furnace (interpolated using the information in Table 1).

The lifecycle energy savings result in a present value of benefits of $20.7 million using a 1994 wholesale price of $.255/therm and a social discount rate of 4%. The wholesale price used is lower than many estimates of gas utility avoided costs, which often are approximately $.30/therm, because it does not include a value for capacity avoided. The net benefits to Wisconsin gas utilities were not estimated in this paper because reliable data on the portion of incremental costs paid by utilities versus customers were not available. However, using the full incremental cost ($459) for all 32,000 furnaces purchased in 1994 above the Michigan baseline and an assumed value of $.30/therm for gas avoided costs (an approach equivalent to the Total Resource Cost test), the net present value of benefits would be $9.7 million.

The economy of Wisconsin receives two types of benefits due to the higher penetration in 1994. First, $1.2 million of funds will be retained in the state each year because of the reduced imports of natural gas (this annual energy savings benefit to the economy of Wisconsin was estimated using a wholesale price of $.255/therm). The present value of the energy savings benefits retained in the state over the 21 year life of the furnaces is $20.7 million (using a social discount rate of 4%). Second, assuming the furnaces are manufactured outside of Wisconsin, about $1.4 million of funds were retained in Wisconsin in 1994 because of the lower prices of high-efficiency furnaces for the baseline customers (equivalent to the 37% baseline penetration in Michigan). These retained funds are equivalent to the wholesale equipment portion ($61) of the higher incremental costs seen in Michigan ($174) that would have been lost from Wisconsin for the baseline purchases in the absence of the lower furnace prices. This wholesale equipment portion of lower incremental furnace costs was estimated by assuming a 50/50 split of equipment versus labor/overhead costs (which was weighted less on equipment than the common overall split of 67/33, because the higher incremental costs were probably due less to higher wholesale equipment costs than to higher labor and overhead costs), and a 30% combined mark-up of wholesale prices at the distributor and contractor level within the state.

Overall, the higher penetration of high-efficiency furnaces purchased in 1994 will provide over $15.2 million in net benefits to the economy of Wisconsin. The net present value of benefits was estimated by summing the present value of the energy savings benefits ($20.7 million) and the lower price benefits associated with the baseline customers ($1.4 million), and then subtracting the wholesale equipment portion of the incremental costs of high-efficiency furnaces ($6.9 million, or $215 per furnace) for the 53% increment of penetration above the Michigan baseline, assuming all furnaces are manufactured outside of Wisconsin (the $215 per furnace was calculated using a 67/33 split of equipment versus labor/overhead costs and a 30% total mark-up on wholesale prices).

No matter how one looks at the findings, the higher penetration of high-efficiency furnaces purchased in 1994 in Wisconsin has resulted (and will continue to result) in substantial benefits and net benefits to customers and to the economy of Wisconsin.

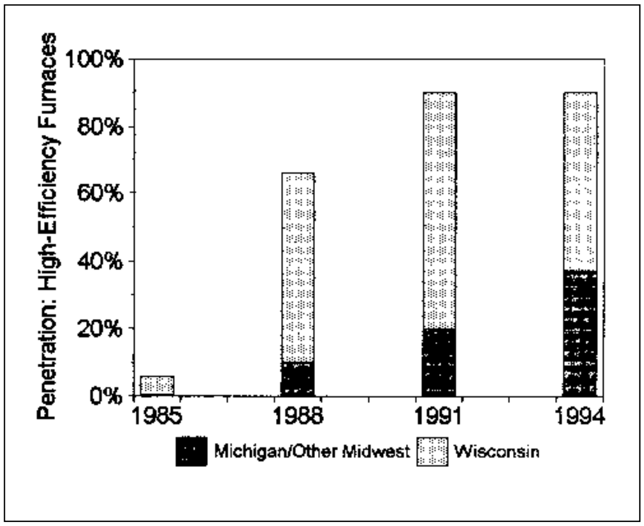
Cumulative Benefits Over Ten Years (1985-1994)

To explore the cumulative benefits of the transformed market in Wisconsin over a ten-year period (1985-1994), the findings from the previously described Michigan/Wisconsin market assessment were combined with findings from prior analyses of the Wisconsin furnace market conducted by the authors (Schlegel et al. 1992, Schlegel and Prahl 1994). Data sources used in these prior analyses included a survey of Wisconsin heating contractors, follow-up interviews with a subsample of contractors, Wisconsin utility saturation studies conducted between 1988 and 1992, and similar data and information available from nearby states (Northern Illinois and Minnesota). These data were used in the prior analyses to make comparisons between Wisconsin and surrounding states. The analysis presented in this paper used the furnace market in the Midwest states surrounding Wisconsin (including Michigan) as the baseline (i.e., as a proxy for what would have happened in Wisconsin in the absence of the specific government and utility efforts).

First, the penetration of high-efficiency furnaces over the ten-year time period in the two states was estimated. The saturation studies conducted in 1991 in two service territories in Wisconsin showed that of the furnaces replaced between 1988 and 1991, about 90% were replaced with high-efficiency systems (i.e., 90% penetration). This compared to high-efficiency furnace penetration of 15 to 30% in nearby states during the same time period. The estimates derived from interviews of Wisconsin contractors in 1992 were consistent with the findings from the saturation studies. The estimates of 1985 through 1991 penetration from the prior analyses (Schlegel et al. 1992, Schlegel and Prahl 1994) were combined with the findings for 1994 from the Michigan/Wisconsin market assessment discussed above to develop two technology diffusion curves: one for Wisconsin, and one for the other Midwest states assumed to represent the baseline (Figure 3).

Based on the data used in the analyses and represented in Figure 3, the average penetration of high-efficiency furnaces in Wisconsin over the ten-year period was almost 66%, compared to 16% for the baseline states (including Michigan) over the same time period. The average incremental

Figure 3. Penetration of high-efficiency furnaces purchased from 1985 through 1994.



penetration in Wisconsin was 49.3%. Using this incremental penetration rate, and data on the number of gas furnaces replaced per year, it was estimated that almost 300,000 additional high-efficiency furnaces were purchased in Wisconsin over the ten-year period compared to what would have happened if the market in Wisconsin had been similar to the markets in the other states.

These 300,000 additional high-efficiency furnace purchases provide 43.3 million therms of annual energy savings, with savings to customers of $26.8 million per year (using the 1994 average Wisconsin retail price of $.62/therm). Lifecycle savings were estimated to be 909 million therms. The present value of these lifecycle energy savings benefits to customers is over $444 million (1994$; using a consumer discount rate of 6%).

The furnace cost savings from lower prices to Wisconsin customers over the ten-year period were not estimated because data on furnace prices and incremental costs over time were not available. Lack of data on furnace prices over time also restricted the estimation of net present value to the single year (1994) analysis discussed in the previous section.

In terms of benefits to the economy of Wisconsin, the state saves about $11 million annually (at the 1994 wholesale price of $.255/therm) due to reduced imports of natural gas. The state will save 909 million therms of natural gas imports over the lifetimes of the high-efficiency furnaces, with a present value of $211 million (using a social discount rate of 4%). The actual value of these savings is likely to be greater if natural gas prices increase above inflation over the next decade, as expected. Furthermore, the ''efficiency gap'' between the Wisconsin market and its neighbor states persists meaning that additional savings and benefits will continued to be captured for the foreseeable future.

CONCLUSIONS

This paper has demonstrated the notable difference in the residential natural gas furnace markets in two neighboring northern tier states: Wisconsin and Michigan. Briefly stated, the Wisconsin market has been almost completely transformed to high-efficiency furnace models, whereas the Michigan market is still dominated by standard-efficiency models. Because of this transformation, almost 300,000 additional high-efficiency furnaces were purchased in Wisconsin from 1985 through 1994 compared to what would have happened if the market in Wisconsin had been similar to the markets in the surrounding states. Wisconsin customers are receiving $26.8 million in annual energy savings (at $.62/therm) due to these additional high-efficiency purchases, with a present value of $444 million (1994$). The economic benefits which have accrued and are accruing to the Wisconsin economy from having a transformed market are considerable, including $11 million in annual savings due to reduced imports of natural gas, with a lifecycle present value of $211 million.

Although not the result of a deliberately planned market transformation strategy, the Wisconsin transformation does appear to be logically attributable to a series of government and utility program interventions in that state. Thus, while this study cannot legitimately be construed as a field test of ''market transformation'' as an intervention technique, it does document the fact that it is possible to transform a particular market into an almost exclusively high-efficiency market, and that the economic benefits of doing so are substantial. In those respects this paper is an incremental contribution toward demonstrating the potential viability and importance of market transformation as a deliberate energy conservation strategy.

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