data were measured. These are used in the model to adjust rated capacity and efficiency to typical operating values.

About 98% of the homes had a natural gas fired furnace for heating. Therefore the model was created with that system. About 2% of the homes in the sample had electric heat, which are candidates for high efficiency heat pumps. To model these, the gas furnace in the average home base case was temporarily replaced with a standard efficiency heat pump or electric strip heat, listed in Table 24 above and Table 26 below as ID numbers 10 and 11.

Calculation of Individual Measure Impacts

The savings for each measure were calculated separately for the northern and southern counties of the state. The statewide savings per house were then calculated as the population-weighted averages of the regional savings. The 2000 U.S. Census data for the northern population of single-family detached homes is 2,549,792, and 519,092 for the southern population. The related weighting fractions, therefore, are about 0.83 and 0.17.

The Chicago metropolitan area dominates the population of northern Illinois. Although there are numerous other population centers in northern Illinois, Springfield and East St. Louis are the only two major population concentrations in southern Illinois.

Savings estimates for each measure and optional retrofit improvement are summarized in Table 26, which includes estimates for the relatively small numbers of electric heated homes. Electric savings occur for all measures except the last four. Savings for these rely on the type of water heater in the home, and the typical home uses gas water heating. Electric savings for those homes (about 4% of the population) with electric water heaters were calculated, and the results are reported in the specific sections of this report that address each measure.

The shaded ID numbers represent the measures and options that have been identified by MEEA as priority measures. The blank shaded cells represent housing types that the respective measure does not apply. For example, ID 10 is a heat pump replacement measure that applies only to homes with heat pump heating systems, and ID 11 is a heat pump replacement of an existing electric strip heating system.

Savings for ID numbers 22 through 34 (except for ID 30) in Table 26 are not directly calculated by DOE2, so the savings for these were taken from the results of previous studies. Direct impacts for lights and appliances located within the conditioned space were programmed into the DOE2 models, however, to capture their secondary impacts on cooling and heating loads.

	Electric Savings Per Home			Diff.	Gas Heated Houses					Electric Strip Heat Houses			Electric Heat Pump Houses		
					Gas Savings Per Home			Total	Payback	Elec Ht	Total	Payback	Elec Ht	Total	Payback
ID	kW	kWh	$ Saved	Cost	BTUH	Therms	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years
1	0.49	470	$42	$110	0	0	$0	$42	2.6	$0	$42	2.6	$0	$42	2.6
2	0.20	105	$9	$90	0	0	$0	$9	9.6	$0	$9	9.6	$0	$9	9.6
3	0.60	530	$48	$807	0	0	$0	$48	16.9	$0	$47	17.0	$0	$47	17.0
4	0.34	257	$23	$78	0	0	$0	$23	3.4	$0	$23	3.4	$0	$23	3.4
5	0.31	305	$27	$500	10318	118	$77	$104	4.8	$255	$283	1.8	$111	$138	3.6
6	0.17	121	$11	-$1,858	0	0	$0	$11	0.1	$0	$11	0.1	$0	$11	0.1
7	0.36	314	$28	-$1,000	0	0	$0	$28	0.1	$0	$28	0.1	$0	$28	0.1
8	0.12	52	$5	$506	2692	81	$53	$57	8.8	$176	$181	2.8	$77	$81	6.2
9	0.56	509	$46	$425	0	0	$0	$46	9.3						
10	0.66	1889	$170	$708									$125	$170	4.2
11	8.43	16960	$1,523	$4,245						$1,488	$1,523	2.8			
12	0.74	484	$43	$839	9080	101	$65	$109	7.7	$218	$261	3.2	$95	$138	6.1
13	0.52	299	$27	$671	6546	62	$41	$67	9.9	$135	$162	4.1	$59	$86	7.8
14	1.10	762	$68	$2,584	22381	451	$294	$362	7.1	$976	$1,044	2.5	$424	$492	5.3
15	0.13	-430	-$39	$270	9089	61	$40	$1	99.0	$134	$95	2.8	$58	$20	13.6
16	0.50	209	$19	$400	16749	265	$172	$191	2.1	$573	$592	0.7	$249	$268	1.5
17	0.73	350	$31	$2,432	5368	41	$27	$58	41.9	$89	$120	20.3	$39	$70	34.9
18	0.31	120	$11	$914	3169	27	$17	$28	32.5	$58	$68	13.4	$25	$36	25.6
19	0.80	364	$33	$384	2007	-14	-$9	$24	16.3	-$30	$2	155.8	-$13	$19	19.7
20	0.80	371	$33	$460	2868	-3	-$2	$31	14.8	-$7	$26	17.7	-$3	$30	15.3
21	0.64	293	$26	$432	103	-5	-$3	$23	18.6	-$10	$16	27.3	-$5	$22	19.9
22	0.62	365	$33	$600	5	-4	-$3	$30	19.8	-$8	$24	24.7	-$4	$29	20.7
23	0.43	786	$71	$85	0	-20	-$13	$57	1.5	-$44	$27	3.2	-$19	$52	1.6
24	0.27	260	$23	$163	0.000	-5	-$4	$20	8.2	-$12	$12	14.0	-$5	$18	8.9
25	0.32	472	$42	$700	0.000	-10	-$6	$36	19.5	-$21	$21	33.6	-$9	$33	21.2
26	0.04	43	$4	$133	400	4.2	$3	$7	20.2	$0	$7	20.2	$0	$7	20.2
27	0.13	180	$16	$133	0	0.0	$0	$16	8.2	$0	$16	8.2	$0	$16	8.2
28	0.00	-4	$0	$404	1500	21	$14	$13	30.3	$0	$13	30.3	$0	$13	30.3
29	0.49	680	$61	$404	0	0	$0	$61	6.6	$0	$61	6.6	$0	$61	6.6
30	2.01	60	$5	$150	22413	26	$17	$22	6.8	$56	$61	2.5	$24	$29	5.1
31	0.00	0	$0	$5	500	5	$3	$3	1.7	$0	$3	1.7	$0	$3	1.7
32	0.00	0	$0	$20	3001	27	$18	$18	1.1	$0	$18	1.1	$0	$18	1.1
33	0.00	0	$0	$50	152	13	$9	$9	5.8	$0	$9	5.8	$0	$9	5.8
34	0.00	0	$0	$50	217	19	$12	$12	4.0	$0	$12	4.0	$0	$12	4.0

Table 26: Electric and Natural Gas Savings by Measure and Heating System Type

Differential costs shown for each measure are the average costs to install the measure, or the difference in cost between a standard retrofit and the high efficiency option. Payback is the simple payback in years, (the ratio of annual fuel dollars saved and differential installed cost).

Total fuel dollars saved are based on annual electric and gas savings and their respective marginal unitary rates. For the measures that strongly affect heating energy usage, monetary savings and payback differ significantly with heating system type, as evidenced by different numbers in the three payback columns. Payback times for ID numbers 6 and 7 are not defined because they cost less to install than their standard retrofit choices, as indicated by the negative differential costs. A fictitious non-zero payback value of 0.1 was used here to permit MEEA to estimate market penetration rates based on payback.

Situation and Measure Improvement Descriptions

The following are descriptions of each listed measure and improvement option, explanations of the assumptions made, and the technical approach to estimating impacts. These measurements include both potential energy efficiency improvements and weatherization measures.

Undercharged AC Systems – ID 1

Published accounts from several other studies, including a recent New England HVAC study conducted by RLW Analytics in 2002, were used to estimate the technical potential percentages for AC systems. From these studies, about 36% of the measured systems are probably undercharged with refrigerant, enough to exhibit recognizable symptoms. The average undercharged condition was modeled as a 20% reduction in both cooling capacity and efficiency. This 20% reduction represents a general consensus of the other studies.

In the baseline DOE2 models, the refrigerant charge factor was adjusted to 0.8 to reflect this 20% loss. In the retrofit models this factor was set to 1.00 to reflect a properly charged system. At this point the operating capacities and efficiencies were still slightly below rated values due to the fact that evaporator airflow is still a little low. This refrigerant charge correction resulted in an estimated annual savings of 470 kWh, and a peak demand reduction of 0.49 kW.

Overcharged AC Systems - ID 2

About 31% of the measured AC systems in other studies were found to be overcharged with refrigerant. The average effect of this situation, however, is not nearly as dramatic, with only a 5% reduction in both cooling capacity and efficiency. This was represented in the models by a refrigerant charge factor of 0.95, which is in fact the average operating condition. The frequency, degree, and impact of overcharging are not as great as undercharging.

In the retrofit models the refrigerant charge factor was set to 1.00. This resulted in an estimated annual savings of 105 kWh, and a peak demand reduction of 0.20 kW.

AC Systems With Low Evaporator Air Flow – ID 3 and 4

According to recent studies, about 70% of residential AC systems have a problem of significantly low evaporator airflow. The threshold for this performance characteristic is considered 350 CFM per ton, which is generally used as the lowest acceptable flow rate before capacity and efficiency are appreciably reduced. The average airflow for all those below the threshold was about 300 CFM per ton.

In the baseline DOE2 models the system airflow rate was set at 300 CFM per ton. In the retrofit models this was increased to 400 CFM per ton.

Two different approaches to the correction of a low airflow problem were examined because the associated costs and impacts of each are significantly different. The easiest, and least expensive, solution is to increase the blower speed whenever practical. In many cases, however, this might not be possible due to the presence of single speed blowers or a limited remaining blower capacity.

The other approach is to reduce airside system operating pressures by locating and removing restrictions or by increasing duct capacities. In an existing system the only practical ways to increase supply duct capacity are to replace existing ductwork with larger run outs to several rooms, or add more run outs at or near the supply plenum to new supply grilles.

In past studies, it was found that many return duct systems are simple but undersized. Return duct under-sizing often occurs with systems in the attic that have one central return air filter grille in the ceiling of a corridor with one large flexible duct to a return plenum. In most, if not all, cases these can be replaced with larger ducts and return grilles, or new ducts and grilles can be added in parallel. Specifically, our audits found a total of 57 units (18%) were located in attics.

Any reliable and practical correction to the problem of low airflow would have to be determined by a careful on-site analysis of each problematic system. Often it may be necessary to combine fan speed corrections along with increased supply and return duct capacities to obtain proper airflow at a reasonable cost.

The retrofit DOE2 model for increased duct capacity, ID 3, assumed that the total static pressure of the air distribution system could be reduced enough to allow the existing blower to deliver the required air flow without increasing the blower speed. The blower power was increased linearly with the increased airflow rate, and the system capacities and efficiencies were increased to rated conditions. This resulted in an estimated annual savings of 530 kWh, and a peak demand reduction of 0.60 kW.

The retrofit model for increasing blower speed, ID 4, required an increase in motor power equal to the square of the ratio of the flow rates. The increased fan power offset about half of the energy savings due to increases in system capacity and efficiency. This resulted in an estimated annual savings of 257 kWh, and a peak demand reduction of 0.34 kW.

AC Systems With High Duct Leakage – ID 5

The recent New England study found that about 73% of the AC systems had a problem of significantly high supply duct leakage to the outside. The threshold for supply air leakage was 15% of actual system airflow. The average leakage for all those above the threshold was 25 percent. The systems with high duct leakage do not seem to correlate at all with duct location or plenum static pressure. Based on field observation, however, these systems were characterized by poor installation workmanship, and they tended to be older than the others.

Qualitative field data from this study suggest that this problem is probably not so drastic throughout the state of Illinois.

The DOE2 model treats duct leakage as primary air delivered to and returning from unconditioned spaces such as attics and basements. One third of the leakage was assigned to the unconditioned portion of the basement, and the remainder went to the first and second floor attic spaces. This leakage air actually tends to cool these spaces slightly, and they are modeled as buffer zones so that return air from them approximates actual zone conditions. In this way, the primary effects of both supply and return air leakage to these spaces are captured in the model.

The baseline model used 25% duct leakage, and this was reduced to 5% in the retrofit case. This resulted in an estimated annual savings of 305 kWh, and a peak demand reduction of 0.31 kW, plus 118 therms of gas per year and 10318 BTU per hour (BTUH) of peak gas consumption due to the reduction in gas heating.

In this analysis the inherent but small reduction in evaporator airflow was not modeled because an average value was not known.[10] Many systems with leaky ductwork also suffer from insufficient airflow. The New England study found that 19 systems, or 79% of those with high duct leakage, also had low airflow below 350 CFM per ton. Additionally, it was observed that 29% had a high blower motor power over 150 Watts per ton. In practice, it is necessary to measure the existing system airflow and blower motor power to determine if these other two potential problems need to be corrected before duct sealing is attempted.

Proper Sizing of AC Systems – ID 6 and 7

An oversized system in this study is defined as having a rated cooling capacity greater than 100% of a valid Manual J cooling load estimate. Based on an average Manual J estimate of capacity in terms of square feet per ton and the individually observed home sizes and installed capacities, about 80% of the AC systems of this study are oversized relative to this criterion. Those that qualified as oversized averaged 50% above the Manual J estimate.

The DOE2 models estimate the cooling system efficiency each hour as a function of a part load ratio. This is the ratio of system load and cooling capacity, and the function is empirically designed to approximate the efficiency penalty due to system cycling.

In the baseline model for ID 6 the oversized system rated capacity is 3.52 tons, and in the first retrofit case the size is reduced to 2.35 tons, with a proportional reduction in airflow and duct sizing to maintain 372 CFM per ton. The rationale for maintaining this airflow rate is the probability that the same duct sizing practice is applied by the contractor independent of system size. This would be applicable to new AC systems that are installed where there is no existing ductwork. The estimated annual savings is 121 kWh, with a peak demand reduction of 0.17 kW.

On the other hand, if a new system is to be installed to replace an old system or with an existing forced air furnace that already has supply and return ductwork, there would be no need to install new ductwork. In this scenario, ID 7, there is even more to gain by keeping the system size to a minimum. This is due to the fact that the existing ductwork would be able to deliver the same airflow as before (which would become a proportionately higher CFM per ton) with the same fan power, thus reducing the system losses due to low airflow and excessive system cycling.

The retrofit DOE2 models for this case assume that the duct sizes, airflow rates, and fan static pressures remain unchanged. Even though the fan power is not increased, the annual fan energy consumption increases due to the fact that the system operates for longer periods of time, and this is accounted for in the models. The estimated annual savings for this scenario is 314 kWh, with a peak demand reduction of 0.36 kW.

The advantages of reducing system size are all positive as long as the system capacity is sufficient to maintain acceptable comfort conditions about 97.5% of the time (which are all but a few hours

[10] The effect on energy usage is even smaller due to offsetting effects of fan power and system efficiency.

of the typical cooling season). The smaller system will typically maintain better humidity control, last longer, make less noise, use less energy and cost less to install.
Most of the problems of low evaporator airflow in houses with evaporator coils added to existing forced air furnaces could be greatly reduced or avoided if the AC system is properly sized for the application. In recent studies, about 70% of the systems that are oversized also have evaporator airflow below 350 CFM per ton.

Unfortunately, downsizing is not a viable option after the system has been installed. Therefore, as an effective conservation program component, information and incentives will need to be presented to prospective participants before the fact. Information and incentives should also be directed toward the contractors.

Addition of Duct Insulation – ID 8
It was observed that most ducts in the basements were not insulated, whereas nearly all ducts in the attics had at least one inch of insulation. The only appreciable savings available would be due to the addition of another inch of insulation to exposed ducts in the attic. Exact modeling of this was not within the scope of this project, but some assumptions were made regarding the duct heat gains due to conduction from a hot attic.

In the baseline DOE2 models it was assumed that 90% of the ducts were located in the attic and the product of U*A (i.e. thermal conduction coefficient times duct surface area) would be about 36, yielding an approximate peak air temperature rise of 1.0 degree Fahrenheit during the cooling cycle. In the retrofit case this U*A value was reduced to 20. The estimated annual savings for this measure is 52 kWh, with a peak demand reduction of 0.12 kW, plus 81 therms of gas per year and 2692 BTUH of peak gas consumption.

There were a few instances observed by our auditors of what appeared to be uninsulated ducts in the attic spaces, but most or all of these were probably internally lined sheet metal. Also, only small portions of most of these "uninsulated" duct systems were located in the attic spaces. Therefore, it may be assumed that the existence of significant portions of uninsulated ductwork in attic spaces is rare in Illinois. If, however, 2" of insulation were added to uninsulated ducts primarily located in an attic space, the savings would be about five to seven times as much as shown above in the previous paragraph.

High Efficiency SEER 13 AC – ID 9
Significant savings are potentially available for the installation of high efficiency AC systems instead of standard efficiency SEER 10 units. In the existing home retrofit market this might be applied to homes with old existing systems that are at the end of their useful operating lifetimes and need to be replaced. This might also apply to an existing home in which air conditioning was never before installed and the homeowner wants to install a new central AC system.

Modeling the unit savings for this measure was straightforward. The baseline DOE2 models were assigned a rated efficiency of SEER 10, and the retrofit model used SEER 13. All other conditions remained unchanged. The estimated annual savings for this measure is 509 kWh, with a peak demand reduction of 0.56 kW.

High Efficiency SEER 13 Heat Pump – ID 10 and 11
Although most of the homes throughout the state employ natural gas furnaces for heat, a few (between 2% and 3%) use electric heat pumps or electric strip heat for primary heat. As a retrofit measure the installation of a high efficiency heat pump might be an option for existing homes with old heat pumps or with electric resistance heat.

The base case model for an old heat pump replacement, ID 10, assumed the baseline replacement heat pump would have been an SEER 10. The retrofit model was the same except the heat pump would be an SEER 13. Potential savings for this option are about 1889 kWh and 0.66 kW for the average home.

The base case models for an old electric resistance heat system replacement, ID 11, assumed the replacement equipment would be same as above. Potential savings calculated for this option were an astounding 16,960 kWh and 8.43 kW. Actual average savings for electric heated homes might be much lower due to the possibility that the average electric strip heated home is smaller and more fully insulated, and the probability that the occupants are more frugal in their energy usage practices (due to excessively high heating costs). In such cases the savings might be more like 50% to 75% of those calculated by these typical DOE2 models.

Add Attic Insulation – ID 12 and 13

Savings achievable for increasing attic insulation vary greatly with the amount of insulation already in place, as well as the amount of extra insulation added. Whether this is cost effective depends more on the amount of existing insulation. Two different baseline insulation values of R-7 and R-11 were assumed. In both retrofit scenarios the final R-value was about R-30. Addition of any more than this is typically not cost-effective.

In the first scenario, ID 12, the baseline models were given an attic insulation value of R-7 with a retrofit to R-30. The calculated savings are 484 kWh and 0.74 kW, plus 101 therms of gas annually and 9080 BTUH of peak gas consumption.

In the second scenario, ID 13, the base case was R-11 and the retrofit was R-30. Savings were estimated to be 299 kWh and 0.52 kW, as well as 62 therms and 6546 BTUH.

Add Wall Insulation – ID 14

Similar to attic insulation, achievable savings by increasing wall insulation vary greatly with the amount of insulation already in place, as well as the amount of extra insulation added. Whether this is cost effective depends more on the amount of existing insulation. MEEA evaluated this measure with a baseline of no wall insulation, and added R-11 insulation to represent a realistic best-case scenario.

The calculated savings are 762 kWh and 1.1 kW, plus 451 therms of gas per year and 22,381 BTUH of peak gas consumption due to the reduction in gas heating. Because of the high cost of adding insulation to existing walls, however, the simple payback for this measure is relatively long at about 7.1 years.

Although the potential savings are high, the long payback suggests that it would not be cost-effective to insulate existing walls with some insulation already in place. In fact, the existence of any batt insulation in existing walls renders it impractical to add more insulation by the normal method of blowing it through holes drilled into the stud cavities because the batts would tend to block the flow of new insulation in many places.

Add Insulation to Floor over Unheated Basement – ID 15

Most basements are enclosed by thick masonry foundation walls and have intimate contact with the earth. As such, they are naturally cooled by relatively low ground temperatures typical of Illinois, where the averages are about 64 degrees Fahrenheit during the summer and about 43 during the winter.

As a result of the low ground temperatures, the savings are negative for most of the cooling season. The base case for this measure assumed no insulation and the retrofit provided for the addition of R-19 to the floors over the basements. Calculated savings are -430 kWh and 0.13 kW, plus 61 therms of gas per year and 9089 BTUH of peak natural gas consumption. Due to major differences in the costs of electricity and gas, the monetary savings from gas are offset by the increase in electricity, and the simple payback exceeds 100 years (99 was used in the market analysis).

Reduce Infiltration by Caulking and Weather stripping – ID 16
For this measure MEEA assumed a baseline infiltration value of 0.8 ACH (Air Changes per Hour) and a retrofit of 0.35 ACH. MEEA learned from several studies in different parts of the country that the average home infiltration rate is about 0.5 ACH. Calculated savings for weatherization measures are 209 kWh and 0.5 kW, 265 therms of gas per year, and 16,749 BTUH of peak natural gas consumption

Replace Standard Double Pane Windows – ID 17, 18 19 and 20
The average house in this study has about 203 square feet of window area. Less than 1% of the windows in this study were triple pane, but another 6% were double pane with storm windows, thus with a triple pane effect. About 64% were double pane windows and another 23% were single pane with storm windows, thus having a double pane effect. The remaining 6% were bare single pane windows, but many of these are fitted with removable storm windows during the winter. The overall average number of glass panes is 2.0, based on the study sample.

MEEA used a typical double pane window with a U_0 (thermal transmission coefficient) value of 0.45 and a SHGC (Solar Heat Gain Coefficient) of 0.76 for the base case, and applied three different potential retrofit scenarios to estimate savings for each. Table 27, below, shows the performance characteristics and results of these glazing options.

Retrofit Scenario	ID No.	Provided for:	U_0	SHGC	Savings
A	17	Low E triple pane windows	.17	.47	350 kWh, 0.73 kW 41 therms, 5363 BTUH
B	18	Addition of storm windows	.32	.68	120 kWh, 0.31 kW 27 therms, 3169 BTUH
C	19	High performance Low E double pane windows	.35	.40	364 kWh, 0.80 kW -14 therms, 2007 BTUH
D	20	Very high performance Low E double pane	.32	.40	371 kWh, 0.80 kW -3 therms, 2868 BTUH

Table 27: Technical Potential: Window Replacement Options

Retrofit Scenarios A and B yield both summer and winter savings, as expected. Scenarios C and D, however, cause slight increases in winter fuel consumption (therms of natural gas). The latter is due to the low SHGC of 0.40 for these options, eliminating enough free solar heat to more than offset the savings due to reduced conduction (low U_0).

Obviously low E double pane windows perform better than double pane clear glazing with storm windows, in spite of the fact that storm windows create a triple glazing effect. Addition of storm windows costs about the same whether the existing windows are old or new. The total cost of replacing existing windows, however, is prohibitive from an energy conservation perspective alone. Therefore the three window replacement options must be reserved for old homes with original windows that already need to be replaced. The conservation program goal would be to identify these homeowners and encourage them to choose high performance Low E windows in lieu of standard clear ones, thus incurring only the differential costs of the two alternatives.

Add Shading to East and West Facing Windows – ID 21 and 22
Although external window shading might be added to all four faces of a house, the east and west faces offer the greatest potential savings. Also, to obtain maximum energy savings, the shade would have to be applied during the cooling season and removed during the heating season to avoid increasing the heating loads during the winter.

MEEA considered and analyzed two different ways of shading east and west facing windows for this study, because one method will apply to some, while the other method is better for others. Neither alternative will be applicable to homes with significant east and west shading from existing trees or other things. To model these measures MEEA removed all but 10% of the external shading from the baseline model.

One practical method, ID 21, of shading windows from the exterior is the addition of solar screens that can be removed during the heating season. To model this retrofit, MEEA reduced the east and west glass shading coefficient (SC) from 0.5 to 0.25 and the U_0 value from 0.8 to 0.7 for the period of June 1 to October 31. Estimated savings for this scenario are 293 kWh, 0.64 kW, -5 therms and 103 BTUH. There was a slight increase in natural gas usage during the swing seasons because, in the model, screens are not removed and reinstalled as the ambient temperatures swings cause homeowners to switch often from cooling to heating mode and back.

The other (and more desirable from both an aesthetic and practical perspective) method is the planting of deciduous trees in strategic locations to the east and west of the house. In this scenario, (ID 22) MEEA assumed that three deciduous trees had been planted at 20 feet from each side of the house (a total of six trees) to shade the windows as much as possible, and that they had grown to an effective height of 16 feet. Their solar transmissivities were changed from 0.1 during the summer (June 1 through October 31) to 0.9 during the winter. Resultant savings are 365 kWh, 0.62 kW, -4 therms and 5 BTUH. As these trees continue to grow, the savings will also grow.

Install Compact Fluorescent Lamps – ID 23
Field data from the site visits indicated that 95% of the homes had less than a 10% presence of CFLs (Compact Fluorescent Lamps) by bulb count. Hence, there is a high technical market potential for this measure. In the impact analysis MEEA assumed that each program participant would install and use an average of thirteen 15 Watt CFLs in place of thirteen 60 Watt incandescent lamps, for a connected load reduction of about 580 Watts.

Lighting hourly usage patterns utilized in the models are based on actual measured hourly residential lighting usage patterns from a large number of long-term and short-term end-use studies. Calculated savings amounted to 786 kWh, 0.43 kW, –20 therms and 0 BTUH. The peak heating load was not measurably affected because it occurred during the night when the lights are not being used. The increase in gas usage is due to the fact that the reduction in internal heat gains requires that the heating system provide enough heating energy to make up the difference.

Notice that the peak kW savings was 0.43, or 430 Watts, whereas the reduction in connected load was 580 Watts. This is due to natural diversity in the lighting usage patterns so that all ten of these lamps are never on at the same time. These electric savings include both direct and indirect savings due to the reduction in internal heat gains that reduce the need for cooling.

Purchase ENERGY STAR Qualified Refrigerator – ID 24 and 25
Two options for replacing an existing refrigerator with an ENERGY STAR certified unit were examined in this study. The first option assumes that an existing refrigerator is at the end of its functional life and the homeowner has already decided to replace it. The other option examines the potential of enticing a homeowner to retire an existing refrigerator before the end of its functional life.

For the first option, ID 24, it was assumed that a standard new refrigerator on the market today uses about 660 kWh per year, and an ENERGY STAR refrigerator will use about 432 kWh per year (10% below the 2001 federal standard average of about 480). The difference is 228 kWh per year. This direct energy reduction was modeled into the retrofit DOE2 model, and the resultant total interactive savings are 260 kWh, 0.27 kW, -5 therms and 0 BTUH. Some secondary impacts are seen due to the fact that the refrigerator is in the conditioned space. Actual BTUH impacts are not zero, but less than 0.5, and the zero shown is due to roundoff.

The baseline for the second option, ID 25, was 850 kWh per year, representing an average of annual consumption of residential refrigerators from about 1987 to about 1992. The replacement unit was an ENERGY STAR equivalent using 432 kWh per year. The resultant total interactive savings are 472 kWh, 0.32 kW, -10 therms and 0 BTUH.

Purchase ENERGY STAR Qualified Dishwasher – ID 26 and 27
An average new dishwasher uses about 121 kWh per year, and an equivalent ENERGY STAR dishwasher will use about only about 78 kWh per year if the water heater is not electric. Estimated savings for a house with gas water heating, ID 26, are 43 kWh, 0.04 kW, 4.2 therms and 400 BTUH.

On the other hand, more substantial electric savings are possible if the water heater is electric. In this scenario, ID 27, the savings would be about 180 kWh per year and 0.13 kW peak demand.

Purchase ENERGY STAR Qualified Clothes Washer – ID 28 and 29
Maximum electric savings for high efficiency clothes washers can be achieved if both the water heater and dryer are electric, although by far most of the savings is due to the dryer. The most common Illinois home, however, uses natural gas for both. Since a significant number of homes had electric dryers (29%) and a few had electric water heaters (about 4%), MEEA calculated savings for both a typical home and one where both dryer and water heater are electric.

For the typical home, ID 28, MEEA estimated annual savings to be about -4 kWh, 0.0 kW, 21 therms and 1500 BTUH. The ENERGY STAR clothes washer actually uses slightly more electric energy during the spin cycle to wring more water out, thus reducing the time required for drying.

For the all-electric scenario, ID 29, MEEA estimated annual savings to be about 680 kWh and 0.49 kW.

Install Programmable Thermostat – ID 30

About half of the homes visited already had programmable thermostats. The others either had manual thermostats or were not air-conditioned. MEEA modeled the potential impacts of programmable thermostats by increasing the cooling set points three degrees F and decreasing the heating set points by four degrees F daily from 8AM to 3PM.

For this scenario MEEA estimated annual savings to be about 60 kWh and 2.01 kW, along with 26 therms and 22,413 BTUH. High positive demand savings are due to the fact that the action of the thermostat sometimes causes the systems to cycle off completely during times that they would normally run under high loads. In reality, there is also a high negative demand savings of about –1.17 kW occurring sometime in the afternoon when the thermostat is returned to its normal setting. A similar effect occurs during the heating mode.

Relatively low energy savings are due to the fact that much of the energy saved during the "setback" mode is lost again as the cooling and heating systems attempt to "catch up" after they are returned to normal.

Install Faucet Aerators – ID 31
It was found during the field audits that about 63% of all single-family detached homes in Illinois do not have a faucet aerator. MEEA estimated the impacts of these by assuming that one faucet aerator would be installed on the kitchen sink, and that the energy savings would occur through a reduction in the use of hot water. In this study the typical home will see no electric savings, because the water heater is gas fired.

The estimated savings for the typical home are 5 therms per year and 500 BTUH. For the 4% of homes with electric water heaters, the annual electric savings would be about 107 kWh and 0.12 kW peak demand. These savings are not shown in Table 26 but were calculated from the natural gas savings.

Some homeowners may be willing to install and keep a faucet aerator in the bathroom. Although savings for these are not well defined, MEEA has previously estimated that they might achieve about one tenth to one third the savings of the kitchen aerator. The reduced savings are, of course, due to the fact that the average bathroom sink utilizes significantly less hot water.

Install Low Flow Showerheads – ID 32
Field results of this study show that about 71% of all single-family detached homes in Illinois do not use a low flow showerhead. MEEA estimated the impacts of these by assuming that two low flow showerheads would be installed, and that the energy savings would occur through a reduction in the use of hot water. Again, the typical water heater is gas fired.

The estimated savings for the typical home are 27 therms per year and 3001 BTUH. For the 4% with electric water heaters the annual savings would be about 641 kWh and 0.72 kW peak demand.

If there are more than two showers in a home, the low flow showerheads should be installed on the two most frequently used showers. If more than two devices are installed in a single home, the savings for the third one will probably be significantly less than those of the first two, but it will depend on how much the showers are actually used. On the other hand, if only one showerhead is installed because there is only one shower present, the savings for the one will probably be more than half the savings shown.

Insulate Hot Water Pipes – ID 33

All the audited homes of this study have hot water piping, but only portions of the pipes are easily accessible. MEEA estimated conservation impacts by assuming that the exposed pipes could be insulated, and that the energy savings would occur through a reduction in the hot water standby losses. Again, the typical water heater is gas fired.

The estimated savings for the typical home are 13 therms per year and 152 BTUH. For the 4% with electric water heaters the annual electric savings would be about 312 kWh and 0.04 kW peak demand. Actual savings will vary significantly, depending on the amount and locations of exposed piping and the hot water usage patterns.

Insulate Water Heater Storage Tanks – ID 34
MEEA found that about 84% of the homes visited had gas water heaters that were not externally wrapped. The estimated savings for the typical home are 19 therms per year and 217 BTUH. For those with electric water heaters the annual electric savings would be about 267 kWh and 0.03 kW peak demand. Savings for this measure will vary with the ambient temperatures surrounding the hot water tank.

VI.3 Technical Assessment of Program Market Potentials by Measure

Preferred Energy Conservation Measures

MEEA initially analyzed 34 potential home improvement options. Of these, it was determined that 19 of these measures represent the best current opportunities for energy conservation programs in the state of Illinois. These measures are listed in Table 28. Some of the improvements apply only to air-conditioned homes.

ID No.	Situation	Treatment or Measure
6, 7	Oversized CAC units	Size replacement units to 100% of Manual J
9	Gas heat and 10 SEER CAC	Replace with ENERGY STAR labeled SEER 13 units
17, 18, 19, 20	Standard double pane windows	Replace with ENERGY STAR labeled windows, or install storm windows
21, 22	No/little east & west window shading	Plant deciduous trees on east and west sides, or add solar screens
23	Incandescent light bulbs	Replace with compact fluorescent bulbs
24, 25	Standard refrigerator	Replace with ENERGY STAR rated refrigerator
26, 27	Standard dishwasher	Replace with ENERGY STAR dishwasher
28, 29	Standard clothes washer	Replace with ENERGY STAR clothes washer
30 –32	Lack of temperature management and hot water flow restrictors	Install: - programmable thermostat - faucet aerators - low flow showerheads

Table 28: Measures With Best Promising Market Potential

Differential installed costs and annual monetary savings for these measures are shown in Table 29, which is an extract of Table 26. These costs and savings are estimates of what it might cost an average homeowner to install the measure and what can be saved on utility bills annually without monetary rebates or other conservation program interventions. Payback for each measure is the simple ratio of installed costs to annual monetary savings from a homeowner perspective.

	Electric Savings Per Home			Diff.	Gas Heated Houses					Electric Strip Heat Houses			Electric Heat Pump Houses		
					Gas Savings Per Home			Total	Payback	Elec Ht	Total	Payback	Elec Ht	Total	Payback
ID	kW	kWh	$ Saved	Cost	BTUH	Therms	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years
6	0.17	121	$11	-$1,858	0	0	$0	$11	0.1	$0	$11	0.1	$0	$11	0.1
7	0.36	314	$28	-$1,000	0	0	$0	$28	0.1	$0	$28	0.1	$0	$28	0.1
9	0.56	509	$46	$425	0	0	$0	$46	9.3						
17	0.73	350	$31	$2,432	5368	41	$27	$58	41.9	$89	$120	20.3	$39	$70	34.9
18	0.31	120	$11	$914	3169	27	$17	$28	32.5	$58	$68	13.4	$25	$36	25.6
19	0.80	364	$33	$384	2007	-14	-$9	$24	16.3	-$30	$2	155.8	-$13	$19	19.7
20	0.80	371	$33	$460	2868	-3	-$2	$31	14.8	-$7	$26	17.7	-$3	$30	15.3
21	0.64	293	$26	$432	103	-5	-$3	$23	18.6	-$10	$16	27.3	-$5	$22	19.9
22	0.62	365	$33	$600	5	-4	-$3	$30	19.8	-$8	$24	24.7	-$4	$29	20.7
23	0.43	786	$71	$85	0	-20	-$13	$57	1.5	-$44	$27	3.2	-$19	$52	1.6
24	0.27	260	$23	$163	0.000	-5	-$4	$20	8.2	-$12	$12	14.0	-$5	$18	8.9
25	0.32	472	$42	$700	0.000	-10	-$6	$36	19.5	-$21	$21	33.6	-$9	$33	21.2
26	0.04	43	$4	$133	400	4.2	$3	$7	20.2	$0	$7	20.2	$0	$7	20.2
27	0.13	180	$16	$133	0	0.0	$0	$16	8.2	$0	$16	8.2	$0	$16	8.2
28	0.00	-4	$0	$404	1500	21	$14	$13	30.3	$0	$13	30.3	$0	$13	30.3
29	0.49	680	$61	$404	0	0	$0	$61	6.6	$0	$61	6.6	$0	$61	6.6
30	2.01	60	$5	$150	22413	26	$17	$22	6.8	$56	$61	2.5	$24	$29	5.1
31	0.00	0	$0	$5	500	5	$3	$3	1.7	$0	$3	1.7	$0	$3	1.7
32	0.00	0	$0	$20	3001	27	$18	$18	1.1	$0	$18	1.1	$0	$18	1.1

Table 29: Electric and Natural Gas Savings by Measure and Heating System Type for Preferred Measures

Market Potentials for the Preferred Measures

The realizable market potential of a measure may be defined to represent the extent to which a measure might actually be applied annually throughout the state over a reasonable period of time, which can be 5 to 10 years of full implementation of a well-designed conservation program.

Statewide market potentials for each measure were calculated by multiplying together the individual savings per measure, the realizable market potentials in terms of percentages, and the total current number of single-family detached homes throughout the state. These realizable potential savings are presented in terms of a) total electric demand in megawatts, b) electric energy savings in megawatt-hours, c) natural gas in kilotherms and d) thousands of dollars. Effects of possible population growth over the projected time period were not considered in this study.

Figure 3 below shows a general market potential schematic. Moving from left to right, the "Technical Potential" for the intended program or measure can be defined as the percentage of all targeted customers who are eligible for the program. The "Raw Economic Potential" reflects the percentage of eligible homes in which the measure can be economically applied.

The expected actual penetration rates under different program scenarios, or the "Market Potential", involves the estimation of how many customers would participate in a specific program over a given time period. That is, the "Market Potential" indicates the percentage of targeted homes that would install the measures delivered by well-defined and aggressively executed programs. The values, of course, depend on the measures, the length of time the program is offered, the specific markets, numbers of customers targeted, and finally the level of subsidy (if any).

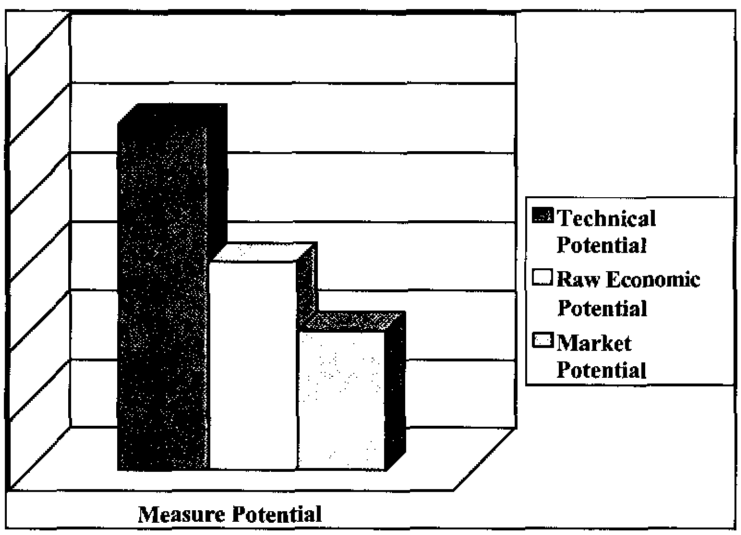

Figure 3: Market Potential Schematic

This measure potential schematic can be applied to the residential population of Illinois as follows:

(1) The "Technical Potential" is the total number of single-family detached homes in Illinois that are eligible for each measure type. Using deciduous shade trees as an example, the

"Technical Potential" for this study is the percentage of all single-family detached residential customers who have air-conditioned homes and have space in their yards to plant trees on the east and west sides of their houses. Homes that are not air-conditioned will not be eligible for this measure because there would be no basis for obtaining energy savings.

(2) The "Raw Economic Potential" was determined through analysis of the in-home audits to assess what percent of qualified customers could achieve savings through installation of the measure within the realm of economic feasibility. For example, it would not be economically feasible for a homeowner to replace existing double pane windows with higher performance windows solely for the purpose of saving energy, even though the home is technically eligible. The total cost of replacing windows is far too great to incur on these terms alone. If, however, the windows need to be replaced for other reasons (such as excessive age and unacceptably poor condition) the much smaller differential cost of choosing high performance windows over standard windows is economically feasible from an energy savings perspective.

(3) The final "Market Potential" was estimated through existing utility research and past participation rates in other programs.

Table 30 below lists the 19 measures that represent the best opportunities for energy conservation programs in Illinois, showing ID numbers, their potential situations, improvement options, and three columns of market potential estimates. The "Technical Potential (% of Homes that Qualify)" is the "Technical Potential" previously described. The last column, "Raw Economic Potential (% of General Population)" is the previously defined "Raw Economic Potential". It is simply the product of the "Technical Potential (% of Homes that Qualify)" and the "Economically Feasible (% of Technical Potential)".

ID	Potential Situation	Improvement	Technical Potential (% of Homes that Qualify)	Economically Feasible (% of Technical Potential)	Raw Economic Potential (% of Population)
6	Oversized AC units A	Size AC units to 100% of Manual J	12.00%	5.00%	0.60%
7	Oversized AC units B	Size AC units to 100% of Manual J	68.0%	7.0%	4.8%
9	Gas heat and 10 SEER AC	Install AC SEER = 13	97.0%	7.0%	6.8%
17	Standard double pane windows A	Install Low E triple pane window	80%	26%	21%
18	Standard double pane windows B	Add storm windows	54%	100%	54%
19	Standard double pane windows C	Install Low E double pane window	80%	26%	21%
20	Standard double pane windows C	Install Low E double pane window	80%	26%	21%
21	No E & W window shading A	Add solar screens to E & W glass	84%	100%	84%
22	No E & W window shading B	Plant deciduous trees on E & W sides	76%	100%	76%
23	No Compact Fluorescent Lamps	Use 10 CFLs throughout house	100%	95%	95%
24	Refrigerator needs to be replaced	Purchase Energy Star refrigerator	94%	12%	12%
25	Refrigerator early retirement	Purchase Energy Star refrigerator	94%	88%	83%
26	Dishwasher to be replaced A	Purchase Energy Star dishwasher	91%	24%	22%
27	Dishwasher to be replaced B	Purchase Energy Star dishwasher	4%	24%	0.9%
28	Clothes washer to be replaced A	Purchase Energy Star clothes washer	64%	17%	11%
29	Clothes washer to be replaced B	Purchase Energy Star clothes washer	2.2%	17%	0.4%
30	No prgrammable thermostat	Install programmable thermostat	41%	100%	41%
31	No faucet aerators	Install faucet aerators	63%	100%	63%
32	No low flow shower heads	Install low fow shower heads	71%	100%	71%

Table 30: Technical and Raw Economic Market Potentials for Preferred Measures

The final "Market Potential" estimates of this study are based partly on historical penetrations of existing programs in other states and partly on an analytical model designed to utilize the differential costs and simple payback periods calculated for each measure. A qualitative adjustment aimed at accounting for known (non-economic) market barriers was also included in the model.

Table 31 shows the results of the market analyses for the 19 preferred program measures and options. The "Quantity" column shows the quantity of each item that was modeled in the impact analysis and used as a basis for estimating the associated installed cost of each measure.

"Raw Economic Potential %" is the same as that shown in Table 30 under "Raw Economic Potential (% of General Population)". The qualitative "Market Barrier Factor" is shown in the fourth column of the table. The column labeled "Annual Market Capture %" shows the results of the analytical model previously mentioned. It represents the probability that a given measure will be adopted based solely on its installed cost, simple payback, and market barrier factor. In the model this probability is inversely proportional to the installed cost, the simple payback and the market barrier factor. First cost was assigned an importance equal to three times that of the payback period.[11]

The market barrier factor captures the effects of known non-economic market barriers by using a discreet value of 1, 2 or 3. A 1 will indicate little or no known barriers exist, a 2 will indicate average barriers and a 3 will indicate the existence of formidable barriers. For example, ID 21 represents the option of adding solar screens to the east and west facing windows for shading. This option was assigned a market barrier factor of 3 because major non-economic market barriers here are the diminished appearance of the home perceived by most homeowners, and the fact that they have to be removed and replaced each year to achieve their potential savings.

The analytical model also includes a scaling constant to permit calibration of the model to known conservation program results. Annual market penetrations expressed as percentages were found for recent programs throughout the country for several of the measures, including high performance windows, compact fluorescent light bulbs, and ENERGY STAR refrigerators, dishwashers and clothes washers. The analytical model was calibrated by iteratively adjusting the scaling factor until the model agreed with the average of the percentages of these existing programs.

[11] In previous market assessment and market potential studies done by RLW, we have found that after other barriers are diminished or eliminated, first cost continues to remain as the primary barrier.

ID	Quantity	Raw Economic Potential %	Market Barrier Factor	Annual Market Capture %	Yearly Realizable Potential %	Multiple Options Fraction	Annual Savings Potential MW	Annual Savings Potential MWh	Annual Savings Potential kTherms	Annual Savings Potential k$
6	3.52 tons	0.6%	3	15.00%	0.090%	1.00	0.5	333	0	30
7	3.52 tons	4.8%	3	15.00%	0.714%	1.00	7.8	6,877	0	618
9	2.83 tons	6.8%	1	2.30%	0.156%	1.00	2.7	2,391	0	215
17	203 SF	21%	2	0.19%	0.040%	0.04	0.0	18	2	3
18	203 SF	54%	3	0.24%	0.129%	0.13	0.2	64	13	14
19	203 SF	21%	1	2.18%	0.456%	0.44	5.0	2,236	-85	145
20	203 SF	21%	1	1.92%	0.402%	0.39	3.8	1,786	-16	150
21	96 SF	84%	3	0.48%	0.408%	0.27	2.1	977	-16	77
22	6 each	76%	1	1.46%	1.114%	0.73	15.5	9,098	-95	755
23	13 CFLs	95%	2	5.49%	5.225%	1.00	69.1	124,990	-3,207	9,134
24	1 each	12%	1	4.99%	0.578%	1.00	4.8	4,572	-94	349
25	1 each	83%	2	0.58%	0.480%	1.00	4.7	6,901	-143	526
26	1 each	22%	2	2.44%	0.526%	1.00	0.6	703	66	106
27	1 each	0.9%	1	5.94%	0.053%	1.00	0.2	294	0	26
28	1 each	11%	2	0.85%	0.089%	1.00	0.0	-3	57	37
29	1 each	0.4%	2	1.18%	0.004%	1.00	0.1	88	0	8
30	1 each	41%	2	2.45%	1.014%	1.00	62.4	2,120	780	699
31	1 each	63%	3	15.00%	9.450%	1.00	0.0	186	1,296	861
32	2 each	71%	3	10.00%	7.102%	1.00	0.0	840	5,845	3,884

Table 31: Market Potential Summary for the Preferred Measures

The "Yearly Realizable Potential %" column shows the actual estimated "Market Potential" for each measure. It is the product of the "Raw Economic Potential %" and the "Annual Market Capture %".

Two of the measures in the preferred list were analyzed with multiple retrofit options that represent different improvement choices. Four window upgrade options, ID 17 through 20, were analyzed to represent different possible homeowner choices. For a single house, however, only one option can be applied. A similar choice of mutually exclusive options is represented by ID 21 and 22 for external window shading. Each option was assigned a fraction proportional to its realizable potential so that all the fractions for each measure sum to unity. This was necessary to avoid double counting of the annual statewide savings when they are summed across all the measures and options.

Savings

Annual statewide savings for each measure and option are shown in the last four columns of Table 31. They are products of weighted individual home savings and the total target population of the state. Savings are presented in terms of total electric demand in megawatts, electric energy savings in megawatt-hours, natural gas in kilotherms, and thousands of dollars. The monetary savings represent annual savings to the homeowner for both electricity and natural gas, and each of these is based on recent average marginal costs taken from published information from the major utilities serving the state of Illinois. For electricity the estimated marginal cost was $0.09 per kilowatt-hour, and for natural gas it was $0.652 per therm.

The total annual statewide potential savings for the preferred measures and options are shown in Table 32, and totals for all 34 measures that were analyzed in this study are also shown for comparison purposes. If all 19 of the preferred measures are implemented within the framework of a reasonably aggressive statewide conservation program, and those programs are executed over a period of 5 to 10 years, the annual impacts on the state of Illinois will potentially be about 179 megawatts of electric demand reduction at the meter, 164,471 megawatt-hours of electrical energy savings at the meter and 4.4 million therms of natural gas savings. Homeowner savings will be almost $17.6 million per year.

Statewide Annual Savings Potentials				
Measures and Options	MW	MWh	kTherms	k$
Top 19 Measure Options	179	164,471	4,403	17,638
All 34 Measure Options	245	209,444	25,405	35,360
Top 19 % of All	73%	79%	17%	50%

Table 32: Statewide Savings Potentials Summary

The preferred measures were selected by MEEA based on priorities of savings and market potentials and reflective of other issues beyond the scope of this study. Although the 19 preferred measures comprise only 56% of the evaluated measures by count, they will potentially achieve about 73% of the electric demand savings and 79% of the total potential electric energy savings, while at the same time delivering some ancillary natural gas savings and significant cash savings to participating Illinois homeowners.

Comparative Savings Analysis

Kouba-Cavallo Associates Study – Potential for Energy Improvement
As a comparison to this study, MEEA reviewed an Illinois energy savings potential study commissioned by the Illinois DCCA in 2002.[12]

In their study, Kouba-Cavallo examined what the energy savings would be if five conservation or energy efficiency measures were widespread and readily available to residential consumers. This analysis assumed a 12-year period in which the following measures would be readily available and used:

Measure	Data Source
Envelope and furnace measures that reduce space heating	70 home energy ratings performed under the Illinois Energy Wise Homes program
Envelope and air conditioner efficiency and sizing measures that lower space cooling needs	Same
Electric water heater conversions in homes that have a natural gas connection or use LPG for space heating	2000 US Census
Replacement of incandescent bulbs with CFLs in high use areas	RECS microdata for the 2000 East North Central census division
Replacement of high energy use refrigerators	RECS microdata for the Midwest

Table 33: Kouba-Cavallo Study – Measures Analyzed

We combined the county and regional tables from the study into north, south, and total Illinois data tables.

[12] Cavallo, James, PhD, Kouba-Cavallo Associates, "Residential Energy Characterization of Illinois", ibid.

By Fuel Type (in billions of BTUs)				
	NG	Oil	LPG	Electricity
North IL	49,809	676	573	18,099
South IL	5,257	474	(109)	4,199
Total	55,066	1150	464	22,298

*LPG is negative because it represents the consequence of households switching out electric water heaters for LPG water heaters; the net electricity savings is much larger than the subsequent increased use of LPG

Table 34: Kouba-Cavallo Study: Final Savings Potential Results

The results show about a two times higher savings totals than this study. We feel the reasons for the difference mainly lies in the assumptions built into the modeling approaches between the two studies. In particular, we incorporated market barriers as factors that impact market potential, and therefore the potential savings total would come up less compared to a complete capture of all available opportunities.

V1.4 Additional Technical and Market Potential Analysis

After the 34 measures were modeled and analyzed, MEEA decided to couple two measures and determine what the technical and market potential impacts of the combined measure might represent. The combination measure option provides for the installation of high efficiency (low-e, double-pane) windows characterized by a U-value of 0.35 and a SHGC of 0.40 and the downsizing of a new air-conditioning system form 3.52 tons (150% of Manual J load with typical windows) to 2.0 tons (100% of Manual J with the high efficiency windows).

Table 35 below shows measure ID's 7 and 19 from the previous study and new measure option numbered 35.

New measure ID 35 is the combination of downsizing (previous ID 7) and high efficiency windows previously analyzed as ID 19.

ID	Potential	Improvement	Quantity
7	Oversized AC	Size AC units to 100% of Manual J	3.52 tons
19	Standard double pan	Install Low E double pane	203 SF
35	O'size B and Std DP	Low E DP Windows and 100% of Manual J	3.52 tons

Table 35: Potential Situations and Improvements Evaluated in this Study

The savings for the new measure were calculated separately for the northern and southern counties of the state. The statewide savings per house were then calculated as the population-weighted averages of the regional savings.

Savings estimates for the new measure in Table 36 on the next page, which includes estimates for the relatively small numbers of electric heated homes. Again, measures designated by ID's 7 and 19 from the previous study are included for reference purposes because they were used again in the new combination measure numbered ID 35.

Energy savings for the combinations of high efficiency windows and AC downsizing to 100% of Manual J calculated loads are 784 kWh. These savings exceed the sum of savings for AC downsizing and high efficiency windows. This is due to the fact that the new windows reduce the cooling loads so that downsizing results in even smaller AC systems than downsizing alone. In the scenario applied here, MEEA assumed that the ductwork was already installed and typically sized for a typical system. Therefore, blower motor power is decreased proportionally to the downsizing, and this results in savings in addition to those due to increased cycling efficiencies.

Combination measure ID 35 saves 784 kWh per year in a typical gas heated home. The two measures, ID's 7 and 19, applied independently save an average of 678 kWh (314+364) per year. When they are applied together interactively the combined savings are 16% more. This is characteristic of downsizing only, since all other combination measures usually lead to a slight interactive reduction in total savings when applied together.

The differential installed costs for the two combination measures are not only negative, but close (around -$900) to those of the downsizing only (-$1000). This is due to the fact that, on average, the degree of downsizing, and resultant installed cost savings, is greater when high efficiency windows are installed first. The additional cost savings for the smaller AC system offsets some of the differential costs of the high performance windows.

Whenever possible, downsizing to 100% of a valid Manual J estimate should be encouraged alone or in combination with other cooling load reduction measures. This will nearly always serve the best interest of the homeowner.

Differential costs shown in Table 36 for each measure are the average costs to install the measure, or the difference in cost between a standard retrofit and the high efficiency option. Payback is the simple payback in years, (the ratio of annual fuel dollars saved and differential installed cost).

					Gas Heated Houses					Electric Heat Strip Houses			Electric Heat Pump Houses		
	Electric Savings Per Home			Diff.	Gas Savings Per Home			Total	Payback	Elec Ht	Total	Payback	Elec Ht	Total	Payback
ID	kW	kWh	$ Saved	Cost	BTUH	Therms	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years	$ Saved	$ Saved	Years
7	0.36	314	$28	-$1000	0	0	$0	$28	0.1	$0	$28	0.1	S0	$28	0.1
19	0.80	364	$33	$384	2007	-14	-$9	$24	16.3	-$30	$2	155.8	-$13	$19	19.7
35	0.85	784	$70	-$916	11822	-21	-$14	$57	0.1	-$40	$28	0.1	-$17	$50	0.1

Table 36: Electric and Natural Gas Savings by Measure and Heating System Type for Preferred Measures

Marketing Potentials for the New Measure

Table 37 below lists the measures involved in this supplemental analysis, showing ID numbers, their potential situations, improvement options, and three columns of market potential estimates. The "Technical Potential (% of Homes that Qualify)" is the "Technical Potential" previously described. The last column, "Raw Economic Potential (% of General Population)" is the previously defined "Raw Economic Potential". It is simply the product of the "Technical Potential (% of Homes that Qualify)" and the "Economically Feasible (% of Technical Potential)".

ID	Potential	Improvement	Technical Potential (% of Homes that Qualify)	Economically Feasible (% of Technical Potential)	Raw Economic Potential (% of Population)
7	Oversized AC	Size AC units to 100% of Manual J	68 %	7.0%	4.8%
19	Standard double pan	Install Low E double pane	80%	26%	21%
35	O'size B and Std DP	Low E DP Windows and 100% of Manual J	54%	1.8%	1.0%

Table 37: Technical and Raw Economic Market Potentials for Prefe rred Measures

VII. MARKET POTENTIAL: PROGRAM REVIEWS

In this final section, we review recent or current programs that promote each of the 19 measures identified as the best energy savings opportunities. Market progress or final evaluations of a number of these programs were used to calibrate the market penetration rates for their respective measures.

CENTRAL AIR CONDITIONING REPLACEMENT

Situation:	**Oversized CAC units**
Measure	Size replacement to Manual J

Situation:	**Gas heat and 10 SEER CAC**
Measure:	Replace SEER 10 or less with ENERGY STAR SEER 13

There are a number of residential HVAC programs currently offered by utilities and agencies, some with significant budget amounts, and many designed as ongoing, multi-year efforts:

Sponsor	**State**	**Program End**	**2001 Budget (Millions)**	**Financing**	**Incentives**	
					Equipment	**Installation**
NEEA	OR, WA, ID, MT	Dec. 2002	0.7	No	-	-
Oregon Office of Energy	OR	Ongoing	-	No	$300-500	$100-400
PG&E	CA	Dec. 2001	5.5	Yes	$250-750	$400
SCE	CA	Ongoing	-	No	$250-450	
SMUD	CA	Ongoing	-	No	-	$200
City of Anaheim	CA	Jan. 2002	0.27	No	$100	-
Xcel Energy	MN	Dec. 2001	-	Yes	$200-300	-
Muscatine Power & Water	IA	Ongoing	-	No	$100-150	-
Indianola MU	IA	Ongoing	0.02	No	$200	-
NEEP	NY,NJ	Ongoing	-	No	$370-710	-
NYSERDA	NY	Ongoing	-	Yes	5% Financing	-
LIPA	NY	Dec. 2001	2.0	No	$320-500	-
Florida Power & Light	FL	Ongoing	20.0	No	$40-925	$154
Southern Maryland Electric Cooperative	MD	Ongoing	-	No	-	-

Source: CEE Residential HVAC Initiative – Program Summary – June 2001

Table 35: Residential 2001 HVAC Program Summaries

A majority of them create a dual targeting of both consumers and contractors, while a few also target distributors. We would recommend the comprehensive strategies that develop a sustainable marketplace and a general professional certification process for correctly fitted and installed ductwork and CAC systems, similar to what NEEA, SMUD, NEEP, and NYSERDA have been offering:

Sponsor	Program	Marketing
NEEA	Develop methods for test and retrofit of systems; train and certify contractors; certify homes	Support materials and mkt. assistance to contractors
Oregon Office of Energy	Tax credits for AC systems and ductwork upgrades; installation tax credits; rebates for blower door tests and ductsealing	Web site advertising
PG&E	Contractor training; perform spot checks for installations; customer education; contractor and consumer rebates for equipment and installation	Direct mail, PR, TV advertising
SCE	Contractor incentives for duct sealing and AC tune-ups	-
SMUD	Duct sealing program; includes certification, testing, and consumer rebates; distributor rebates for products	Listed on SMUD website
City of Anaheim	Product incentives and promotion of high efficiency products	Direct mail, ads, inserts, PR
Xcel Energy	Rebates on ENERGY STAR CAC	TV ads, inserts, established network of HVAC contractors
Muscatine Power & Water	Consumer incentives and promotional information	Inserts, PR articles, special events
Indianola MU	Rebates on SEER 12 CAC	Brochure, newsletter, dealer info, website
NEEP	Consumer incentives; consumer education, contractor training	[Promoted individually by participating utilities]
NYSERDA	Home Performance w/ENERGY STAR program – build consumer awareness, develop contractor infrastructure by training, certification; provide consumer incentives, education, and financing	Multi-media advertising; public event displays; complete branding strategy
LIPA	Consumer rebates, customer and contractor education, installation verification	Advertising, mailings, inserts, public event displays
Florida Power & Light	Duct Repair and Central H/C Program; combination of incentives with contractor training	Inserts, TV ads, web site
Southern Maryland Electric Cooperative	Contractor certification	Web site, inserts, flyers

Source: CEE Residential HVAC Initiative – Program Summary – June 2001

Table 36: Recent HVAC Programs – Program Description and Marketing Summaries

WINDOW REPLACEMENT

Situation:	**Standard windows, either double pane or single pane with storm**
Measure:	Replace with ENERGY STAR labeled windows matched to Illinois climate conditions

Window-specific programs are relatively new compared to other energy efficiency initiatives. The most successful had been the recently completed NEEA program, which took a comprehensive approach targeting all points along the product chain, and ended with a successful transformation of the marketplace:

Sponsor	Agency	State	Program
CA and WA utilities	Northwest Energy Efficient Alliance	OR, WA, MT, ID	ENERGY STAR Residential Fenestration Program: Decreased high-efficiency windows' initial cost premiums and increased awareness of high-efficiency windows; increased market share for the residential fenestration up to 66% by 2001; worked directly with manufacturers and distributors to make energy efficient windows more available and closer in cost as standard windows
CT, MA, VT, RI utilities	NEEP	CT, MA, VT, RI	Recently finished a New England baseline study to assess the current marketplace; currently developing a program initiative based on the results
LIPA	KeySPAN	Long Island (NY)	ENERGY STAR Window Program: Provided rebate incentives and customer education
U.S. Department of Energy & the State of Florida	Florida Solar Energy Central	FL	Central Florida High Performance Windows Initiative: Interaction and intervention with manufacturers and market actors; consumer and market actor education, presentations; training of window sellers
America Electric Power Company	-	TX	Texas Window Initiative: Promoted the installation of high performance windows in the residential new construction and remodeling markets; created interventions with manufacturers, distributors, and retailers to develop availability of product, standardization, and reduced first cost

Table 37: Energy Efficient Window-specific Program Summaries

RLW Analytics recently researched ENERGY STAR windows programs as part of a baseline study for Oncor (formerly Texas Utilities). We found hat there has been a steady national market penetration of Low E coated window products, which appears to be the result of previous market transformation efforts in the Northwest, the Northeast, and California. This has been pushing the manufacturing sector to provide the necessary products at reasonable prices.

The NEEA program is one of the best to emulate. Over the lifetime of the program, they achieved a market penetration of 66% of all fenestration products. NEEA took a detailed, comprehensive approach to target all actors within the product chain. The program staff and contractors used traditional marketing, promotion, and advertising to attract customer interest, and built upon existing business relationships between manufacturers and retailers, distributors, builders and remodelers to deliver the ENERGY STAR message to customers. Incentives and support were provided to manufacturers to encourage promotion through traditional channels, and sales training and materials were provided to retailers.

DICIDEOUS TREE PLANTING FOR SHADE	
Situation:	**No or little east & west window shading**
Measure:	Plant deciduous trees on east and west sides

The American Public Power Association detailed a comprehensive list of utilities and municipalities that are participating in their TREE POWER program. In 2002, the APPA reported about 170 utilities are participating.[13] There are 25 tree programs in the Midwest identified by the APPA. Of those, 12 provide a specific benefit program for homeowners to plant shade trees:

Utility or Municipal Shade Tree Programs - Midwest		
Sponsor	**City/State**	**Homeowner Shade Tree Incentive or Program**
Columbus Water & Light	Columbus, WI	$15 rebate per shade tree
Coon Rapids Utilities	Coon Rapids, IA	Free trees to electric customers; $10 subsidized charge for delivery and planting
Loup River Public Power District	Columbus, NE	Distributes seedlings to the public
Osage Municipal Utilities	Osage, IA	Distributes trees to customers annually
Paulina Municipal Electric Utility	Paullina, IA	Reimburses homeowner ½ price of tree or $20 (least amount) – reimbursement is made as Chamber of Commerce Bucks
Richmond Power & Light	Richmond, IN	Distributes 5,000 trees a year
Sikeston Board of Municipal Utilities	Sikeston, MO	$25 coupon per customer for a shade tree
Wadena Light & Power	Wadena, MN	Gives away 250 seedlings annually
Waterloo Water & Light	Waterloo, WI	Two-tiered incentive: $15 a shade tree, plus $15 for shade trees planted on W or SW side of house
Waupun Utilities	Waupun, WI	$35 or 50% off cost of a shade tree
Waverly Light & Power	Waverly, IA	Subsidized prices for shade trees, with further discounts for planting in "energy efficient locations"
Zeeland Board of Public Works	Zeeland, MI	Gives away about 500 trees annually to electric customers

Source: APPA Tree Power Report

Table 38: Utilities and Municipalities Participating in the APPA Tree Power Program - 2002

[13] APPA "TREE POWER Report", Summer 2002, accessed via the internet at www.appanet.org

A handful of other utilities nationwide also offer residential shade tree programs:

Utility or Municipal Shade Tree Programs– Other Regions		
Sponsor	**City/State**	**Homeowner Shade Tree Incentive Program**
Key Energy Services	Key West, FL	Gives away 3,000 shade trees a year
Riverside Public Utilities	Riverside, CA	$25 rebate per tree, up to three trees annually
Braintree Electric Light Department	Braintree, MA	Offers to plant two maple trees on south or west side of homes

Table 39: Recent Homeowner Shade Tree Programs

The other utility programs not listed have tree programs that benefit the community at large (versus individual homeowners). Of those shown above, the majority of these are non-specific to tree placement, which implies that these programs are designed to also help on broader objectives such as public relations or carbon sequestration. Three utilities – Waterloo Water & Light, Waverly Light & Power, and Braintree Electric Light – have program elements specifically addressing sun shading on the home to reduce energy use.

We recommend that a utility program that emulates the approach of these last-mentioned utilities would be best effective in reducing solar heat gain in homes. In particular, the Waterloo, MN approach diplomatically moves them towards two compatible goals: inducing ratepayers to at least plant additional shade trees, and providing additional inducements for those who can and want to plant those trees in strategic shading locations.

INCANDESCENT LIGHT BULB REPLACEMENT	
Situation:	**Incandescent bulbs used for interior lighting**
Measure:	Replace frequently used lamps with CFLs

CFL lamp and fixture replacement programs are, of course, the most ubiquitous of energy efficiency promotional initiatives used throughout the country. As the subsequent tables show below, the most common programs utilize two basic strategies of providing incentives for purchase and turn-ins as well as using a comprehensive array of marketing tools to educate, inform, and enhance awareness.

Since MEEA has conducted lighting programs already, it may be superfluous to suggest program strategies. However, since we discovered that only 23% of our audited homes had CFLs while a large majority of Illinois homeowners claim a desire and readiness to purchase and use energy efficient lighting, it appears that a strategy of consumer education combined with active intervention methods of such things as rebates, incentives, and torchiere turn-ins will continue to yield useful results.

Table 40 on the next page shows the wide distribution of lighting programs throughout the U.S., which shows similar first cost buy down incentives across the programs for CFLs, fixtures, torchieres, and ceiling fans. The subsequent table shows the depth of marketing elements used in the larger programs to promote lighting.

Sponsor	State	Program End	2001 Budget Total ($M)	2001 Budget Incentives ($M)	CFLs Incentive	CFLs Type	Hardwired Fixtures Incentive	Hardwired Fixtures Type	Torchieres Incentive	Torchieres Type	Ceiling Fans Incentive	Ceiling Fans Type
NEEA	OR,WA,ID, MT	June 2003	1.5	-	-	-	-	-	-	-	-	-
BPA	OR,WA,ID, MT	-	-	-	-	-	-	-	-	-	-	-
SCL	WA	Ongoing	-	-	Full	Giveaway	-	-	-	-	-	-
Puget Sound Energy	WA	Ongoing	-	-	-	-	$25	Mail-in	-	-	-	-
Snohomish PUD	WA	Dec. 31 2001	1.65	-	$2 $3	Buy down Instant	-	-	-	-	-	-
PG&E	CA	Dec. 31 2001	5.8	-	$2	Instant	$10	Instant	$10	Instant	$20	Instant
SCE	CA	Ongoing	-	-	Full	Giveaway	-	-	-	-	-	-
SDG&E	CA	Ongoing	1.5	-	$2	Buy down	$10	Buy down	$10	Buy down	$20	Buy down
SMUD	CA	Ongoing Dec. 2002	1.67	0.77	$4	Mail-in	-	-	$10 $20	Mail-in Retailer	-	-
LADWP	CA	Dec. 2002	3.0[a]	-	-	-	-	-	-	-	-	-
Anaheim	CA	Feb. 8 2003	0.3	-	$5	Mail-in	-	-	-	-	$50	Mail-in
MEEA	OH,IL,MN, MO, KY	Dec. 2002	0.5	-	$3	Instant	-	-	-	-	-	-
WECC	WI	June 2004	2.4[a]	-	$3	Mail-in	$10	Mail-in	$20	Mail-in	$15	Mail-in
IL DCEO	IL	Ongoing	.6	-	$3	Mail-in	-	-	$20	Instant	$35	Instant
Xcel Energy	MN	Ongoing	-	-	-	-	-	-	-	-	-	-
MG&E	WI	Ongoing	-	-	-	-	-	-	-	-	-	-
Muscatine Power & Water	IA	Ongoing	0.002	-	Half purchased price	Mail-in	-	-	-	-	-	-
NEEP Utilities	MA,RI,CT, VT,NH	Dec. 2002	20.0	8-12	$3 - $4	Instant	$10 outdoor $15 indoor	Instant	$15	Instant	$10-$15	Instant
NYSERDA	NY	Ongoing	2.2[a]	7.0	-	-	-	-	$25	Mail-in	-	-
LIPA	NY	Dec. 2003	3.0[a]	2.0[a]	$3	Instant	$10	Instant	$15	Instant	-	-
Totals			**43.4**	**19.8**								

Source: CEE Residential Lighting Programs National Summary, May 2002

Table 40: Summaries of Lighting Programs

Region	State(s)	Main Agent	Program Name	Retailer Participation	Incentives	Coop Funds	Field Reps	Manufacturer Outreach	Publicity Campaigns	POP Materials	Product Catalog	Special Events
-	CA	California Utilities	CA Residential Lighting and Appliance Program	X	X	X	X		X	X		X
Sacramento	CA	SMUD	Residential Retail Lighting Program	X	X		X		X	X		X
Long Island	NY	LIPA	Residential Lighting and Appliance Program	X	X		X		X	X	X	X
New England	MA, CT, VT, RI	NEEP	Residential Lighting Market Transformation Initiative	X	X		X		X	X	X [a]	X
Pacific Northwest	WA, ID, OR, MT	NEEA	ENERGY STAR Residential Lighting Program	X	X		X		X	X		X
-	NY	NYSERDA	Energy $mart ENERGY STAR Appliances and Products Program	X	X		X	X	X	X		X
-	WI	WECC	ENERGY STAR Program	X	X		X		X	X	X	X

[a] Lighting fixtures offered through Northeast Utilities/United Illuminating Smart Living Catalog

Adapted from Vrabel, Paul, Kathryn Gaffney, Heidi Curry, "A Comparison of Lighting Market Transformation Programs in New York, New England, Wisconsin, California, and the Pacific Northwest", ACEEE 2000 Summer Study Conference Proceedings, Washington DC.

Table 41: Marketing Elements in Lighting Market Transformation Program

ENERGY STAR APPLIANCE REPLACEMENTS

Situation:	**Old standard appliances set to be replaced: refrigerator, dishwasher, clothes washer**
Measure:	Replace with ENERGY STAR appliances

ENERGY STAR appliance programs have also become a frequent element in utility and agency residential initiatives. The most common and successful has been ENERGY STAR clothes washer promotional programs. Since these washers provide a significant amount of energy cost reduction, it is not surprising to see so many entities, from small municipal utilities to large multi-state agencies, provide promotions and incentives to raise market share for these products. Table 42 and Table 43 below show that ENERGY STAR clothes washers are the most prevalent appliance promoted.

The opportunity to promote ENERGY STAR clothes washers grows even further in 2004. Clothes washers manufactured to meet the 2004 standard will be 22 percent more efficient than today's baseline clothes washer. Units that meet the 2007 requirements will be 35 percent more efficient that today's baseline clothes washer.

As the tables depict, the incentive range for ENERGY STAR appliances is wide. Clothes washers rebates are the most prevalent, and they run from $50 to $150. We have seen from past evaluations and market progress reports that rebates, combined with a well-planned marketing campaign, are a useful element in early market intervention programming. However, qualitative research done in 2002 in support of the marketing strategy development for the NYSERDA residential ENERGY STAR Appliances and Products program found that significant manufacturers have appeared to position their products in a higher price point categories as high quality, high value products geared towards specific consumer segments. Secondary source price research found that price differentials for ENERGY STAR appliances actually increased between 2000 and 2001. NYSERDA uses a program design theory of creating sustainable market transformation in appliances without direct cash incentives.

This is not without precedent. The NEEA Tumble Wash program purposely trimmed back rebates as ENERGY STAR clothes washers gained market share after several years of program intervention. These two example s, plus the recent research evidence, suggests that the strategy of consumer education and awareness, plus a purposeful appeal towards the "high quality, high value" proposition, creates a sustainable path towards true market transformation, and one that we would recommend as well.

Sponsor	Service Territory	State	Program End	2002 Budget Tot($M)	Clothes Washers		Dishwashers		Refrigerators		Room Air Conditioners	
					Incentive	Type	Incentive	Type	Incentive	Type	Incentive	Type
Blachly-Lane	Eugene	OR	Dec. 31 2001	0.005	$50	Mail-in	$20	Mail-in	$25	Mail-in	-	-
BPA	OR,WA,ID, MT	OR,WA, ID,MT	-	-	-	-	-	-	-	-	-	-
Emerald PUD	Eugene	OR	Ongoing	0.135	$100	Mail-in	$30	Mail-in	$75	Mail-in	-	-
Eugene WEB	Eugene	OR	Ongoing	-	$45-$125	Mail-in	$30	Mail-in	-	-	$40	Mail-in
Lane Electric	Eugene	OR	Ongoing	0.05	$85	Mail-in	$50	Mail-in	$65	Mail-in	-	-
LOTT	Western WA	WA	Ongoing	-	$100	Mail-in	-	-	-	-	-	-
MEEA	Chicago, ComEd	IL	July 2002	.6					$50	Mail In	-	
NEEA	OR,WA,ID, MT	OR,WA, ID,MT	Dec. 2003	2.0	-	-	-	-	-	-	-	-
OOE	OR	OR	Ongoing	-	$160-$230	Tax Credit	$60	Tax Credit	$30-$70	Tax Credit	-	-
Seattle City Light	Seattle	WA	-	-	$75	Mail-in	-	-	-	-	-	-
Snohomish County PUD	Snohmish County	WA	Dec. 31 2002	0.48	$100	Mail-in	$35	Mail-in	-	-	-	-
Springfield Utility Board	Springfield	OR	Ongoing	-	$130	Mail-in	$30	Mail-in	$60	Mail-in	-	-
City of Anaheim	Anaheim	CA	February 2004	.23	$100	Mail-in	$50	Mail-in	$100	Mail-in	$50	Mail-in
City of Millbrae	Millbrae	CA	Ongoing	.006	$75	Mail-in	-	-	-	-	-	-
EBMUD	Oakland	CA	Ongoing	.5	$150	Mail-in	-	-	-	-	-	-
LADWP	Los Angeles	CA	Ongoing	3.0[(a)]	-	-	-	-	-	-	-	-
MWD	Southern California	CA	Ongoing	0.57	$25-$75	Mail-in	-	-	-	-	-	-
PG&E	Northern and Central CA	CA	Dec. 31 2002	12[(a)]	$75	Mail-in	$50	Mail-in	-	-	$50	Mail-in
Riverside Public Utilities	Riverside	CA	Ongoing	-	$100	Mail-in	$50	Mail-in	$100 $25	Mail-in Recycling	$50	Mail-in
SMUD	Sacramento	CA	August 2002	1.57[(a)]	$75-$125	Mail-in	-	-	$50	Recycling	$50	Mail-in
SDCWA	San Diego County	CA	June 30 2004	2.8	$125	Instant	-	-	-	-	-	-
SDG&E	San Diego	CA	Dec. 31 2002	.57	$75	Mail-in	$50	Mail-in	-	Mail-in	$50	Mail-in

Table 42: Residential ENERGY STAR Programs (Part I)

Sponsor	State Territory	State	Program End	2002 Budget Tot ($M)	Clothes Washers		Dishwashers		Refrigerators		Room Air Conditioners	
					Incentive	Type	Incentive	Type	Incentive	Type	Incentive	Type
SCVWD	Santa Clara Valley	CA	June 30 2004	-	$100	Mail-in	-	-	-	-	-	-
Silicon Valley Power	Santa Clara	CA	Ongoing	0.13	-	-	$50	Mail-in	$75	Mail-in	-	-
SCE	Southern California	CA	-	-	-	-	-	-	-	-	-	-
SoCal Gas	Southern California	CA	May 31 2001	1.8	$75	Mail-in	$50	Mail-in	-	-	-	-
Austin Energy	Austin	TX	Ongoing	8.7[a]	$100	Mail-in	-	-	-	-	$50	Mail-in
City of Albuquerque	Albuquerque	NM	Ongoing	0.1	$100	Bill Credit	-	-	-	-	-	-
City of Austin	Austin	TX	Ongoing	0.1	$100	Mail-in	-	-	-	-	-	-
City of Boulder	Boulder	CO	Ongoing	0.03	$75	Main-in	-	-	-	-	-	-
ComEd	Chicago	IL	Ongoing	0.03	-	-	-	-	-	-	-	-
Denver Water	Denver	CO	Ongoing	_	-	-	-	-	-	-	-	-
MGE	Madison	WI	Ongoing	-	-	-	-	-	-	-	-	-
Minnesota DOC	MN	MN	Ongoing	0.007	-	-	-	-	-	-	-	-
Muscatine Power & Water	Muscatine	WI	Ongoing	-	$50	Mail-in	$50	Mail-in	$50-$100	Mail-in	$25-$50	- Mail-in
Waverly Light & Power	Waverly	MN	Ongoing	-	$100	Mail-in	$25-$50	Mail-in	$50	Mail-in	$25-$50	Mail-in
WECC	32 Utilities in WI	WI	June 2003	2.9[a]	-	-	-	-	-	-	-	-
Xcel Energy - MN	MN	MN	Ongoing	12.0[a]	-	-	-	-	$55	Mail-in	$30	Mail-in
LIPA	Long Island	NY	Dec. 2003	3.1	$75	Mail-in	-	-	-	-	$75	Bounty
NYSERDA	NY	NY	Ongoing	20.7[a]	-	-	-	-	-	-	$75	Bounty
NEEP Utilities	MA,RI,CT,VT, NH,NY		Ongoing	10.0	$25-$75	SPIFFS & mail-in	$25	Mail-in	$25	Mail-in	$25	Mail-in
State of Maryland	MD	MD	July 2004	-	5%	Tax exemption	-	-	5%	Tax exemption	5%	Tax exemption

Table 43: Residential ENERGY STAR Programs (part II)

Source: CEE Residential ENERGY STAR Appliances Program Summary, 2001

Table 44 below shows the wide range of marketing tools and strategies found in major ENERGY STAR appliance program promotions. In this study conducted by RLW Analytics for the Massachusetts utilities in 2001, it was concluded through program results and interviews with most market actors that the most sustainable and successful programs utilize a wide range of marketing tools. As shown in the table, these tools range from high impact and cost effective public promotions to mass media advertising. In particular, the clothes washer program run by the Northwest Energy Efficiency Alliance was notable in the significant market growth created by creative limited budget promotions that were geared toward high consumer visibility.

ENERGY STAR Programs	Region	Main Agent(s)	Marketing Tools Used
Residential Appliances	New England	NEEP	Rebates, PR events, advertising, brand awareness (displays, sweepstakes, referral services, and others)
ENERGY STAR Home products	Northwest	NWEEA	PR events, dealer/salesperson incentive, selected utility rebate, financing (selected municipal utilities), brand awareness advertising
Downstream Appliance Program	California	Four major public utilities	Rebates, dealer/salesperson incentive, billing inserts, retailer training, coop advertising, brand awareness (contest, sweepstakes, public display)
Energy $mart Residential Appliances and Products Program	New York	NYSERDA	Rebates for clothes washers (LIPA), dealer/salesperson incentive, PR events, retailer outreach, consumer education materials, advertising
Appliances and Lighting Program	Wisconsin	WECC	Consumer education, rebates, dealer/salesperson incentive, advertising, PR events, retailer outreach

Source: Adapted from RLW Analytics, "ENERGY STAR Appliances Research Study", for NSTAR Services Company, Western Massachusetts Electric Company, National Grid USA Service Company, Inc., Fitchburg Gas and Electric Light Company, August 15, 2001.

Table 44: Major Regional/State ENERGY STAR Programs – Marketing Tools Used

As discussed earlier under the Technical Potential section, refrigerator replacements are also a strong opportunity because of the low percentage of households found with ENERGY STAR labeled refrigerators, a high average age level, and the significant savings differential potentially available. In addition, a recent study conducted for the Chicago Energy Cooperative shows that Cook County residents queried about possible replacement purchases mentioned refrigerators above many other home appliances (Figure 4 below):

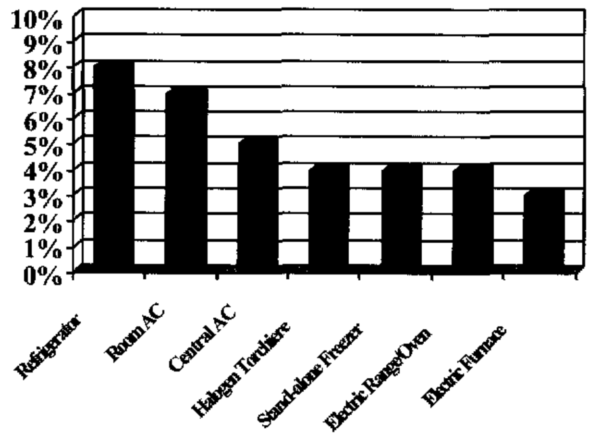

Figure 4: CEC 2001 Study –Those who probably/likely to buy these appliances in the next 12 months

In our market potential analysis, we used 19 years old or older as the median retirement age for refrigerators. For early replacement programs, there is significant analytical progress towards determining the best means for determining what refrigerators can be targeted for a return and recycling program. An ACEEE 2002 Summer Study paper presented by Kouba-Cavallo provides a very good foundation for setting rules on qualifying refrigerators to be recycled.[14]

WEATHERIZATION AND SIMPLE CONSERVATION

Situation:	**Lack of temperature management, hot water management, and weatherization measures**
Measure:	Install: - programmable thermostat - faucet aerators - low flow showerheads - insulation around hot water pipes - Insulation around gas water heater - Window caulking and door weather stripping

Low-income weatherization and conservation programs usually target weatherization, conservation measures, and temperature controls. The Department of Energy funds weatherization programs in all 50 states to serve low-income populations, and utility programs have normally targeted multifamily housing units for weatherization and conservation measures. Illinois in particular has a number of statewide programs:

- Illinois Bureau of Energy and Recycling public education and awareness programs

[14] Cavallo, James, PhD, Kouba-Cavallo Associates, and James Webb, PhD, Wisconsin Division of Energy, "Evaluating Alternative Simple Rules for Choosing Refrigerators to Replace", ACEEE 2002 Summer Study Proceedings (accessed via www.kouba-cavallo/art/rules02.pdf.

- Weatherization Assistance Program
- Rebuild America funding and support provided through local entities

This study and report was aimed at single family owned homes. However, the table below provides a snapshot of the weatherization implementation strategies used by utilities within their multi-family housing programs:

Utility Multifamily Housing Efficiency Programs			
Sponsor	**State**	**Pgm End**	**Program**
Austin Energy	TX	Ongoing	Technical and financial search assistance; Rebates for efficient heating, cooling, and lighting equipment; rebates for efficiency measures such as ceiling insulation and duct repair
Bay State Gas	MA	Ongoing	Free energy audits; financial assistance for controls, insulation, and other weatherization measures
Berkshire Gas	MA	Ongoing	Incentives for controls, insulation, and weatherization measures
California Utilities	CA	Ongoing	Integrated approaches of information, education, energy management services, and customer incentives
Efficiency Vermont	VT	Ongoing	No-cost technical assistance, project-based financial incentives
Long Island Power Authority	NY	Ongoing	Education and free installation of controls, insulation, and CFLs
Madison Gas & Electric	WI	Ongoing	Education and Neighborhood Revitalization Grant Program
NGRID	MA	Ongoing	Free analysis and installation of insulation, water heating measures, lighting, and other measures to electrically heated apartments of five or more
NEEA	OR, WA, ID, MT	March 2001	3-year project to demonstrate benefits of public housing efficiency initiative
NSTAR	MA	Ongoing	Comprehensive weatherization, energy conservation, and education services
NYSERDA	NY	Ongoing	Multifamily Building Program provides comprehensive energy audit with financial incentives; Bulk Purchase Program provides cash incentives for bulk purchases of energy efficient residential products
Ohio Dept. of Development	OH	Ongoing	On-site audit; client education; comprehensive weatherization measures based on audit results
Tacoma Public Utilities	WA	Ongoing	Installation of energy efficient technologies and weatherization measures
United Illuminating	CT	Ongoing	No-cost installation of conservation and weatherization measures
Wisconsin Div. Of Energy	WI	Ongoing; new statewide effort in 2002	Direct installation of conservation measures

Source: CEE Multifamily Housing 2002 Program Summary

Table 45: Weatherization Programs

Our audit results show that about 2/3 of all audited homes across income levels lacked a number of the energy conservation measures we looked for, such as hot water wraps, faucet aerators, and low flow showerheads. This suggests that basic weatherization and conservation offerings should find plenty of opportunities within Illinois.

VIII. CONCLUSIONS

This section provided a comparative overview of recent programs that have been implemented towards raising share and consumer acceptance of high efficiency home products and measures. The strategies and program designs, to be sure, are driven in large part by the existing markets for the "standard" product the promoted item is meant to replace. Given that, there are common threads that can be incorporated into the program designs for any of these measures that were analyzed at length here.

Utilize a wide variety of marketing tools and elements. As discussed earlier, the best programs for sustainable market share growth utilized a comprehensive set of marketing and promotional tools to build and sustain knowledge, interest, and product desirability. Successful strategies have not just used the traditional means – bill inserts, advertising – but also used creative and highly visible promotional campaigns and events to build "top of mind" awareness and recognition. Conversely, program managers that RLW interviewed in a recent study felt that a marketing campaign built on only one or two elements made only limited impact and will not generally move consumers to any notable degree.

Engage the market actors at all levels of the product sales cycle. Successful programs have outreach tasks that identify and engage key players on each step of the product sales cycle – manufacturer, distributor, retailer, contractor, and consumer. The complementary "push" and "pull" strategy creates buy-in from the market actors on each level, and helps reinforce the message between them (ex. in a balanced approach, the distributor knows and understands the energy efficient product as well as the contractor, who in turn can reinforce or corroborate the information known by the consumer).

Position the energy efficient product as a desirable "high quality, high value" item. Appliance manufacturers in particular have added a variety of special features and functions to their ENERGY STAR models. Although no literature explicitly explains why, it appears these features, many of which are "high tech" in design and function, creates a "high value" perception. This high value perception is likely geared toward those consumers who can afford, and less likely to balk at, the higher price premium comparable to "standard" models that lack these specialized designs and functions. This kind of product positioning is typically built towards consumers who are comfortable paying a premium for products that are perceived to be of a high quality, reliability, or safety, whether it's cars, appliances, or organically grown foods.[15]

A recent example of the product promotional shift from a "green" to a "high value" message are CFLs sold by Phillips Electronics, who have now shifted emphasis on the marketing message. Originally billed as "eco-friendly" energy saving "Earthlights", Phillips shifted the marketing message recently to promote a more successful campaign of convenient, long lasting "Marathon" bulbs.[16] This does not necessarily mean that Phillips has abandoned the environmental message, but the company has broadened the message to promote personal benefits of cost and convenience.[17]

We recommend these marketing approaches as safe and proven approaches towards capturing the market potentials found in this study.

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[15] De Lisser, Eleena, "Is That $5 Gallon of Milk Really Organic?", Wall Street Journal, August 20, 2002, page D1. In the article, the Organic Trade Association s states that organic food sales have been growing about 20% annually, even though organic products have a price premium of 10% or more; Rathke, Lisa, Associated Press, "Farmers see new niche in organic milk products", Troy Sunday Record, September 15, 2002, p. A7. The article reports the number of organic dairy farms have tripled from 20 to 61 in the past six years to capture demand.

[16] Fowler, Geoffrey, A. "'Green' Sales Pitch Isn't Moving Many Products", Wall Street Journal, March 6, 2002.

[17] Ottman, Jacquelyn A., "The Real News About Green Consuming", from the J. Ottman Consulting website (www.greenmarketing.com/articles/gbl_may02.html). In this article and in a recent keynote presentation at the ACEEE Market Transformation Symposium in March 2002, Ms. Ottman stressed that marketing green products can work if consumer desires for improvements or enhancements of personal cost, comfort, and convenience is appealed to as well.

Specifically, the assessment has identified the following energy efficiency and weatherization programs that the State, the Clean Energy Trust or the various Illinois utilities could undertake that will have a significant impact on the market:

Energy Efficiency Programs:

1. **Energy Efficient Lighting Programs.** In particular, the field data from the site visits indicated that 95% of the homes had less than a 10% presence of CFLs (Compact Fluorescent Lamps) by bulb count. Programs offering rebates or other incentives to encourage homeowners to purchase CFLs to replace their existing incandescent light bulbs are simple and highly cost-effective programs that should be utilized. Programs should only rebate CFLs that qualify for the ENERGY STAR label to ensure the products quality and longevity. Additionally, the CFL industry is making tremendous strides with the technology and have produced ENERGY STAR qualified lighting products ranging from a simple CFL, reflector lamps, outdoor application lamps all with a wide array of sizing and wattages to meet the needs of consumers. In the assessment, lighting hourly usage patterns utilized in the models are based on actual measured hourly residential lighting usage patterns from a large number of long-term and short-term end-use studies. Calculated annual savings amounted to approximately 786 kWh, 0.43 kW, –20 therms and 0 BTUH.

   Additionally, programs focusing on ENERGY STAR qualified fixtures and ceiling fans should also be considered after the market for CFLs has begun to be established. Various programs could be undertaken including torchiere turn-in events that emphasize both the energy and safety message of turning in a halogen torchiere and replacing it with a fluorescent torchiere, incentives on ceiling fans that have a lighting component as part of the fixture, outreach to lighting showrooms and builders to encourage them to stock and market the benefits of energy efficient fixtures.

2. **Programs focusing on high-efficiency heating, ventilation and air conditioning units.** Significant savings are available for the installation of high efficiency AC systems instead of standard efficiency SEER 10 units. Furthermore, while most of the homes throughout Illinois employ natural gas furnaces for heat, a few (between 2% and 3%) use electric heat pumps or electric strip heat for primary heat; so, as a retrofit measure the installation of a high efficiency heat pump might be an option for existing homes with old heat pumps or with electric resistance heat. Example HVAC program templates include, but are not limited to:

   - Rebates and financing to encourage customers to install HVAC equipment meeting ENERGY STAR requirements at a minimum, and to test and seal HVAC ducts using Aeroseal diagnostics protocol and sealing technology. Program implementers can partner with local contractors who must meet participation-eligibility requirements, including product efficiency minimums and installation specifications. Participating contractors could be permitted to offer the program's financing and rebates to customers. Program requirements, incentives, and marketing should be coordinated, as applicable and practicable, with utilities, utility groups, and public agencies to promote market transformation.
   - Programs focusing on incentives, customer education, and contractor training. Contractor training includes combustion appliance safety testing, duct diagnostic testing and sealing, HVAC system tune-ups, ACCA Manual J, Manual D, and zoning. PG&E also educates customers on the importance of quality installation through a video on duct sealing and a requirement of proper installation for some rebates.

HVAC equipment rebates generally vary from $200 to $500, depending upon equipment type and efficiency. Per this assessment, the estimated annual savings from upgrading from a SEER 10 AC units to a SEER 13 is 509 kWh, with a peak demand reduction of 0.56 kW. The potential annual savings for replacing an older SEER 10 heat pump with a SEER 13 heat pump are approximately 1889 kWh and 0.66 kW for the average home. Replacement of old electric resistance heat systems can have potential annual savings of 16,960 kWh and 8.43 kW

3. **ENERGY STAR qualified appliance programs.** Across the country, numerous programs use incentives to reward consumers who purchase ENERGY STAR qualified appliances. There are substantial electric, gas and water savings that can be achieved through these programs. The assessment revealed that Illinois consumers would reap similar benefits if they replaced their existing appliance with an ENERGY STAR qualified model. The table below reflects these savings:

Appliance	Annual kWhr Savings	Annual BTUH Savings
Refrigerators	260 – 472	0
Dishwashers	43 – 180*	400
Clothes Washers	-4 – 680*	1500

* Savings depend on whether the water is heated by electric or gas.

The majority of the programs that are being implemented revolve around two key components: consumer incentives and retail education. Offering consumers incentives to lower their end cost of the appliance will afford more customers the opportunity to purchase the ENERGY STAR qualified appliances which are typically higher-end units. Additionally, programs should try to leverage their rebate dollars with matching contributions from manufacturers and provide retail education on how to properly market and sell energy-efficient products and appliances. However, MEEA does not feel that refrigerators should be just given rebates without coupling the program with the recycling of the older appliance. Programs must ensure that the older refrigerator is placed out of operation, not used as a secondary unit and not resold back into the market place. Additionally, programs must ensure that proper recycling occurs and meets all federal, state and local environmental requirements.

4. **Programmable Thermostat Programs.** This market assessment estimates that by increasing the cooling set points three degrees F and decreasing the heating set points by four degrees F daily from 8AM to 3PM, the estimated annual savings will be about 60 kWh and 2.01 kW, along with 26 therms and 22,413 BTUH. High positive demand savings are due to the fact that the action of the thermostat sometimes causes the systems to cycle off completely during times that they would normally run under high loads. Programs for programmable thermostats generally involve either a straight rebate to the consumer, usually around $20, for the purchase of a programmable thermostat or it is added into an existing HVAC program where the incentive is coupled with the HVAC incentives.

5. **Programs focusing on proper sizing of AC systems.** For this assessment, an oversized system is defined as having a rated cooling capacity greater than 100% of a valid Manual J cooling load estimate. The audits identified that about 80% of the AC systems of this study are oversized relative to this criterion. Those that qualified as oversized averaged 50% above the Manual J estimate.

The energy savings from retrofitting the baseline capacity of 3.52 tons and in the first retrofit case the size is reduced to 2.35 tons, with a proportional reduction in airflow and duct sizing to maintain 372 CFM per ton. The rationale for maintaining this airflow rate is the probability that the same duct sizing practice is applied by the contractor independent of system size. This would be applicable to new AC systems that are installed where there is no existing ductwork. The estimated annual savings is 121 kWh, with a peak demand reduction of 0.17 kW.

On the other hand, if a new system is to be installed to replace an old system or with an existing forced air furnace that already has supply and return ductwork, there would be no need to install new ductwork. This is due to the fact that the existing ductwork would be able to deliver the same airflow as before with the same fan power, thus reducing the system losses due to low airflow and excessive system cycling. The estimated annual savings for this scenario is 314 kWh, with a peak demand reduction of 036 kW. The advantages of reducing system size are all positive as long as the system capacity is sufficient to maintain acceptable comfort conditions about 97.5% of the time (which are all but a few hours of the typical cooling season). The smaller system will typically maintain better humidity control, last longer, make less noise, use less energy and cost less to install.

Programs to address the over-sizing of AC systems would likely take the form of either training of AC installation contractors on Manual J and proper sizing of AC units for new homes, or an incentive structure to reduce the cost of the homeowner to retrofit their existing system with an AC that meets their load estimate. The incentives should be tiered and correspond to whether or not new ductwork is needed or if the new system can use the existing AC infrastructure.

6. **An ENERGY STAR homes program or equivalent or training for builders and architects on building homes beyond existing energy codes.** Homes built exceeding the existing energy code will use substantially less energy for heating, cooling, and water heating. Additionally, the energy-efficient features of these new homes keep out excessive heat, cold, and noise, and ensure consistent temperatures between and across rooms - making these homes more comfortable to live in. Builders and architects can learn how to build and sell these homes that have significant consumer benefit and the incremental cost to the builder is low. Specifically, this assessment identifies several home system components and envelope components may not be cost-effective or practical to implement in retrofit applications, however, in new construction applications, the incremental cost of executing these recommendations are extremely cost-effective.

   Two separate programs could be implemented: 1) A series of trainings for builders and architects on how to build beyond code homes; and 2) a system of incentives for homeowners (tax incentives, rebates, low-cost financing) to build a better home. However, in states and metropolitan areas that do not have a strict energy code, adapting the training prior to the homeowner incentives is recommended so that when consumers begin to demand more efficient homes, the building and architecture community will be prepared to handle this demand.

7. **An energy-efficient program in conjunction with the downsizing of an AC system.** After the initial assessment was completed, MEEA took the analysis a step further to look at the market potential of combining the planned replacement of window to a high-efficiency window and then downsizing the AC system at the same time. This new model estimated that the energy savings for the combinations of high efficiency windows and AC downsizing to 100% of Manual J calculated loads are as high as 784 kWh. These savings exceed the sum of savings for AC downsizing and high efficiency windows. This is due to the fact that the new windows reduce the cooling loads so that downsizing results in even smaller AC systems than downsizing alone. When these two measures are applied independently, they save an average of 678 kWh (314+364) per year. When they are applied together interactively the combined savings are 16%

more. This is characteristic of downsizing only, since all other combination measures usually lead to a slight interactive reduction in total savings when applied together.

Furthermore, the differential installed costs for the two combination measures are not only negative, but close (around -$900) to those of the downsizing only (-$1000). This is due to the fact that, on average, the degree of downsizing, and resultant installed cost savings, is greater when high efficiency windows are installed first. The additional cost savings for the smaller AC system offsets some of the differential costs of the high performance windows.

So, programs that combine education and awareness to contractors as well as small incentives for homeowners should be considered to achieve these desired savings.

Weatherization Programs:

1. **A weatherization program focused on duct and wall insulation.** The market assessment observed that most of the ducts in the basements of the Illinois homes were not insulated, whereas nearly all ducts in the attics had at least one inch of insulation. In our baseline models, it was assumed that 90% of the ducts were located in the attic and the product of U*A (i.e. thermal conduction coefficient times duct surface area) would be about 36, yielding an approximate peak air temperature rise of 1.0 degree Fahrenheit during the cooling cycle. In the retrofit case this U*A value was reduced to 20. The estimated annual savings for this measure is 52 kWh, with a peak demand reduction of 0.12 kW, plus 81 therms of gas per year and 2692 BTUH of peak gas consumption. Additionally, if 2" of insulation were added to any uninsulated ducts located in an attic space, the savings would be about five to seven times as much.

   Additionally, there are energy savings potential with attic and wall insulation retrofits. The models demonstrated that retrofitting R-7 attic insulation to R-30 insulation would yield savings of 484 kWh and 0.74 kW, plus 101 therms of gas annually and 9080 BTUH of peak gas consumption. Furthermore, we modeled a baseline of no wall insulation, and added R-11 insulation to represent a realistic best-case scenario. The calculated savings are 762 kWh and 1.1 kW, plus 451 therms of gas per year and 22,381 BTUH of peak gas consumption due to the reduction in gas heating.

   Although the potential savings are high, the long payback suggests that it would not be cost-effective to insulate existing walls with some insulation already in place. So, programs could be focused on reducing the retrofit cost to the homeowners so they would be more inclined to add more insulation to their attic and walls.

2. **Insulation of hot water pipes and water heater storage tanks.** MEEA estimated conservation impacts by assuming that any exposed pipes could be insulated, and that the energy savings would occur through a reduction in the hot water standby losses. The typical water heater is gas fired, so the estimated savings for the typical home are 13 therms per year and 152 BTUH. For the 4% with electric water heaters the annual electric savings would be about 312 kWh and 0.04 kW peak demand. Additionally, MEEA found that about 84% of the homes visited had gas water heaters that were not externally wrapped. The estimated savings for the typical home are 19 therms per year and 217 BTUH. For those with electric water heaters the annual electric savings would be about 267 kWh and 0.03 kW peak demand. Savings for this measure will vary with the ambient temperatures surrounding the hot water tank.

NRDC TV Energy Efficiency Research

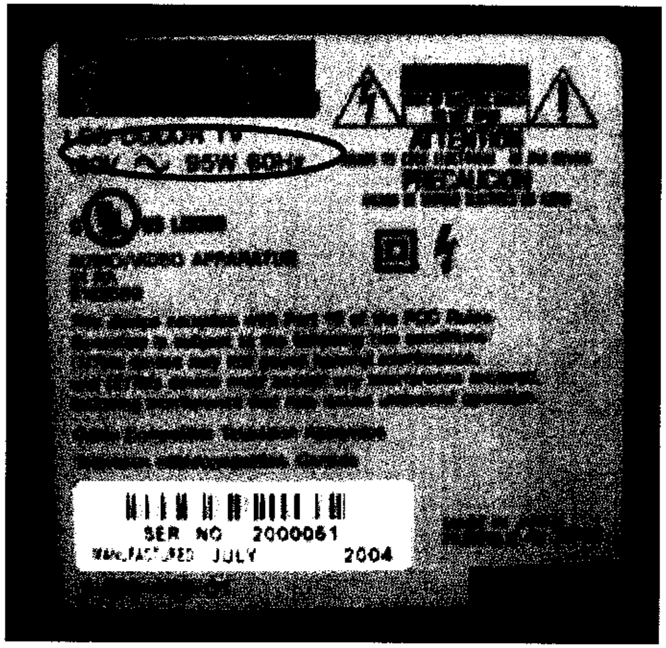
TV International Stakeholder Meeting
San Francisco, California
[illegible]

THE EARTH'S BEST DEFENSE

ecos CONSULTING

dorp
Research Analyst
Ecos Consulting
postendorp@ecosconsulting.com
(970)259-6801 ext. 307

Little information on TV power use

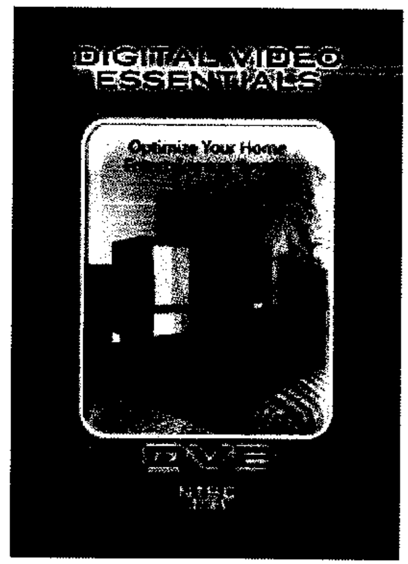


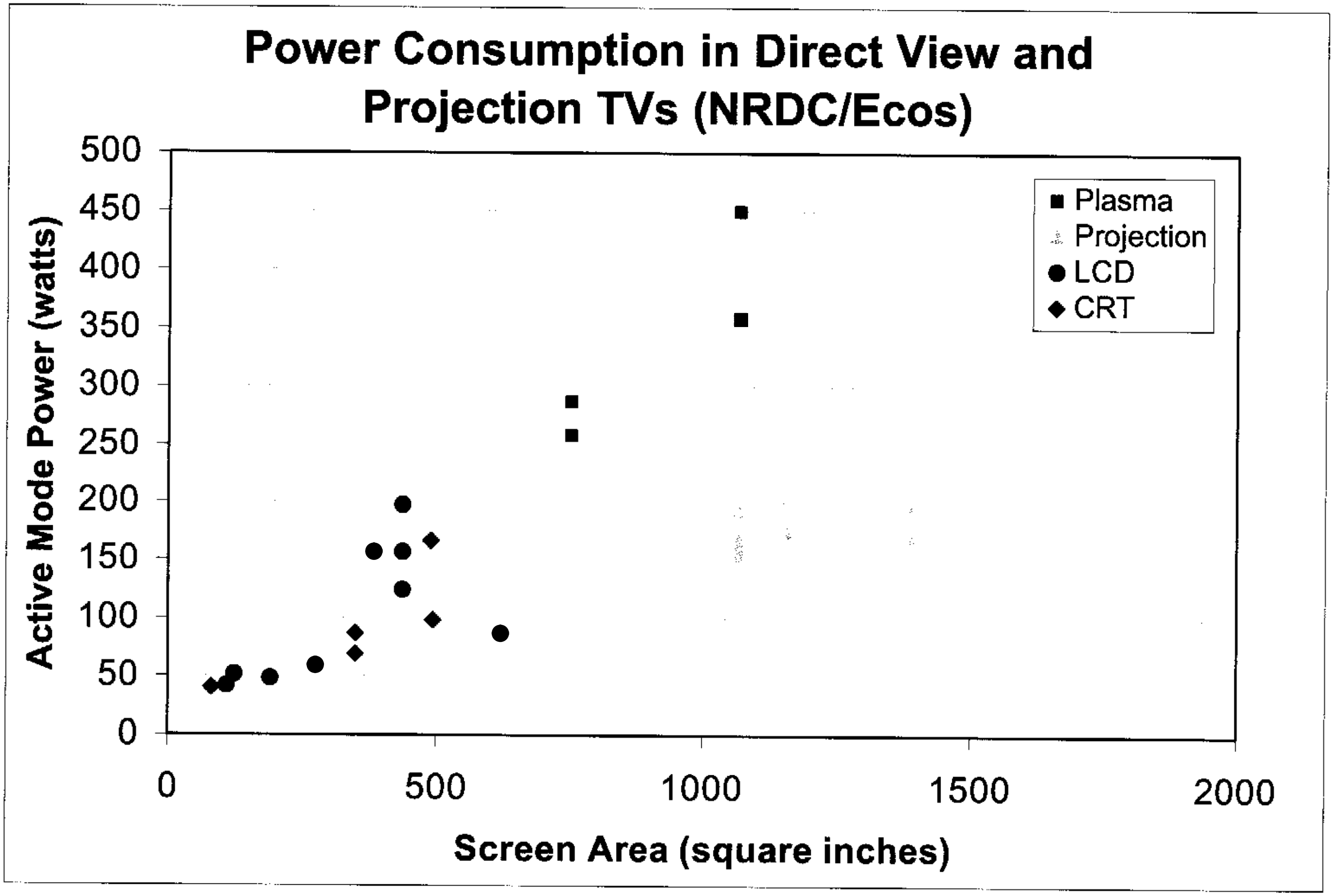
What test methods are available?

	Measures black and white CRTs	Measures color CRTs	Measures new display types	Reflects real world power consumption
DOE method	✓			
JEITA method	✓		✓	
IEC 62087	✓	✓	✓	

Our Field Test Method

- Measured TV power use in retail setting with WattsUp? Pro power meter
- Used showroom screen settings
- Measured average power over 2 minutes using standard test clip
- Digital Video Essentials video clip used as reference material




Power Consumption in Direct View and Projection TVs (NRDC/Ecos)
Active Mode Power (watts)
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Screen Area (square inches)
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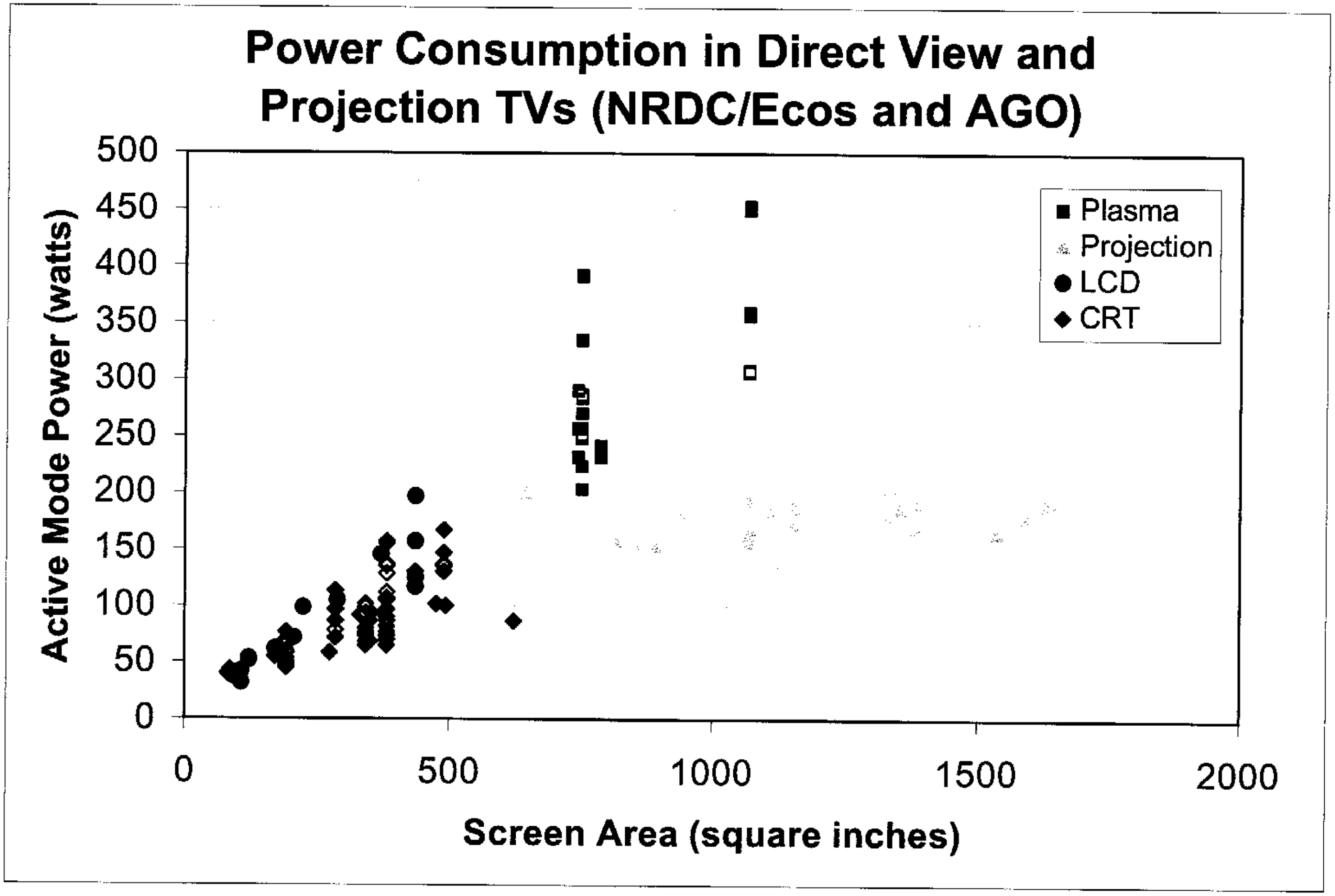
Plasma
Projection
LCD
CRT


Power Consumption in Direct View and Projection TVs (NRDC/Ecos and AGO)
Active Mode Power (watts)
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Screen Area (square inches)
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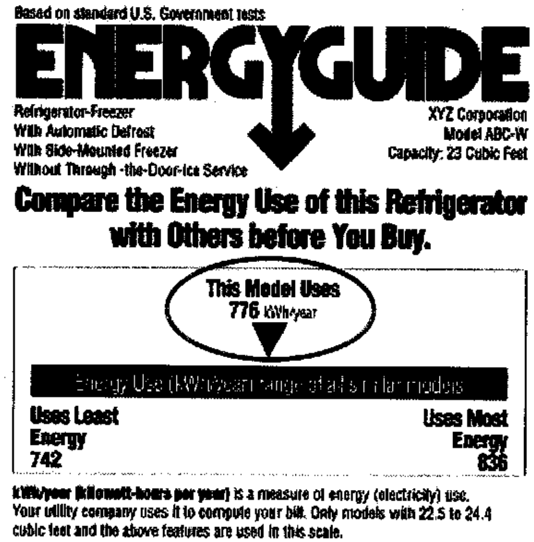
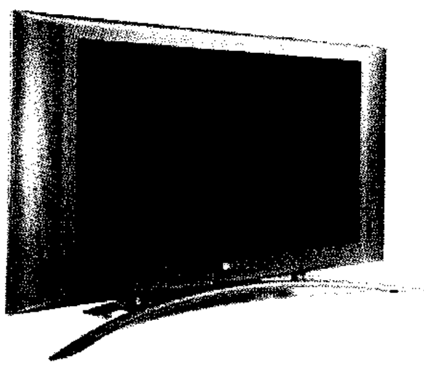
1500
2000
Plasma
Projection
LCD
CRT

How do we fairly gauge efficiency in TVs?

Lumens/watt

kWh/year





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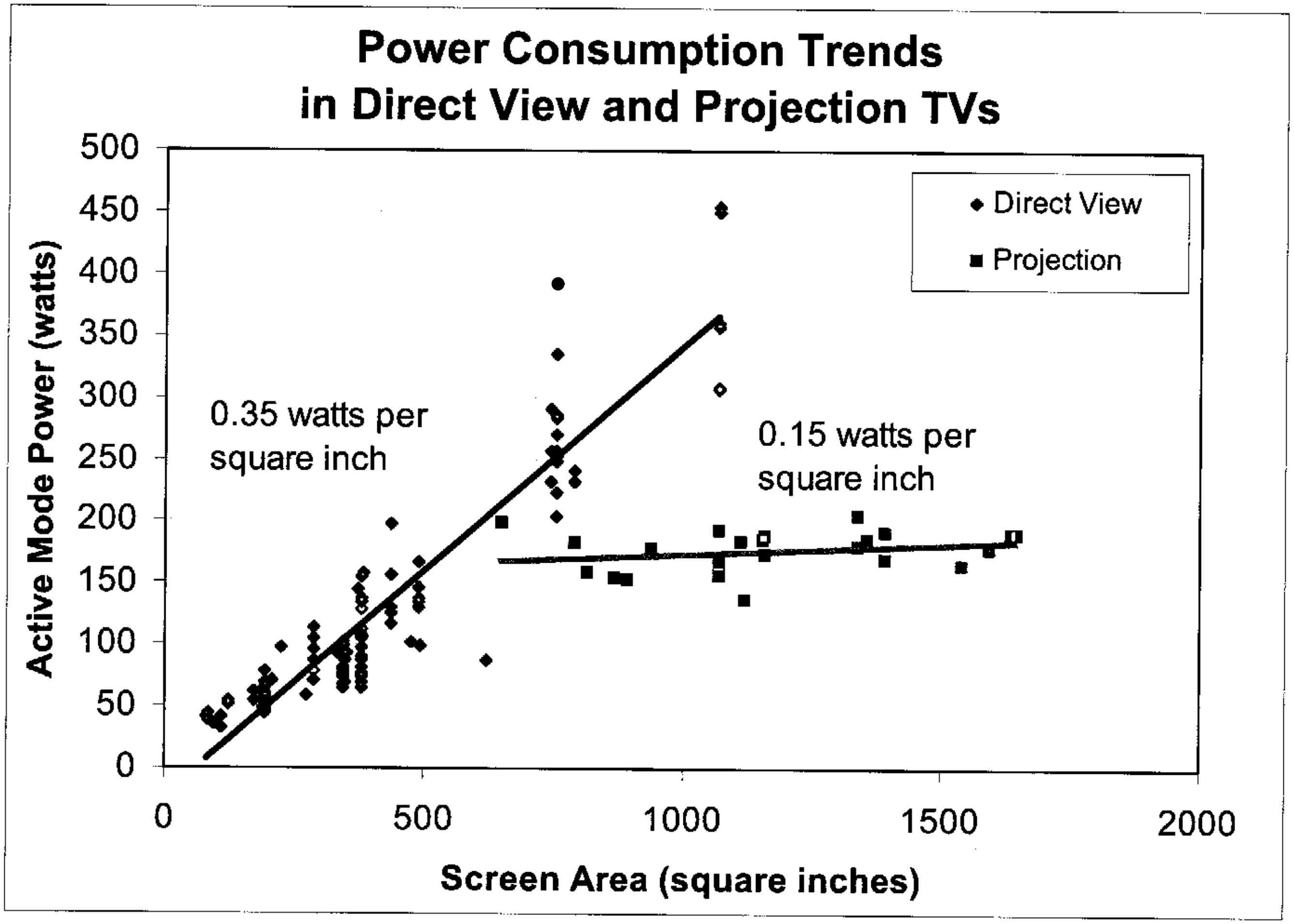
Different Trends for Different Technologies



Room for efficiency improvements in all technologies