A Tool for Estimating the Mix of Energy Conservation Measures Given Competing Acquisition Scenarios

R. W. Schultz

March 1991

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EXECUTIVE SUMMARY

To support the analysis work of the Bonneville Power Administration's Resource Program Environmental Impact Statement, analysts needed the ability to quickly and easily evaluate the effect of the energy conservation measure (ECM) mix and the amount of equipment/technology that could be replaced if they were adopted, given an alternative regional forecast of electricity savings potential. A tool called ECMMIX was developed in response to this need. A base-case forecast was provided by BPA to serve as a point of departure for the alternative forecasts, and a base-case ECM mix was estimated from the base-case forecast of regional megawatt savings. In addition, equipment and technology that could be replaced by the adoption of the ECM mix can be calculated. When alternative forecasts of regional savings are under consideration, ECMMIX is capable of calculating a new set of estimates for the associated ECM mix and the equipment replaced. A table demonstrating ECMMIX results is included.

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1.0 INTRODUCTION

Bonneville Power Administration (BPA) is conducting analyses that are to serve the Resource Program Environmental Impact Statement (RP/EIS). Parts of the RP/EIS are to address the impacts of commercial sector electricity conservation acquisitions under various conservation acquisition alternatives. These impacts include the energy conservation measure (ECM) mix adopted by the commercial sector and the equipment/technology that would be replaced by implementing new ECMs.

The goal of this project was to develop a tool that has the capability to detail region-wide numerical estimates of the commercial sector ECM and replaced technology mix. The tool (hereafter called ECMMIX) was to be sufficiently flexible and "user friendly" that analysts could easily perform sensitivity tests of alternative forecasts of energy conservation acquisitions. It needed to have the capability to assess impacts across different building types, utility regions, vintage and end-use categories, as well as to aggregate similar ECMs across all categories. The aggregation capability was to exist for the replaced technology as well.

The BPA provided all the necessary data for the analysis. The regional commercial sector conservation acquisition data for this analysis were obtained from BPA's resource analysis models, which are being used to project resource acquisitions for the RP/EIS alternatives. The ECM data is based primarily on DOE-2 Commercial Building Prototype Review and Revision, an analysis of ten commercial building types completed for BPA by United Industries Corporation (UIC 1987, 1988). Results from two other studies are incorporated into BPA's commercial sector conservation supply estimates. These studies are Commercial Refrigeration Resource Assessment by ADM Associates, Inc. (Wikler and Alereza 1988), and Lost Conservation Opportunities Created by Remodeling and Renovation in the Commercial Sector by Ecotope (Katz, Baylon & Gordon 1989).

There are several considerations that add complexity to ECMMIX development. First, the UIC building prototypes that account for the majority of conservation potential are based on a mix of building categories that differ

somewhat from building-type definitions in BPA's commercial load forecast, the source for BPA's commercial floorspace and electricity fuel share data. Second, the ECMs related to the ADM and Ecotope studies are not tied to specific, identifiable measures in the same way as the UIC measures. Third, adjustments to forecasted savings must be reversed for measures that are considered fuel-sensitive and have had line-loss credits applied to them, so as not to overestimate the number of ECMs associated with any particular savings forecast.

Chapter 2 presents specific details about the methodology and assumptions adopted in developing ECMMIX. Included is a discussion of data disaggregation, adjustments to forecasted savings estimates, and incorporation of ADM and Ecotope ECMs. Chapter 3 contains a user's guide to ECMMIX and concluding comments.

2.0 METHODOLOGY

This chapter describes the methodology adopted for the development of ECMMIX. Included are data specifics and a discussion of assumptions and problem resolutions.

2.1 OVERVIEW

The ECMMIX tool and its estimating capabilities evolved out of a base-case conservation-acquisition scenario. The data for the base case correspond to BPA's high-load case scenario detailed in Draft 1990 Conservation Resource Supply Document (BPA 1990), and represent an accelerated and higher level of resource acquisition relative to no action. As discussed in the introduction, data for individual ECMs were obtained from the UIC, ADM, and Ecotope studies.

Base-case conservation acquisitions consist of individual ECM savings specific to a building type, utility region, vintage, timing opportunity, and end-use category. Relevant data for each line-item ECM include the size of the applicable prototypical building, the percentage of applicable floorspace serviced by electricity exclusively, a savings rate, and the regional savings potential. The savings rate reflects the potential kWh savings per thousand square feet (TSF). Each savings-rate value incorporates, among other things, adjustments for fuel-share sensitivities and line-loss credits. The regional savings potential represents the average megawatts of electricity savings that a line-item ECM would contribute under a high-load case scenario. Specifics regarding the procedure followed to obtain regional savings potential can be found in Draft 1990 Conservation Resource Supply Document (BPA 1990).

The objective of ECMMIX is to estimate the number of ECMs and the amount of replaced technology that correspond to a forecasted regional savings potential. The basic approach to meeting this objective is to multiply the savings rate per TSF by the prototypical building floorsize, which results in a savings rate per building type. Next, the regional savings potential is converted to kWhs by applying a conversion factor of 8.76E6. Dividing this regional savings potential value by the savings rate per building yields an

estimate of the number of buildings corresponding to the savings potential. The number of ECMs that is applicable to each building type is provided by the ECM studies and, when applied to the number of buildings, produces an estimate of the number of ECMs needed to achieve the forecasted savings potential. Also available from the ECM studies is the technology/equipment replaced when a single ECM is adopted. With this information the replaced technology can be computed directly.

A critical category of the ECMs is the timing opportunity. Timing opportunity includes categories called lost opportunity, discretionary, remodel, and renovation. Lost opportunities correspond to ECMs that can be adopted only during construction or when a building undergoes major renovation and/or remodeling. Most remodel and renovation opportunities are associated with Ecotope ECMs and can be considered lost opportunities; however, their unique identification is maintained so analysts can more easily isolate Ecotope-related measures. Discretionary opportunities can occur at any point in the life-cycle of an existing structure.

Categorizing by timing opportunity becomes important when new forecasts of potential savings need to be evaluated. Forecasts are categorized by utility type, vintage, and timing opportunity. The percentage of change between the base case and alternative case is computed for each combination of categories and is used to adjust the estimated base-case ECM count for each ECM within the relevant category. The replaced technology/equipment is computed in the same way.

The results of these computations are made available in ECMMIX, which is a macro- and menu-driven LOTUS 1-2-3 worksheet file. Capabilities of ECMMIX include modifying forecasted savings values, sorting results by any one of four categories, viewing results, and aggregating ECMs or replaced technology across utility regions.

Although the methodology outlined above is straightforward, the data revealed a number of inconsistencies and/or considerations that had to be reconciled. The following sections provide the specifics of these considerations and any necessary assumptions that were adopted.

2.2 ECMMIX DEVELOPMENT

Development of ECMMIX began with a file (BPADATA) containing ECM specific data, including:

- percentage of regional floorspace served by electricity
- building floorspace (1000 sq. ft. per prototypical building)
- savings rate (kWh savings/1000 sq. ft.)
- regional savings potential (aMW).

Each ECM and its savings potential were to fall ultimately into one of the following categorical combinations:

- ECM Description
- Utility Sector: investor-owned-utility, public utility
- Vintage: existing (pre-1981 building stock), new (post-1991 building stock)
- Building Type: large office, small office, large retail, small retail, school, warehouse, restaurant, grocery, hotel/motel, hospital
- Timing Opportunity: lost opportunity, discretionary, remodel, renovation
- Measure End-use Category: lighting end uses, other end uses
- Fuel Type Affected: electricity only, electricity or gas.

2.2.1 Split Composite Measures

Before the ECM mix could be computed, several adjustments to BPADATA were required. The first adjustment involved ECMs that are a composite of two or more individual ECMs. It was necessary to separate composite ECMs into their individual components. This was accomplished by prorating the composite ECM regional savings and savings rate, using the ratio of an individual ECM's savings potential to the group total provided in the UIC report (1988, Tables 6.1 and 6.2). The composite ECM splits and their ratios are shown below by applicable building type.

TABLE 2.1.

<u>Building Type/ECM</u>	<u>Composite ECM Share</u>
• Hotel	
Efficient incandescents	0.81
Efficient lamps (32-watt)	0.19
• Hospital	
Efficient incandescents	0.22
Parabolic reflectors	0.78
• Grocery	
Refrig. anti-sweat timer	0.60
Beverage case timer	0.40
• Large Office (New Buildings)	
T-8 Fluorescents	0.84
Efficient incandescents	0.16
• Large Office (Existing Buildings)	
Efficient lamps	0.85
Efficient incandescents	0.15
• Restaurant	
Efficient incandescents	0.54
Efficient lamps	0.22
Parabolic reflectors	0.24
• School	
Efficient incandescents	0.08
Efficient lamps (32-watt)	0.92

2.2.2 ADM ECMS

Energy conservation measures in the ADM study are refrigeration measures that apply to either restaurants or grocery stores; they were added to BPADATA to develop a more comprehensive representation of the refrigeration ECMs that are available in the marketplace. Details of ADM measure stack development can be reviewed in Commercial Refrigeration Resource Assessment (Wikler and Alereza 1988).

Refrigeration measures from ADM exhibit the same problem as the composite ECMs; that is, each measure listed in BPADATA is essentially a combination of measures. Further complicating the issue is that neither the ADM report nor the ECM description directly identifies the actual equipment or technology making up the composite ECM for a particular building type. Instead, each ECM reflects a particular range of the region-wide energy conservation supply curve provided by ADM. The procedures used in determining

the equipment and/or technology making up a composite measure and the replaced equipment/technologies are fully explained in Appendix A.

2.2.3 Line Item Adjustments

Certain adjustments to the savings rate and savings potential of ECMs in BPADATA were necessary to prevent overestimation of the number of ECMs needed to achieve the forecasted potential; they include adjustments for competing fuel-type floorspace and line-loss credits.

The savings rate values provided in BPADATA have an adjustment for electricity fuel-type floorspace built in, but the savings potential values do not. To calculate the number of ECMs needed without adjusting the savings rate would result in an overestimation of ECMs. Thus, where an ECM is sensitive to the fuel type, the savings rate is adjusted by dividing this parameter by the fuel share assigned to the measure (the fuel type shares are resident in BPADATA). This adjustment increases the savings rate value and ultimately decreases the number of measures needed to achieve the forecasted savings potential.

In the original forecasting procedures, the savings potential was given a line-loss credit of 1.075. Again, to prevent overestimation of the number of ECMs, this credit had to be backed out of the savings potential values. To make this adjustment, the savings potential of each ECM was divided by the line-loss credit of 1.075, which reduces the savings potential and ultimately decreases the number of measures needed to achieve it.

2.2.4 Measure Consolidation

In the version of BPADATA provided by BPA, there were ECMs applicable to three composite building types in addition to the ten building types identified in section 2.2. These composite building types included "miscellaneous," "college," and "health." Each composite building type is identified with ECMs lifted from a subset of the other building-type ECMs according to a BPA distribution criteria. The composite building types were created out of a need to represent commercial facilities that were not covered by the UIC studies.

Only the ten building types identified in section 2.2 are needed for the RP/EIS; thus, it was necessary to collapse each composite building-type ECM into its respective parent building-type ECM. For example, an ECM associated with college buildings may actually originate from the large-office-building-type category. The consolidation process involved adding the savings potential of the composite building-type ECM to that of its parent building-type ECM. The savings rate is retained from that reported for the parent building-type ECM.

In certain instances, a parent building-type ECM did not exist for a composite building type ECM, due to elimination by the price-induced screening process of the forecasting procedure. In this case, the potential savings was retained from the composite building type ECM, but the savings rate is calculated. The calculation involved determining the ratio of the savings rates for composite to parent building-type ECMs of ECMs within the same category and applying the ratio to the parentless composite building-type ECM savings rate.

An additional consolidation effort was needed, in which ECMs were identified in a vintage category called "recent." This category of buildings corresponded to structures built between 1981 and 1985 and was treated uniquely in the forecasting procedures, to incorporate the consideration of newly adopted building codes and standards during this period. Since some of the ECMs associated with pre-1981 structures are now required by building codes, interactive effects of some ECMs result in reduced potential savings estimates, or the ECM is not included in the list of discretionary adoptable ECMs if the structure was built during the "recent" period. ECMs associated with "recent" vintages were consolidated with like ECMs in the "existing" vintage category in the same manner as described above for composite building type ECMs.

2.2.5 Renovation and Remodel Measures

Additional ECMs were added to the measure stack of BPADATA to more fully represent measures associated with major remodel and/or renovation activities beyond those of existing lost opportunities. These ECMs were provided by BPA from the Ecotope study. Due to extensive uncertainties inherent in the

Ecotope study, BPA provided a list of the ECM savings potential and required ECMs to achieve that potential directly. That is, no further calculation of the ECM mix was required except in the case of heating, ventilation and air conditioning (HVAC) measures. In the case of HVAC measures, potential savings were provided along with the corresponding required number of buildings.

Extensive professional judgement was exercised in obtaining the end-use applications per building, because that information was not provided by ECOTOPE. The list of HVAC ECMs and assumptions employed in determining their end-use applications is provided in Appendix B.

2.2.6 Estimation of ECM Mix

To derive the ECM mix and the technology/equipment replaced, it was first necessary to establish the number of ECMs per prototypical building and the replacement rate per ECM adopted. Appendix C presents the estimates of ECMs per building. Replaced equipment/technology per ECM are available in ECMMIX. A large share of the ECMs do not replace any equipment/technology, because they are retrofit measures that add to a system. Where replacements do occur, ECMs generally replace equipment/technology one-for-one; for other cases a multiplier is built into ECMMIX that calculates the correct number of replacements.

With the ECMs per building established, calculating the number of ECMs and replacements associated with forecasted savings potential is straightforward as described in Section 2.1. That is, the number of buildings associated with the savings potential is computed and multiplied by the ECMs per building type. At this point BPADATA is fully developed for incorporation into ECMMIX.

3.0 ECMMIX USER GUIDE

The following sections describe the capabilities of ECMMIX. Included are a discussion of the procedures and options available to the user and concluding remarks.

3.1 USER CAPABILITIES

ECMMIX pulls together the data of BPADATA, baseline conditions of applicable building types, and data manipulation capabilities and results. The tool is a LOTUS 1-2-3 worksheet file with macro-driven menus that lead a user through an analysis session. User requirements consist of an IBM PC or clone, LOTUS 1-2-3, and a beginner's understanding of LOTUS 1-2-3.

To access ECMMIX.WK1, retrieve the file as any other worksheet file would be loaded. An introductory screen appears and is shown below:

ELECTRICITY CONSERVATION
MEASURE ESTIMATIONS

prepared by
Robert W. Schultz
Pacific Northwest Laboratory
for
Bonneville Power Administration

February 15, 1991

>>>> Strike ALT A to initiate the analysis macro <<<<

From the introductory screen, and after striking ALT A (strike the keys simultaneously), the macro process will be activated and will guide the user through an analysis session. The next screen presented to the user appears below:

You now have the option to perform one of the menu items shown at the top of the screen and described below.

FORE_MW:	Show and/or change the current forecasted megawatt savings.
VIEW:	View the ECM measure stack.
UTILITY_TYPE:	Sort the ECMs by utility type (IOU vs Public) and vintage.
BUILDING_TYPE:	Sort the ECMs by building type (LO, SO, etc.) and by Utility type.
TIMING:	Sort the ECMs by timing category (Lost Opportunity, discretionary, remodel, renovation) and utility type.
ECM:	Sort the ECMs by measure description and utility type.
AGGREGATE:	Select to sort on ECMS or replacements.
QUIT:	Select to terminate the analysis.

Each of the options described in the above screen will appear in the command line of the worksheet, and one should be selected in the same manner as selecting options in other LOTUS 1-2-3 worksheet files. That is, either move the cellpointer to the desired option or simply type the first character of the option.

If the user selects FORE_MW, a new screen will reveal the Megawatt Savings Summary Table, and the menu options MODIFY and CONTINUE will appear on the command line. Selecting MODIFY will transfer control to the user and allow changes to be made to the highlighted sections of the summary table. It is through this avenue that a user enters new forecasts for potential savings. That is, alternative projections of savings potential will be in terms of utility type, vintage and/or timing opportunity, and all ECMs associated with an altered savings category will be adjusted accordingly. Once all changes have been entered the user strikes ALT B to reactivate the macro process. If no changes are to be made to the summary table, the user can then select option CONTINUE to return to the previous set of menu options. The summary table is shown below in Table 3.1. In this example, a new savings forecast

TABLE 3.1. Megawatt Savings Summary Table. Alternative Case 1

<u>Conservation Acquisition Alternative</u>	<u>Vintage and Opportunity Category</u>	<u>Average Megawatts</u>		<u>Percent of Base Case</u>	
		<u>Public</u>	<u>IOU</u>	<u>Public</u>	<u>IOU</u>
Basecase:	Existing-Discr.	45	73	--	--
	Existing-Lost Opp.	85	95	--	--
	New-Lost Opp.	<u>170</u>	<u>389</u>	--	--
Total Basecase:		300	558		
Alternative:	Existing-Discr.	90	73	2.00	1.00
	Existing-Lost Opp.	85	95	1.00	1.00
	New-Lost Opp.	<u>170</u>	<u>389</u>	1.00	1.00
Total Alternative:			345		558

for existing discretionary-public-utility ECMs has been entered as reflected by the percent of base-case value shown. All ECM estimates associated with this category will be adjusted by a factor of 2.0.

The options UTILITY_TYPE, BUILDING_TYPE, TIMING, and ECM all relate to sorting capabilities. As described in the options screen, the results of computations specific to the current values of the summary table will be sorted on primary and secondary keys. For example, if the user selected TIMING, all results would be sorted first by timing opportunity (in ascending order; e.g., discretionary, lost opportunity, remodel, and renovation) and second, by utility type.

Once the sorting process has been completed, the options menu reappears on the command line. By selecting VIEW the user can peruse the results and return to the options menu by striking any key. Selecting the AGGREGATE option will present a menu with choices of NEW_TECHNOLOGY and REPLACED_TECHNOLOGY. Selecting the first choice will collapse all like ECMs by utility type. Selecting REPLACED_TECHNOLOGY will collapse all like replaced equipment/technology, again by utility type. In either aggregation procedure, certain classifications of ECMs or replaced equipment will be lost. For example, the building type associated with an ECM can no longer be retained when collapsing two like ECMs with different building type origins.

The last option of the options menu is the QUIT option. By selecting QUIT the macro process cleans up the worksheet and notifies the user to save

any desired results under a new file name for future use. Control is then transferred to the user, where further analyses can be implemented at will.

The results section of ECMMIX is 15 columns wide. For presentation purposes it is shown below in a horizontal manner, allowing easy visual representation of ECMMIX results (Table 3.2).

To demonstrate the data provided by ECMMIX consider line two of the results shown below. The ECM adopted is efficient incandescent light fixtures applicable to existing large office buildings in investor-owned utility regions. This ECM is a lighting measure affecting the electricity fuel type and is available for adoption at any time during the life cycle of the building (i.e., discretionary timing opportunity). According to BPA base-case forecasts, this ECM could save 0.315 average megawatts regionwide, corresponding to 96,237 fixtures. Since there is a one-to-one replacement rate, 96,237 100-watt incandescent downlight fixtures are replaced. The alternative forecasted savings potential is the same as the base-case forecasts; therefore, the ECM estimate is unchanged from that of the base case.

3.2 CONCLUSIONS

The ECMMIX tool was developed to provide BPA analysts with the ability to quickly and easily evaluate the impact on the ECM mix associated (and equipment/technology replaced) with a given alternative regional forecast of electricity savings potential. A base-case forecast was provided by BPA to serve as a point of departure for alternative forecasts. More specifically, a base-case ECM mix has been estimated from a base-case forecast of regional megawatt savings. In addition, equipment and technology replaced from adoption of the ECM mix has been provided. When alternative forecasts of regional savings are under consideration, ECMMIX is capable of calculating a new set of estimates for the associated ECM mix and the equipment replaced.

The entire results section of ECMMIX is too large to be represented in this document, but it can be reviewed in an analysis session using ECMMIX. Problems or questions regarding the use of the ECMMIX tool can be directed to the author.

TABLE 3.2. ECMMIX Results

Building Type	Utility Type (I=IOU, P=Public)	Vintage (N=New, E=Exist.)	Measure End-use Category (L=Ltg., O=Other)	Fuel Type Affected (E=Electric, G=Gas)	Discre., Lost Opp., ReNovation	ECM Measure Description	ECM Unit	Ave. MW Savings in Base-case Scenario	Total Number of ECMs in Base-case Scenario	Ave. MW Savings in Alternative Scenario	Total Number of ECMs in Alternative Scenario	Baseline Scenario Equipment Quantity Replaced	Alternative Scenario Equipment Quantity Replaced	Type of Equipment Replaced
SR	I	E	O	G	DI	Water heater tank insulation	Blanket	0.357	2,815	0.357	2,815	0	0	NA
LO	I	E	L	E	DI	Efficient incandescents	Fixture	0.315	96,237	0.315	96,237	96,237	96,237	100-watt incandescent downlight fixtures
WA	I	E	L	E	DI	Efficient incandescents	Fixture	0.214	9,409	0.214	9,409	9,409	9,409	150-watt floodlights
LO	I	E	L	E	DI	Efficient lamps (32-watt)	Lamp	1.787	2,004,930	1.787	2,004,930	2,004,930	2,004,930	40-watt fluorescent lamps
LR	I	E	O	G	DI	Water heater tank insulation	Blanket	0.114	897	0.114	897	0	0	NA
LO	I	E	O	G	DI	Temperature reset for multi-zone control	Reset control	1.832	141	1.832	141	0	0	NA
LR	I	E	L	E	DI	Efficient incandescents	Fixture	0.087	14,238	0.087	14,238	14,238	14,238	150-watt floodlights
LO	I	E	O	G	DI	Variable air volume	Square foot	16.003	28,189,060	16.003	28,189,060	0	0	NA
GR	I	E	O	G	DI	Heat recovery to water heater	Unit	1.726	704	1.726	704	0	0	NA
GR	I	E	L	E	DI	Efficient incandescents	Fixture	0.628	27,037	0.628	27,037	27,037	27,037	150-watt floodlights

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APPENDIX A

ADM REFRIGERATION ECMs

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ADM REFRIGERATION ECMs

Presented below are the procedures adopted for splitting ADM refrigeration measures into individual ECMs in BPADATA. ADM data development will not be repeated here, but can be reviewed in Commercial Refrigeration Resource Assessment (Wikler and Alereza 1988).

The ADM study did not provide a sufficient data disaggregation to determine ECM shares of the savings potential. Individual ECMs are identified only when linked with the regional savings as a whole. To determine the amount to which an individual ECM contributes to the region total, and more importantly, assign it to a building and vintage category, it was first necessary to determine whether a building/vintage category could physically adopt the ECM. Also, any ECMs already represented by the UIC studies are excluded.

Next, the share the remaining ECMs contribute to the regional savings potential within a given building/vintage is used to distribute the savings potential and savings rates shown in BPADATA.

The ADM study did identify the number of system applications a particular ECM could affect. These were extracted and used to reflect the number of units per building type in BPADATA. An assumption was adopted that presumes 100% application rate in all applicable end-uses of a building.

Once all composite ADM measures were split into individual ECMs in BPADATA, a comparison of the number-of-buildings calculation (across like line-item measures) revealed identical estimates. It could only be assumed that each ECM savings rate used in calculating the savings potential had an adjustment for applicable floorspace availability built in, meaning that the calculated number of buildings for any particular line item represents the total number of buildings needed to achieve the sum of each like line-item savings potential.

ADM equipment/technology replacements for each ECM are available in ECMMIX. In all ADM refrigeration measures where replacements occur, substitutions are one-for-one with ECMs adopted.

The disaggregation process described above resulted in the following list of individual ECMs for each composite ADM measure. The ECMs are grouped by vintage and building type and by ADM composite ECM (e.g., ADM.E.GR.R1 refers to existing grocery stores, range 1 of the energy conservation supply curve). Included is the number of units per building type affected by ECM adoption and the share of the BPADATA savings rate and savings potential attributable to the individual ECM.

TABLE A.1. ADM Composite ECM Distributions and Unit Estimates

<u>Building Type</u>	<u>Units per Building</u>	<u>Composite ECM Share</u>
<u>Existing Grocery</u>		
ADM.E.GR.R1		
Floating condenser head press. cntrl.	14	0.36
Liquid pressure amplifier	14	0.28
Hot gas defrost	14	0.20
Ambient sub-coolers	14	0.05
Shell improvements	2	0.12
ADM.E.GR.R2		
Screw compressor	14	0.21
Parallel unequal compressor	14	0.10
Floating condenser head press. cntrl.	14	0.21
Liquid pressure amplifier	14	0.27
High efficiency fan	16	0.02
Ambient sub-coolers	14	0.05
Shell improvements	2	0.13
ADM.E.GR.R3		
Screw compressor	14	0.25
Parallel unequal compressor	14	0.04
Floating condenser head press. cntrl.	14	0.05
Liquid pressure amplifier	14	0.26
High efficiency fan	16	0.03
Ambient sub-coolers	14	0.06
Shell improvements	2	0.31

TABLE A.1. (contd)

<u>Building Type</u>	<u>Units per Building</u>	<u>Composite ECM Share</u>
<u>Existing Grocery (contd)</u>		
ADM.E.GR.R4		
Screw compressor	14	0.44
Parallel unequal compressor	14	0.05
Floating condenser head press. cntrl.	14	0.01
Liquid pressure amplifier	14	0.11
Evaporative pre-cooler	14	0.01
High-efficiency fan	16	0.02
Ambient sub-coolers	14	0.01
Shell improvements	2	0.08
Heat recovery	14	0.27
ADM.E.GR.R5		
Parallel unequal compressor	14	0.63
Evaporative pre-cooler	14	0.04
High-efficiency fan	16	0.14
Mechanical sub-cooler	14	0.20
ADM.E.GR.R6		
Screw compressor	14	0.48
Parallel unequal compressor	14	0.25
Floating condenser head press. cntrl.	14	0.07
Variable speed compressor	14	0.01
High-efficiency fan	16	0.06
Ambient sub-coolers	14	0.03
Shell improvements	2	0.09
ADM.E.GR.R7		
Variable speed compressor	14	0.88
High-efficiency fan	16	0.12
<u>New Grocery</u>		
ADM.N.GR.R1		
Floating condenser head press. cntrl.	12	0.36
Liquid pressure amplifier	12	0.28
Hot gas defrost	12	0.20
Ambient sub-coolers	12	0.05
Shell improvements	2	0.12
ADM.N.GR.R2		
Screw compressor	12	0.21
Parallel unequal compressor	12	0.10
Floating condenser head press. cntrl.	12	0.21

TABLE A.1. (contd)

<u>Building Type</u>	<u>Units per Building</u>	<u>Composite ECM Share</u>
Liquid pressure amplifier	12	0.27
High efficiency fan	14	0.02
Ambient sub-coolers	12	0.05
Shell improvements	2	0.13
ADM.N.GR.R3		
Screw compressor	12	0.25
Parallel unequal compressor	12	0.04
Floating condenser head press. cntrl.	12	0.05
Liquid pressure amplifier	12	0.26
High-efficiency fan	14	0.03
Ambient sub-coolers	12	0.06
Shell improvements	2	0.31
ADM.N.GR.R4		
Screw compressor	12	0.44
Parallel unequal compressor	12	0.05
Floating condenser head press. cntrl.	12	0.01
Liquid pressure amplifier	12	0.11
Evaporative pre-cooler	12	0.01
High-efficiency fan	14	0.02
Ambient sub-coolers	12	0.01
Shell improvements	2	0.08
Heat recovery	12	0.27
ADM.N.GR.R5		
Parallel unequal compressor	12	0.63
Evaporative pre-cooler	12	0.04
High-efficiency fan	14	0.14
Mechanical sub-cooler	12	0.20
ADM.N.GR.R6		
Screw compressor	12	0.48
Parallel unequal compressor	12	0.25
Floating condenser head press. cntrl.	12	0.07
Variable speed compressor	12	0.01
High-efficiency fan	14	0.06
Ambient sub-coolers	12	0.03
Shell improvements	2	0.09
ADM.N.GR.R7		
Variable speed compressor	12	0.88
High-efficiency fan	14	0.12

TABLE A.1. (contd)

<u>Building Type</u>	<u>Units per Building</u>	<u>Composite ECM Share</u>
<u>Existing Restaurant</u>		
ADM.E.RE.R2		
Floating condenser head press. cntrl.	3	0.31
Liquid pressure amplifier	3	0.39
High-efficiency fan	7	0.03
Ambient sub-coolers	3	0.07
Shell improvements	4	0.19
ADM.E.RE.R3		
Floating condenser head press. cntrl.	3	0.07
Liquid pressure amplifier	3	0.37
High-efficiency fan	7	0.04
Ambient sub-coolers	3	0.08
Shell improvements	4	0.44
ADM.E.RE.R4		
Floating condenser head press. cntrl.	3	0.05
Liquid pressure amplifier	3	0.47
Evaporative pre-cooler	3	0.02
High-efficiency fan	7	0.09
Ambient sub-coolers	3	0.02
Shell improvements	4	0.34
ADM.E.RE.R6		
Floating condenser head press. cntrl.	3	0.30
High-efficiency fan	7	0.24
Ambient sub-coolers	3	0.11
Shell improvements	4	0.35
<u>New Restaurant</u>		
ADM.N.RE.R2		
Floating condenser head press. cntrl.	3	0.31
Liquid pressure amplifier	3	0.39
High-efficiency fan	7	0.03
Ambient sub-coolers	3	0.07
Shell improvements	4	0.19
ADM.N.RE.R3		
Floating condenser head press. cntrl.	3	0.07
Liquid pressure amplifier	3	0.37
High-efficiency fan	7	0.04
Ambient sub-coolers	3	0.08
Shell improvements	4	0.44

TABLE A.1. (contd)

<u>Building Type</u>	<u>Units per Building</u>	<u>Composite ECM Share</u>
ADM.N.RE.R4		
Floating condenser head press. cntrl.	3	0.05
Liquid pressure amplifier	3	0.47
Evaporative pre-cooler	3	0.02
High-efficiency fan	7	0.09
Ambient sub-coolers	3	0.02
Shell improvements	4	0.34
ADM.N.RE.R5		
Evaporative pre-cooler	3	0.21
High-efficiency fan	7	0.79
ADM.N.RE.R6		
Floating condenser head press. cntrl.	3	0.30
High-efficiency fan	7	0.24
Ambient sub-coolers	3	0.11
Shell improvements	4	0.35

REFERENCE

Wikler, G. A., and T. Alereza. November 1988. Commercial Refrigeration Resource Assessment. ADM Associates, Inc., Sacramento, California.

APPENDIX B

ECOTOPE REMODEL AND RENOVATION ECMs

APPENDIX B

ECOTOPE REMODEL AND RENOVATION ECMs

The following section describes the approach used to determine the end use applications per building for Ecotope HVAC ECMs. Initially, an ECM and system application were compared with the systems identified in the UIC and/or ADM studies. If the systems appeared compatible, the end-use applications were lifted from these sources. If a system was not compatible, or was not present in any configuration for a particular building type, then an ECM's size per square foot was determined for a building type most closely configured to the building type under consideration. Using the square foot sizing and the square footage of the building type under consideration, an estimate of the end-use application could be determined. For example, if the fan horsepower sizing for an ECM is not available for a small office building, then the sizing for horsepower requirements per square foot in large office buildings was determined and multiplied by the small office building square footage. These assumptions and the calculation results are presented in the following tables.

TABLE B.1. Ecotope HVAC Renovation ECM/Building Assumptions

Building Type	ECM Description	Source of ECM/Building
LO	Chiller water reset	UIC
LO	High-eff. motor	UIC
LO	High-eff. chiller	UIC
LO	Variable speed drive fan	Assumed equal to high efficiency motor
LO	Screw compressor	Assumed 2-reciprocating compressors used in 2 chillers
LR	Energy management system	Assumed one system per building
LR	High-eff. heat pump	Assumed ton per sq.ft. equals that for small retail (7.5/4.88*120)
LR	Var. spd. drive: circ. pumps	Assumes one 25-Hp pump per chiller (2 chillers)
SR	Optimal start timer	Ecotope assumes one timeclock for all units
SR	High-eff. heat pump	UIC
SR	Heat pump	UIC
SR	Eff. fan motor	Assumed Hp per sq.ft. equals that for Large Office (900/408*4.88)
RE	Optimal start timer	Ecotope assumes one timeclock for all units
RE	Eff. fan motor	Assumed Hp per sq.ft. equals that for Large Office (900/408*2.624)
GR	Eff. fan motor	Assumed fan motors are used in each refrigeration case (UIC)
GR	High-eff. cooling	UIC
HM	High-eff. chiller	2-200 ton chillers are present
HM	Var. spd. drive on circ. pumps	Assumes one 25-Hp pump per chiller (2 chillers)
HM	Energy management system	Assumes one system per building
HM	Heat pump	Assumes tons per sq.ft. equals that for high-efficiency heat pump of Small Retail (7.5/4.88*277)
HM	Eff. fan motor	Assumed Hp per sq.ft. equals that for Large Office (900/408*277)

TABLE B.1. (contd)

<u>Building Type</u>	<u>ECM Description</u>	<u>Source of ECM/Building</u>
SC	High-eff. heat pump	Assumes tons per sq.ft. equals that for high-efficiency heat pump of Small Retail (7.5/4.88*67)
SC	Energy management system	Assumes one system per building
SC	Eff. fan motor	Assumed Hp per sq.ft. equals that for Large Office (900/408*67)
HO	Screw compressor	Assume 2 reciprocating compressors used in 2 chillers
HO	High-eff. chiller	UIC
HO	Chiller water reset	UIC
HO	Eff. fan motor	Assumed Hp per sq.ft. is same as that for Large Office (900/408*277)

LO = Large Office, LR = Large Retail, SR = Small Retail,
 RE = Restaurant, GR = Grocery, HM = Hotel/Motel, SC = School,
 HO = Hospital.

TABLE B.2. Ecotope HVAC Renovation ECMs

Building Type	ECM Description	Number of Units/ Building	Units
LO	Chiller water reset	2	Chillers
LO	High-eff. motor	900	Hp
LO	High-eff. chiller	2	Chillers
LO	Variable speed drive fan	900	Hp
LO	Screw compressor	2	Compressors
LR	Energy mangmt. system	1	System
LR	High-eff. heat pump	184	Ton
LR	Var. spd. drive on circ. pumps	50	Hp
SR	Optimal start timer	1	Timer
SR	High-eff. heat pump	7.5	Ton
SR	Heat pump	27.5	Ton
SR	Eff. fan motor	11	Hp
RE	Optimal start timer	1	Timer
RE	Eff. fan motor	6	Hp
GR	Eff. fan motor	14	Units
GR	High-eff. cooling	14	Refrig. cases
HM	High-eff. chiller	2	Chillers
HM	Var. spd. drive on circ. pumps	50	Hp
HM	Energy mangmt. system	1	System
HM	Heat pump	425	Tons
HM	Eff. fan motor	611	Hp
SC	High-eff. heat pump	103	Ton
SC	Energy mangmt. system	1	System
SC	Eff. fan motor	148	Hp
HO	Screw compressor	2	Compressors
HO	High-eff. chiller	2	Chillers
HO	Chiller water reset	2	Chillers
HO	Eff. fan motor	611	Hp

TABLE B.3. Ecotope HVAC Renovation Savings Potential and ECM Mix (values are applicable to both investor-owned and public utilities).

<u>Building Type</u>	<u>ECM Description</u>	<u>Ave. MW Savings</u>	<u>Number of of Bldgs.</u>	<u>Number of of ECMs</u>
LO	Chiller water reset	0.010	2.2	4
LO	High-eff. motor	0.016	3.8	3429
LO	High-eff. chiller	0.047	1.8	4
LO	Variable speed drive fan	0.039	1.0	864
LO	Screw compressor	0.058	1.9	4
LR	Energy mangmt. system	0.199	22.5	23
LR	High-eff. heat pump	0.005	0.5	26
LR	Var. spd. drive on circ. pumps	0.051	14.9	3941
SR	Optimal start timer	0.036	118.2	354
SR	High-eff. heat pump	0.050	66.5	1828
SR	Heat pump	0.055	29.6	813
SR	Eff. fan motor	0.014	248.8	2737
RE	Optimal start timer	0.114	467.9	468
RE	Eff. fan motor	0.091	1387.9	8327
GR	Eff. fan motor	0.026	43.3	606
GR	High-eff. cooling	0.060	39.2	549
HM	High-eff. chiller	0.004	0.4	1
HM	Var. spd. drive on circ. pumps	0.005	0.6	1
HM	Energy mangmt. system	0.005	0.2	0
HM	Heat pump	0.032	0.2	12
HM	Eff. fan motor	0.005	1.3	798
SC	High-eff. heat pump	0.277	29.6	830
SC	Energy mangmt. system	0.125	16.4	16
SC	Eff. fan motor	0.043	69.7	10448
HO	Screw compressor	0.069	2.1	4
HO	High-eff. chiller	0.101	4.2	8
HO	Chiller water reset	0.038	6.4	13
HO	Eff. fan motor	0.097	5.3	3176

REFERENCE

Katz, G., D. Baylon, and F. Gordon. 1989. Lost Conservation Opportunities Created by Remodeling and Renovation in the Commercial Sector. Momentum Engineering and Ecotope, Seattle, Washington.

APPENDIX C

ECMs PER PROTOTYPICAL BUILDING

APPENDIX C

ECMs PER PROTOTYPICAL BUILDING

ECMs per Prototypical Building

Tables C.1 and C.2 provide a summary of the ECMs per prototypical building for ECMs associated with existing and new buildings, respectively. The units per building shown below were obtained from the UIC studies (UIC 1987, 1988).

TABLE C.1. ECMs per Prototypical Building: Existing Buildings.

<u>Building Type</u>	<u>ECM Description</u>	<u>Units</u>	<u>Units/ Building</u>
GR	Beverage case timer	Timer	2
GR	Caulking and weatherstripping	Linear foot	62
LR	Caulking and weatherstripping	Linear foot	80
SC	Caulking and weatherstripping	Linear foot	6274
SR	Caulking and weatherstripping	Linear foot	40
WA	Caulking and weatherstripping	Linear foot	168
GR	Contrast controls	Control switch	58
GR	Destratifiers	Fan	3
WA	Destratifiers	Fan	6
RE	Economizer	Unit	4
SO	Economizer	Unit	2
WA	Economizer	Unit	1
WA	Eff. ballasts (electronic office)	Ballast	48
GR	Eff. ballasts (electronic sales)	Ballast	230
GR	Eff. ballasts (electronic storage)	Ballast	18
HM	Efficient ballasts (electronic)	Ballast	988
HO	Efficient ballasts (electronic)	Ballast	4815
LO	Efficient ballasts (electronic)	Ballast	8500
RE	Efficient ballasts (electronic)	Ballast	43
SC	Efficient ballasts (electronic)	Ballast	1378
SO	Efficient ballasts (electronic)	Ballast	86
WA	Eff. ballasts (magnetic warehouse)	Ballast	32
LR	Efficient ballasts (sales)	Ballast	2496
SR	Efficient ballasts (sales)	Ballast	180
LR	Efficient ballasts (storage)	Ballast	281
SR	Efficient ballasts (storage)	Ballast	30
HM	Efficient exhaust hoods	Unit	4

TABLE C.1. (contd)

Building Type	ECM Description	Units	Units/ Building
RE	Efficient exhaust hoods	Unit	2
HO	Efficient fan motors	HP	350
LO	Efficient fan motors	HP	900
HM	Efficient gas heat	Control unit	2
HO	Efficient gas heat	Control unit	2
LO	Efficient gas heat	Control unit	2
LR	Efficient gas heat	Control unit	1
SC	Efficient gas heat	Control unit	2
SR	Efficient gas heat	Control unit	1
WA	Efficient gas heat	Control unit	6
GR	Efficient gas heat (sales)	Control unit	5
GR	Efficient gas heat (storage)	Control unit	5
GR	Efficient incandescents	Fixture	52
HM	Efficient incandescents	Fixture	640
HO	Efficient incandescents	Fixture	306
LO	Efficient incandescents	Fixture	816
LR	Efficient incandescents	Fixture	442
RE	Efficient incandescents	Fixture	19
SC	Efficient incandescents	Fixture	170
SO	Efficient incandescents	Fixture	4
SR	Efficient incandescents	Fixture	33
WA	Efficient incandescents	Fixture	4
LR	Efficient lamps (32-watt sales)	Lamp	4992
SR	Efficient lamps (32-watt sales)	Lamp	360
LR	Efficient lamps (32-watt storage)	Lamp	562
HM	Efficient lamps (32-watt)	Lamp	1482
HO	Efficient lamps (32-watt)	Lamp	9630
LO	Efficient lamps (32-watt)	Lamp	17000
RE	Efficient lamps (32-watt)	Lamp	86
SC	Efficient lamps (32-watt)	Lamp	2756
SO	Efficient lamps (32-watt)	Lamp	172
WA	Efficient lamps (32-watt)	Lamp	96
LR	Efficient lamps (34-watt sales)	Lamp	4992
SR	Efficient lamps (34-watt sales)	Lamp	360
LR	Efficient lamps (34-watt storage)	Lamp	562
HM	Efficient lamps (34-watt)	Lamp	1482
HO	Efficient lamps (34-watt)	Lamp	9630
LO	Efficient lamps (34-watt)	Lamp	17000
RE	Efficient lamps (34-watt)	Lamp	86
SC	Efficient lamps (34-watt)	Lamp	2756
SO	Efficient lamps (34-watt)	Lamp	172
WA	Efficient lamps (34-watt)	Lamp	96
GR	Efficient lamps (60-watt)	Lamp	460
WA	Eff. windows (double low-e office)	Square foot	164

TABLE C.1. (contd)

Building Type	ECM Description	Units	Units/ Building
WA	Eff. windows (double low-e warehouse)	Square foot	410
GR	Efficient windows (double low-e)	Square foot	1080
HO	Efficient windows (double low-e)	Square foot	13613
LR	Efficient windows (double low-e)	Square foot	1530
RE	Efficient windows (double low-e)	Square foot	461
SC	Efficient windows (double low-e)	Square foot	9194
SO	Efficient windows (double low-e)	Square foot	461
SR	Efficient windows (double low-e)	Square foot	490
SC	Efficient windows (double)	Square foot	9194
SO	Efficient windows (double)	Square foot	461
HM	Exhaust heat recovery (kitchen)	Unit	1
RE	Exhaust heat recovery (kitchen)	Unit	1
GR	Heat pump water heater	Unit	1
HM	Heat pump water heater	Unit	4
RE	Heat pump water heater	Unit	1
GR	Heat recovery from HVAC exhaust	Unit	5
HM	Heat recovery from HVAC exhaust	Unit	2
HO	Heat recovery from HVAC exhaust	Unit	4
RE	Heat recovery from HVAC exhaust	Unit	1
SO	Heat recovery from HVAC exhaust	Unit	2
SR	Heat recovery from HVAC exhaust	Unit	2
WA	Heat recovery from HVAC exhaust	Unit	1
GR	Heat recovery to water heater	Unit	2
RE	Heat recovery to water heater	Unit	1
GR	High efficiency heat pump	Ton	53
RE	High efficiency heat pump	Ton	10
SO	High efficiency heat pump	Ton	11
SR	High efficiency heat pump	Ton	27.5
WA	High efficiency heat pump	Ton	5
SO	Optimum start timer	Timer	2
WA	Parabolic reflectors	Fixture	24
GR	Parabolic reflectors (sales)	Fixture	230
GR	Parabolic reflectors (storage)	Fixture	18
GR	Radiant heater	kW	40
LR	Radiant heater	kW	29
WA	Radiant heater	kW	137
GR	Reduce minimum outside air	Labor unit	1
LR	Reduce minimum outside air	Labor unit	9
SC	Reduce minimum outside air	Labor unit	1
SO	Reduce minimum outside air	Labor unit	1
WA	Reduce minimum outside air	Labor unit	1
LO	Reflective solar film	Square foot	16167
RE	Reflective solar film	Square foot	461

TABLE C.1. (contd)

Building Type	ECM Description	Units	Units/ Building
SO	Reflective solar film	Square foot	461
GR	Refrigeration anti-sweat timer	Timer	2
GR	Refrigeration case covers	Linear foot	60
GR	Replace elec. resistance w/ heat pump	Ton	53
RE	Replace elec. resistance w/ heat pump	Ton	10
SO	Replace elec. resistance w/ heat pump	Ton	11
SR	Replace elec. resistance w/ heat pump	Ton	27.5
WA	Replace elec. resistance w/ heat pump	Ton	5
HM	Roof insulation	Square foot	24000
HO	Roof insulation	Square foot	54406
LO	Roof insulation	Square foot	17000
LR	Roof insulation	Square foot	60000
RE	Roof insulation	Square foot	2756
SC	Roof insulation	Square foot	67784
SO	Roof insulation	Square foot	2440
WA	Roof insulation	Square foot	16375
GR	Roof insulation (sales)	Square foot	19539
SR	Roof insulation (sales)	Square foot	11156
GR	Roof insulation (storage)	Square foot	6513
SR	Roof insulation (storage)	Square foot	1969
GR	Strip curtains for cold space	Linear foot	24
RE	Strip curtains for cold space	Linear foot	3
LR	T8 fluorescents (electronic sales)	Fixture	1248
SR	T8 fluorescents (electronic sales)	Fixture	90
LR	T8 fluorescents (electronic storage)	Fixture	281
HM	T8 fluorescents (electronic)	Fixture	988
HO	T8 fluorescents (electronic)	Fixture	1762
LO	T8 fluorescents (electronic)	Fixture	8500
RE	T8 fluorescents (electronic)	Fixture	43
SC	T8 fluorescents (electronic)	Fixture	689
SO	T8 fluorescents (electronic)	Fixture	3
WA	T8 fluorescents (electronic)	Fixture	24
HM	Temperature reset for multi-zone	Reset control	3
HO	Temperature reset for multi-zone	Reset control	6
LO	Temperature reset for multi-zone	Reset control	3
WA	Temperature setback control unit	Control unit	6
GR	Two-level switching	Fixture	230
HO	Two-level switching	Fixture	360
SC	Two-level switching	Fixture	689
SO	Two-level switching	Fixture	14
WA	Two-level switching	Fixture	12
HM	Variable air volume	Square foot	63800
LO	Variable air volume	Square foot	458266
GR	Wall insulation	Square foot	9931

TABLE C.1. (contd)

Building Type	ECM Description	Units	Units/ Building
LR	Wall insulation	Square foot	25039
RE	Wall insulation	Square foot	2191
SC	Wall insulation	Square foot	27124
SO	Wall insulation	Square foot	3825
SR	Wall insulation	Square foot	4218
WA	Wall insulation (office)	Square foot	1547
WA	Wall insulation (warehouse)	Square foot	8859
GR	Water heater tank insulation	Blanket	3
HM	Water heater tank insulation	Blanket	6
LR	Water heater tank insulation	Blanket	4
RE	Water heater tank insulation	Blanket	1
SC	Water heater tank insulation	Blanket	3
SO	Water heater tank insulation	Blanket	1
SR	Water heater tank insulation	Blanket	1
WA	Water heater tank insulation	Blanket	1
GR	Water heater time clock	Clock unit	1
LR	Water heater time clock	Clock unit	4
RE	Water heater time clock	Clock unit	1
SC	Water heater time clock	Clock unit	3
SO	Water heater time clock	Clock unit	1
SR	Water heater time clock	Clock unit	1
WA	Water heater time clock	Clock unit	1

LO = Large Office, SO = Small Office, LR = Large Retail,
 SR = Small Retail, RE = Restaurant, GR = Grocery, HM = Hotel/Motel,
 SC = School, WA = Warehouse, HO = Hospital.

TABLE C.2. ECMs per Prototypical Building: New Buildings.

Building Type	ECM Description	Units	Units/ Building
GR	Beverage case timer	Timer	2
GR	Contrast controls	Control switch	3
SC	Daylight dimming photocell ctrl. unit	Control unit	9
WA	Daylight dimming photocell ctrl. unit	Control unit	12
LO	Daylight dimming photocell ctrl. unit	Control unit	42
SO	Daylight dimming photocell ctrl. unit	Control unit	14
HO	Daylight dimming photocell ctrl. unit	Control unit	9
GR	Destratifiers	Fan	3
WA	Destratifiers	Fan	6
WA	Economizer	Unit	1
SO	Economizer	Unit	2
RE	Economizer	Unit	4
WA	Eff. ballasts (electronic office)	Ballast	48
LR	Eff. ballasts (electronic sales)	Ballast	2242
SR	Eff. ballasts (electronic sales)	Ballast	198
GR	Eff. ballasts (electronic sales)	Ballast	230
SR	Eff. ballasts (electronic storage)	Ballast	31
GR	Eff. ballasts (electronic storage)	Ballast	18
LR	Eff. ballasts (electronic storage)	Ballast	281
HO	Efficient ballasts (electronic)	Ballast	4815
HM	Efficient ballasts (electronic)	Ballast	988
RE	Efficient ballasts (electronic)	Ballast	45
LO	Efficient ballasts (electronic)	Ballast	7650
SO	Efficient ballasts (electronic)	Ballast	86
SC	Efficient ballasts (electronic)	Ballast	1378
WA	Efficient ballasts (magnetic office)	Ballast	48
GR	Efficient ballasts (magnetic sales)	Ballast	230
LR	Efficient ballasts (magnetic sales)	Ballast	2242
SR	Efficient ballasts (magnetic sales)	Ballast	198
SR	Efficient ballasts (magnetic storage)	Ballast	31
GR	Efficient ballasts (magnetic storage)	Ballast	18
LR	Efficient ballasts (magnetic storage)	Ballast	281
WA	Eff. ballasts (magnetic warehouse)	Ballast	22
RE	Efficient ballasts (magnetic)	Ballast	45
SO	Efficient ballasts (magnetic)	Ballast	86
SC	Efficient ballasts (magnetic)	Ballast	1378
HO	Efficient ballasts (magnetic)	Ballast	4815
HM	Efficient ballasts (magnetic)	Ballast	988
LO	Efficient ballasts (magnetic)	Ballast	7650
RE	Efficient exhaust hoods	Unit	2
LR	Efficient fan motors	HP	150
HO	Efficient gas heat	Control unit	2
WA	Efficient gas heat	Control unit	4
LO	Efficient gas heat	Control unit	2

TABLE C.2. (contd)

Building Type	ECM Description	Units	Units/ Building
HM	Efficient gas heat	Control unit	2
SC	Efficient gas heat	Control unit	2
SR	Efficient gas heat	Control unit	1
HO	Efficient incandescents	Fixture	306
SC	Efficient incandescents	Fixture	34
LO	Efficient incandescents	Fixture	816
SO	Efficient incandescents	Fixture	4
LR	Efficient incandescents	Fixture	401
WA	Efficient incandescents	Fixture	4
SR	Efficient incandescents	Fixture	36
RE	Efficient incandescents	Fixture	24
GR	Efficient incandescents	Fixture	52
HM	Efficient incandescents	Fixture	643
LR	Efficient lamps (32-watt sales)	Lamp	4484
SR	Efficient lamps (32-watt sales)	Lamp	396
LR	Efficient lamps (32-watt storage)	Lamp	562
LO	Efficient lamps (32-watt)	Lamp	15300
HM	Efficient lamps (32-watt)	Lamp	1482
SO	Efficient lamps (32-watt)	Lamp	172
RE	Efficient lamps (32-watt)	Lamp	90
SC	Efficient lamps (32-watt)	Lamp	2756
WA	Efficient lamps (32-watt)	Lamp	96
HO	Efficient lamps (32-watt)	Lamp	9630
SR	Efficient lamps (34-watt sales)	Lamp	396
LR	Efficient lamps (34-watt sales)	Lamp	4484
LR	Efficient lamps (34-watt storage)	Lamp	562
RE	Efficient lamps (34-watt)	Lamp	90
WA	Efficient lamps (34-watt)	Lamp	96
HM	Efficient lamps (34-watt)	Lamp	1482
SO	Efficient lamps (34-watt)	Lamp	172
SC	Efficient lamps (34-watt)	Lamp	2756
LO	Efficient lamps (34-watt)	Lamp	15300
HO	Efficient lamps (34-watt)	Lamp	9630
GR	Efficient lamps (60-watt)	Lamp	460
WA	Eff. windows (double low-e office)	Square foot	164
WA	Eff. windows (double low-e warehouse)	Square foot	410
GR	Efficient windows (double low-e)	Square foot	1080
SO	Efficient windows (double low-e)	Square foot	778
SC	Efficient windows (double low-e)	Square foot	9194
RE	Efficient windows (double low-e)	Square foot	461
HO	Efficient windows (double low-e)	Square foot	13613
HM	Efficient windows (double low-e)	Square foot	21176
LO	Efficient windows (low-e)	Square foot	59252
LR	Efficient windows (low-e)	Square foot	900

TABLE C.2. (contd)

Building Type	ECM Description	Units	Units/ Building
SR	Efficient windows (low-e)	Square foot	490
RE	Exhaust heat recovery (kitchen)	Unit	2
RE	Heat pump water heater	Unit	1
GR	Heat pump water heater	Unit	1
HM	Heat pump water heater	Unit	4
HM	Heat recovery from HVAC exhaust	Unit	2
RE	Heat recovery from HVAC exhaust	Unit	1
SO	Heat recovery from HVAC exhaust	Unit	2
WA	Heat recovery from HVAC exhaust	Unit	1
HO	Heat recovery from HVAC exhaust	Unit	4
GR	Heat recovery from HVAC exhaust	Unit	5
SR	Heat recovery from HVAC exhaust	Unit	2
GR	Heat recovery to water heater	Unit	2
RE	Heat recovery to water heater	Unit	1
HM	High efficiency chiller	Unit	2
LO	High efficiency chiller	Unit	2
HO	High efficiency chiller	Unit	2
GR	High efficiency heat pump	Ton	53
SR	High efficiency heat pump	Ton	27.5
WA	High efficiency heat pump	Ton	5
SO	High efficiency heat pump	Ton	2
RE	High efficiency heat pump	Ton	10
SO	Optimum start timer	Timer	2
HM	Parabolic reflectors	Fixture	272
SO	Parabolic reflectors	Fixture	35
HO	Parabolic reflectors	Fixture	2798
LO	Parabolic reflectors	Fixture	3098
LR	Parabolic reflectors	Fixture	908
SR	Parabolic reflectors	Fixture	80
SC	Parabolic reflectors	Fixture	558
RE	Parabolic reflectors	Fixture	37
WA	Parabolic reflectors (office)	Fixture	20
GR	Parabolic reflectors (sales)	Fixture	230
GR	Parabolic reflectors (storage)	Fixture	18
WA	Parabolic reflectors (warehouse)	Fixture	20
WA	Radiant heater	kW	86
GR	Radiant heater	kW	32
SR	Radiant heater	kW	11
WA	Reduce minimum outside air	Labor unit	1
GR	Reduce minimum outside air	Labor unit	1
SO	Reduce minimum outside air	Labor unit	1
RE	Reflective solar film	Square foot	461
GR	Refrigeration anti-sweat timer	Timer	2

TABLE C.2. (contd)

Building Type	ECM Description	Units	Units/ Building
GR	Refrigeration case covers	Linear foot	72
GR	Replace elec. resistance w/ heat pump	Ton	53
WA	Replace elec. resistance w/ heat pump	Ton	5
SR	Replace elec. resistance w/ heat pump	Ton	27.5
RE	Replace elec. resistance w/ heat pump	Ton	10
SO	Replace elec. resistance w/ heat pump	Ton	2
GR	Roof insulation	Square foot	26052
HM	Roof insulation	Square foot	24000
WA	Roof insulation	Square foot	16375
LR	Roof insulation	Square foot	60000
SC	Roof insulation	Square foot	67784
SO	Roof insulation	Square foot	2440
LO	Roof insulation	Square foot	17000
HO	Roof insulation	Square foot	54406
RE	Roof insulation	Square foot	2625
SR	Roof insulation (sales)	Square foot	11156
SR	Roof insulation (storage)	Square foot	1969
RE	Strip curtains for cold space	Linear foot	3
GR	Strip curtains for cold space	Linear foot	24
LR	T8 fluorescents (electronic sales)	Fixture	1121
SR	T8 fluorescents (electronic sales)	Fixture	99
LR	T8 fluorescents (electronic storage)	Fixture	281
HM	T8 fluorescents (electronic)	Fixture	988
SC	T8 fluorescents (electronic)	Fixture	689
LO	T8 fluorescents (electronic)	Fixture	3825
WA	T8 fluorescents (electronic)	Fixture	24
SO	T8 fluorescents (electronic)	Fixture	43
HO	T8 fluorescents (electronic)	Fixture	1762
RE	T8 fluorescents (electronic)	Fixture	45
SR	T8 fluorescents (magnetic sales)	Fixture	99
LR	T8 fluorescents (magnetic sales)	Fixture	1121
LR	T8 fluorescents (magnetic storage)	Fixture	281
HM	T8 fluorescents (magnetic)	Fixture	988
RE	T8 fluorescents (magnetic)	Fixture	45
HO	T8 fluorescents (magnetic)	Fixture	1291
LO	T8 fluorescents (magnetic)	Fixture	3825
SC	T8 fluorescents (magnetic)	Fixture	689
WA	T8 fluorescents (magnetic)	Fixture	24
SO	T8 fluorescents (magnetic)	Fixture	43
HO	Temperature reset for multi-zone	Reset control	6
HM	Temperature reset for multi-zone	Reset control	3
LO	Temperature reset for multi-zone	Reset control	24
WA	Temperature setback control unit	Control unit	4

TABLE C.2. (contd)

Building Type	ECM Description	Units	Units/ Building
HO	Two-level switching	Fixture	360
SC	Two-level switching	Fixture	689
GR	Two-level switching	Fixture	230
LO	Two-level switching	Fixture	1590
WA	Two-level switching	Fixture	12
SO	Two-level switching	Fixture	14
RE	Wall insulation	Square foot	2191
LO	Wall insulation	Square foot	119491
HO	Wall insulation	Square foot	43428
SO	Wall insulation	Square foot	3969
HM	Wall insulation	Square foot	84254
SC	Wall insulation	Square foot	27124
WA	Wall insulation (office)	Square foot	1547
SR	Wall insulation (sales)	Square foot	2618
LR	Wall insulation (sales)	Square foot	21564
GR	Wall insulation (sales)	Square foot	5741
SR	Wall insulation (storage)	Square foot	1600
GR	Wall insulation (storage)	Square foot	4190
LR	Wall insulation (storage)	Square foot	4105
WA	Wall insulation (warehouse)	Square foot	8859
GR	Water heater tank insulation	Blanket	3
LR	Water heater tank insulation	Blanket	4
WA	Water heater tank insulation	Blanket	1
SO	Water heater tank insulation	Blanket	1
SR	Water heater tank insulation	Blanket	1
HM	Water heater tank insulation	Blanket	6
SC	Water heater tank insulation	Blanket	3
RE	Water heater tank insulation	Blanket	1
LR	Water heater time clock	Clock unit	4
SR	Water heater time clock	Clock unit	1
SC	Water heater time clock	Clock unit	3
RE	Water heater time clock	Clock unit	1
SO	Water heater time clock	Clock unit	1
GR	Water heater time clock	Clock unit	1
WA	Water heater time clock	Clock unit	1

LO = Large Office, SO = Small Office, LR = Large Retail,
 SR = Small Retail, RE = Restaurant, GR = Grocery, HM = Hotel/Motel,
 SC = School, WA = Warehouse, HO = Hospital.

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