SCE Comprehensive Mobile Home Program
HVAC QM: Data Analysis - Phase II
Volume 3: Energy Impacts for the QM and Brushless Fan Motor Measures

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1. Introduction and Executive Summary

In Volumes I and II of this report ADM discusses our findings and recommendations regarding data collection techniques and implementation processes employed by the CMHP HVAC Quality Maintenance Program. In addition to our recommendations on the data collection equipment and methods, the first volume also present our findings regarding the QM measure impacts. In summary, we found that both the refrigerant-side and air-side measurements provided similar estimates for the improvement in system efficiency between "Test-In" and "Test-Out.' Given uncertainties in the air-side data (on-site measurements of air conditioning performance found in the program traking database and described in detail in Volume I) we found the refrigerant-side estimate for the QM measure effectiveness to be the most reliable of the two. In this, the final volume, we provide energy impact estimates for two of the measures offered by the program:

1. Quality Maintenance (QM); and
2. Brushless fan motors

The magnitude of the impacts for these measures are quite small relative to the total energy used by a residence and a "top-down" pre/post billing analysis approach can not be expected to produce significant results. Thus, ADM elected to derive the savings estimates using a "ground-up" engineering approach which leveraged on-site data collected from program participants. The impact estimates presented in this volume are predicated on the CMHP program tracking data, exported from EM-HVAC and analyzed in Volume I, as well as customer billing histories from program participants. Billing analysis was used to develop weather normalized estimates for equipment (air-handler fans) run-time and cooling loads. The results of our analysis are summarized by weather zone for each measure in Table 1.1. A more throughout explanation of our methodology can be found in sections 2 and 2.2 for the QM and Brushless fan motor measures respectively. Note that Cooling Degree Days (CDD) and Heating Degree Days (HDD) are provided in Table 1.1 (and in other tables in this report) to aid in comparisons of the reported impacts across weather zones.

Table 1.1: Summary of Billing Regression Results

Weather Zone	Annual Run-Time Hours [Hrs]	QM Energy Savings kWh/Ton	QM Demand Red. kW/Ton	Fan Motor Savings kWh/Ton	Fan Motor Demand Red. kW/Ton	CDD_{80}	HDD_{65}
6	1,736	3	0.002	43	0.040	0	1,671
8	2,602	8	0.005	64	0.040	0	1,550
9	2,890	12	0.007	72	0.042	4	1,489
10	3,625	16	0.012	90	0.040	42	1,797
13	4,341	21	0.018	108	0.062	211	2,356
14	4,749	20	0.011	118	0.040	214	3,108
15	5,285	45	0.022	131	0.037	1,270	952
16	4,967	6	0.003	123	0.042	0	5,595

2. Analysis of Energy Impacts for the QM and Brushless Fan Motor Measures

Energy impacts for the QM and brushless fan motor measures were derived by leveraging the CMHP program tracking data, exported from EM-HVAC and analyzed in Volume I, with customer billing histories. The program tracking data was used to empirically develop the measures' impacts on equipment efficiency (e.g. System EER for the QM measure and electric demand reduction for the brushless fan motors). Customer billing histories were then used to estimate weather normalized equipment run-times and mobile home cooling loads. This Section describes our analysis and results as follows:

1. We discuss our analysis of customer billing history and present the results for annual HVAC loads and fan run time hours;
2. We summarize the results presented in Volume I for the measured QM measure impacts and integrate them with the weather normalized cooling loads deduced from the billing histories - providing typical annual energy impacts for the QM measure; and
3. We present our analysis of electric demand reduction for brushless fan motors and integrate the weather normalized fan run-times developed from the billing history analysis - providing typical annual energy impacts for the Brushless Fan Motor Measure.

Demand reductions were determined using the peak demand window definitions presented in the DEER 2014 literature. Separate demand windows were applied for each of the California Weather Zones. Peak demand reductions were assessed using the regressed hourly billing history data - reviewing the average system demand (and subsequent coincidence factor) within the appropriate demand window. The resultant coincident factors are presented in Tables 2.1 and 2.5

2.1. Analysis of Mobile Home HVAC Usage and Run-time

In order to develop "ground-up" energy savings estimates for the QM and brushless fan motor measures we first need to derive estimates for 'typical' HVAC cooling loads and fan run time hours in mobile homes. Furthermore, these estimates needed to be weather normalized and extrapolated to each of the eight California Weather Zones encompassed by SCE's service territory. This was done by applying the variable base degree day method to customer billing histories for the sub-set of program participants not on master meters. The billing histories, and subsequent regressions, were hourly interval data for 297 customers. Note that the customer billing data reviewed in this analysis is limited to customers with individual meters. A subset of customers were found to be on master meter accounts and as such were precluded from this analysis (as it was impossible to tease out individual usagages of residences touched by the program).

As mentioned above, the hourly utility billing histories were regressed in an application of the variable base degree day method. The zip codes for each residence were mapped together with NOAA weather station locations. ADM identified (5) weather stations corresponding the geographical locations of each residence:

1. KRIV
2. KSNA
3. KPSP
4. KDAG
5. KWJF

Hourly weather data was downloaded from these NOAA weather stations for use in the regression models. Care was taken to ensure that the date/time stamps in the hourly weather data from NOAA were aligned with the corresponding date/time stamp(s) in the utility billing histories. While developing a regression equation is often a somewhat iterative process in which various explanatory variables are explored for significance, they also must be grounded in physical first principles. In our regression equation we use cooling and heating *Degree Hours* to estimate the portion of hourly demand associated with the HVAC system (includes fans and compressors). The remaining variables account for the remaining *base loads* in the home (e.g. lighting and appliances). The final regression took the following form:

$$kW_i = \beta_1 * Sin(\Theta + \alpha) + \beta_2 * CDH + \beta_3 * CDH_{n-1} + \beta 4 * HDH + \beta_5 * SUM + \beta_6 * WE + \beta_7 * NT + \beta_{Int} \quad (2.1)$$

Where:

kW_i	is the estimated total electrical demand for hour *i* [kW]
β_n	are the regression coefficients for each regressed variable (described below).
Θ	is the hour of the day represented in radians (Hour $1 = \frac{2\pi*1}{24}$ and Hour $24 = \frac{2\pi*24}{24}$).
α	adjusts the phase angle of the hourly Θ variable.
CDH	are the cooling degree hours for the current hour (hour *i*).
CDH_{n-1}	are the cooling degree hours for the previous hour (hour *i-1*).
HDH	are the heating degree hours for the current hour (hour *i*).
SUM	is a binary flag to indicate whether hour *i* falls in the "cooling" (1) or "heating" (0) season.
WE	is a binary flag indicating whether hour *i* falls on a "weekday" (1) or "weekend" (0).
NT	is a binary flag indicating whether hour *i* falls during the "night" (1) or "day" (0).

Individual regressions were run for each of the 297 customers for which billing histories were available. The adjusted R^2 was optimized for each regression by varying the base temperature used to calculate cooling and heating degree hours. Additional optimization was performed by varying the phase angle α such that the cyclical base loads were modeled to represent occupant usage habits unique to each residence. The regressed billing histories were used to estimate the following:

1. Annual HVAC fan run-time hours; and
2. Annual cooling energy usage per ton of installed capacity [kWh/Ton] (this includes fan energy).

Regressed hourly electric demand is plotted over billed electric demand data for one of the residences in Figure 2.1. Figure 2.1 provides a visual representation of the "goodness" of fit for these models. Note that the values plotted in Figure 2.1 represent the total electric demand for the residence. Detailed results of the regressions (including the coefficients, t values, standard errors, etc.) are provided in Appendix A. In Equation 2.1, regression coefficients β_2 through β_4 were used to estimate the hourly demand attributable to the HVAC systems (indoor + outdoor unit) inclusive of fan energy. The annual cooling energy was estimated by summing the hourly demand predicted by coefficients β_2 and β_3 which represent the hourly power consumption attributable to variances in the cooling degree hour variables. Annual fan run-time was estimated by counting the number of hours for which a positive power demand was predicted by coefficients β_2 through β_4. Equations 2.2 and 2.3 are provided to demonstrate these calculations.

<u>For the Annual Cooling Energy:</u>

$$kWh_{Cooling} = \sum_{i=1}^{8760} (\beta_2 * CDH_i + \beta_3 * CDH_{n-1,i}) \quad (2.2)$$

<u>For the Annual Fan Hours:</u>

$$n_{observations} \text{ where } \beta_2 * CDH_i + \beta_3 * CDH_{n-1,i} + \beta 4 * HDH_i > 0 \quad (2.3)$$

ADM applied Hourly California Weather Zone temperature data (provided by the California Energy Commission)to the regressed billing histories in order to derive weather normalized estimates of fan run-time and cooling energy use for each of the eight weather zones encompassed by SCE service territory. The results of this modeling are demonstrated for each service territory in Table 2.1. Later in this report the data in Table 2.1 will be applied to the on-site measurements of system performance and fan power to generate energy savings estimates for the QM and brushless fan motor measures.

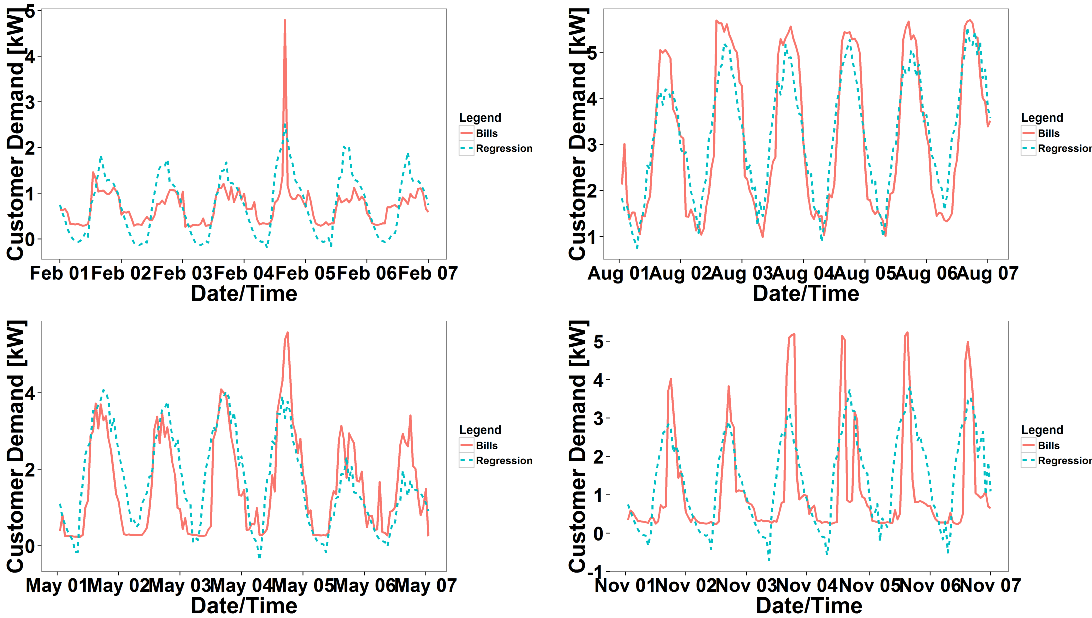

Figure 2.1: Illustration of Regression Fit for One Residence

Table 2.1: Summary of Billing Regression Results

Weather Zone	Annual Run-Time Hours [Hrs]	Coincidence Factor	Base Annual kWh/Ton	CDD_{80}	HDD_{65}
6	1,736	0.4	83	0	1,671
8	2,602	0.4	217	0	1,550
9	2,890	0.5	315	4	1,489
10	3,625	0.4	420	42	1,797
13	4,341	0.7	548	211	2,356
14	4,749	0.4	526	214	3,108
15	5,285	0.4	1,167	1,270	952
16	4,967	0.5	152	0	5,595

2.2. Analysis of QM Measure Impacts

ADM explored the QM measure's impact on air-conditioner performance in Volume I of this report. EM-HVAC tracks both air-side and refrigerant-side field measurements made at each residence. Two sets of measurements are performed on all systems upon which the Quality Maintenance procedure was performed. The first set, "Test-In", represent a baseline system performance measurement. The second set, "Test-Out" represent the "improved" system performance. The differences between the "Test-In" and "Test-Out" measurements are the impacts of the QM activities. An empirical estimate of system performance impacts was derived by leveraging the program tracking measurement data to quantify in-situ system efficiencies (reported in units of EER) for both the test-in and test-out conditions. As described above, measurement data exist for both air-side and refrigerant-side system performance. However; this analysis applies the results only from the refrigerant-side measurements as they represent a more reliable estimate of system performance (and subsequently performance improvements) than do the air-side data. Our discussion regarding data reliability and a comparison between the refrigerant side and air-side measurements can be found in Volume I. Figure 2.2 illustrates the distribution of system capacities observed in the program tracking data. The average system size was observed to be 3.74 tons.

While there is significant overlap between the system efficiencies for both Test-In and Test-Out measurements,

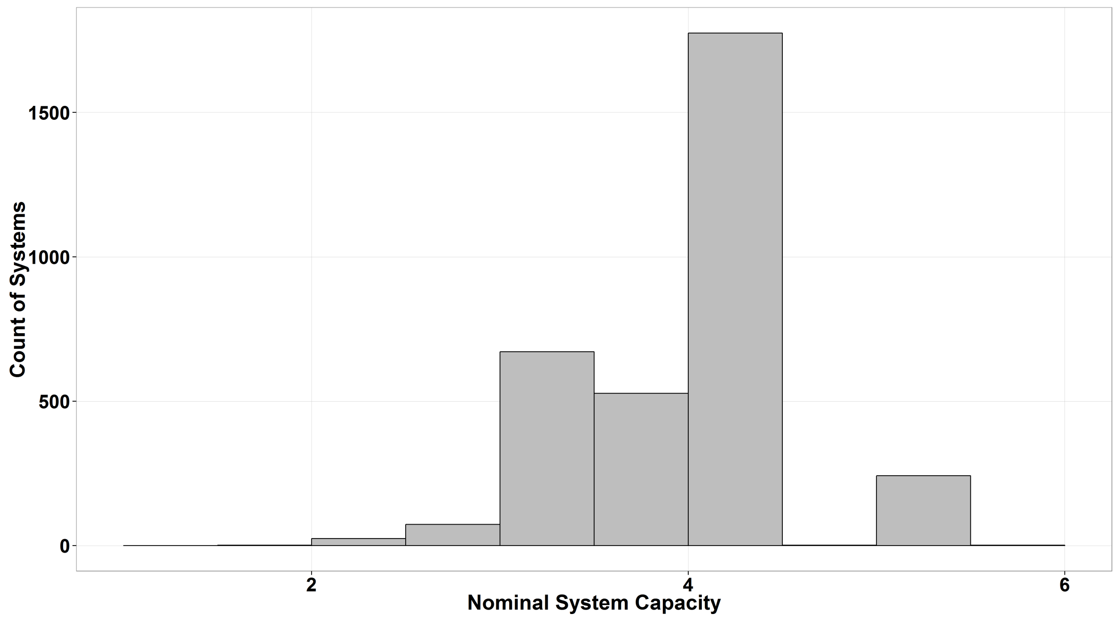

Figure 2.2: Distribution of System Sizes Seen in Population (Nominal Capacity)

there is also a difference in the mean in-situ EER between the two conditions. The program tracking data indicate that in the population there was an average increase in the EER by approximately 0.38 (or 4%). Table 2.2 provides some additional detail regarding the in-situ EERs tracked by the program while the plots in Figure 2.3 illustrate the distribution of in-situ EER measurements for both test-in and test-out conditions.

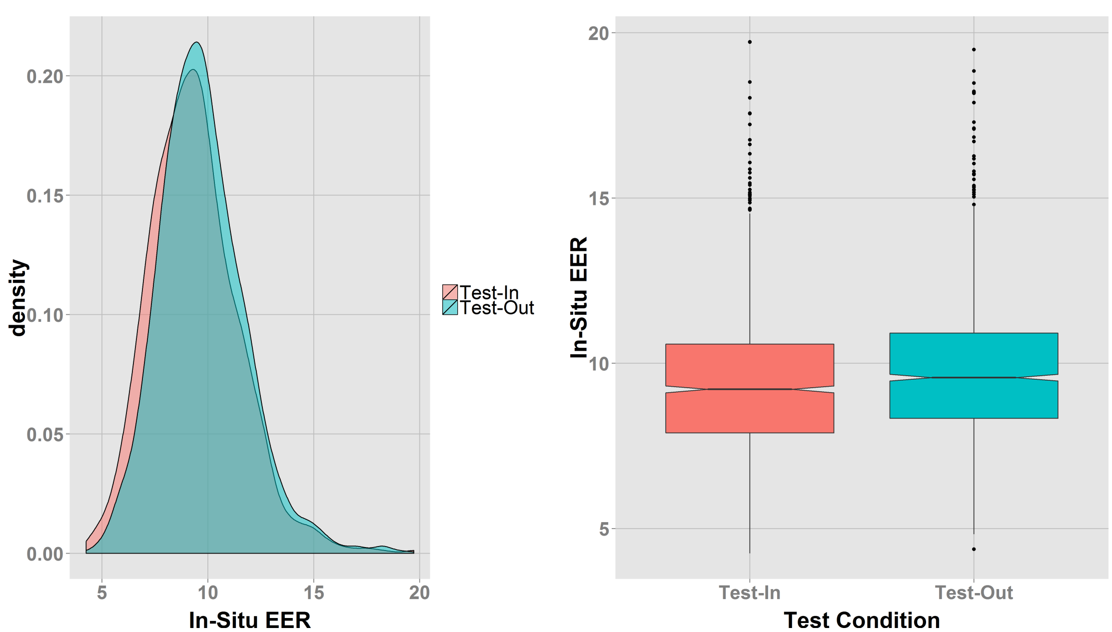

Figure 2.3: Comparison of In-Situ EER Measurements Between Test-In and Test-Out (Refrigerant Side)

Annual energy impacts for the QM measure were estimated by applying the system efficiency impacts listed in

Table 2.2: Summary of Refrigerant Side EER Measurements

X	Activity	n	Mean	Std..Dev.	Median	Min	Max	Range	Skew	Kurtosis
1	Test-In	1,627	9.4	2	9.2	4	20	15	0.7	1
2	Test-Out	1,627	9.7	2	9.6	4	19	15	0.7	1
3	Change	1,627	0.4	1	0.3	-7	8	15	1.0	12

Table 2.2 to the annual per ton estimates for system usage in each of the eight California Weather Zones (listed in Table 2.1). The typical annual savings were calculated by applying these values in formula 2.4. The resultant annual energy savings estimates for the QM measure are presented in Table 2.3 by weather zone.

$$kWh/Ton_{Saved} = kWh_{Base} * (1 - \frac{EER_{Test-In}}{EER_{Test-Out}}) \qquad (2.4)$$

Where:

kWh/Ton_{Saved}	is the weather and capacity normalized annual energy savings estimate [kWh/Ton]
kWh_{Base}	is the baseline (per ton) annual energy use estimate for cooling equipment [kWh/Ton]
$EER_{Test-In}$	is the baseline system efficiency in units of EER (e.g. the efficiency the unit tested in at) [9.4 EER]
$EER_{Test-Out}$	is the system efficiency, in units of EER, after the QM treatment (e.g. the efficiency the unit tested out at) [9.7 EER]

Table 2.3: Summary of QM Savings Analysis

Weather Zone	Base Annual kWh/Ton	Post Annual kWh/Ton	Annual Savings kWh/Ton	Annual Demand Red. kW/Ton	CDD_{80}	HDD_{65}
6	83	80	3	0.002	0	1,671
8	217	209	8	0.005	0	1,550
9	315	303	12	0.007	4	1,489
10	420	404	16	0.012	42	1,797
13	548	527	21	0.018	211	2,356
14	526	506	20	0.011	214	3,108
15	1,167	1,121	45	0.022	1,270	952
16	152	146	6	0.003	0	5,595

2.3. Analysis of Brushless Fan Motor Measure Impacts

The energy impacts for the Brushless fan motors were assessed in a similar fashion to the QM measure. While the specific size of each fan motor (e.g. HP) was not tracked in EM-HVAC, the programs implementer indicated that the majority of fan motors installed were rated at 1/2 HP. The majority of brushless fan motors installed by the program are RESCUE EcoTech (5532ET) motors. The specifications for these motors are provided as an appendix at the end of this report. During the QM treatment, technicians also take one-time power measurements of the fan motor. This data is recorded in EM-HVAC, along with the type of fan motor, for each site and testing condition (e.g. test-in vs. test-out). Reviewing the EM-HVAC data, ADM found three fan motor classifications:

1. Permanent Split Capacitor; (PSC)
2. Electronically commutated; and
3. Brushless Fan Motor (BFM).

Table 2.4 summarizes the in-situ power measurements made for each. It should be noted that ADM found no instance in the EM-HVAC data where the motor was changed (e.g. the fan motor type was different between the test-in and test-out). However; one aspect of the QM treatment is an assessment and adjustment of the indoor unit airflow. Therefore, in order to prevent the impacts of the QM measure from influencing the results for the brushless fan motor, the EM-HVAC data shown in Table 2.4 only represent the Test-Out conditions.

Table 2.4: Summary of Fan Motor Power Measurements

	n	Mean	Std. Dev.	Median	Min	Max	Range	Skew	Kurtosis
ECM	962	602	157	619	124	1,477	1,354	-0.2	0.6
PSC	2,313	694	186	697	97	1,897	1,800	0.9	3.8
BFM	13	649	130	638	487	962	475	0.8	0.1

From Table 2.4 it can be seen that the ECM motors are draw 93 Watts less than PSC motors. While the vast majority of motors in the data-set are PSC, 29.3 % of the motors reviewed in this study are ECM. Several observations are classified as BFM motors, and it is unclear whether or not these motors are truly Brushless Fan Motors. The field data collection forms do not indicate BFM as a category (they only list options for ECM and PSC), and the recorded wattage does falls between those for the ECM and PSC motors. Given this uncertainty, and the comparatively few observations of this motor type (13 out of 3,288) ADM elected to remove these observations from this analysis. Figure 2.4 illustrates the distribution of power measurements for the ECM and PSC motors.

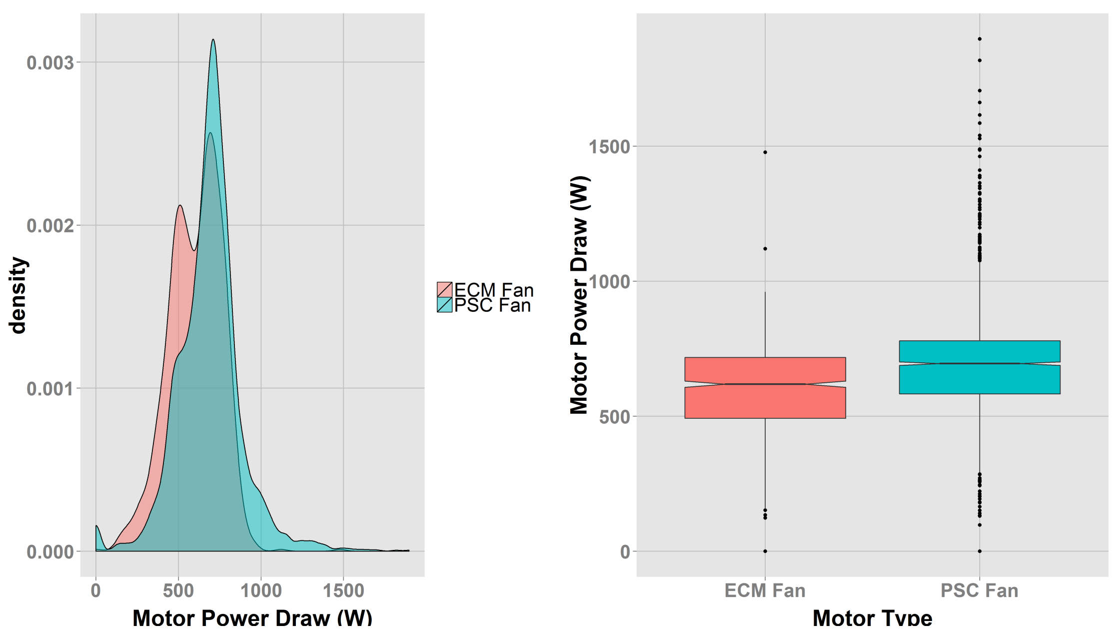

Figure 2.4: Comparing Brushless ECM motor and PSC motor Power Measurements

Annual energy impacts for the brushless fan motor measure were estimated by applying the fan power measurements listed in Table 2.4 to the annual fan run-time estimates for each of the eight California Weather Zones (listed in Table 2.1). The typical annual savings were calculated using formula 2.5. Annual energy savings estimates for the brushless fan motor measure are presented in Table 2.5.

$$kWh_{Saved} = \frac{(W_{PSC} - W_{ECM})}{1000} * HRS_{Annual} \tag{2.5}$$

Where:

kWh_{Saved}	is the weather normalized annual energy savings estimate [kWh]
W_{PSC}	is the measured power draw of a permanent split capacitor fan motor [Watts]
W_{ECM}	is the measured power draw of an electrically commutated fan motor [Watts]
HRS_{Annual}	are the annual fan run-time hours [Hrs]

Table 2.5: Annual Energy Savings Estimates for Brushless Fan Motors

Weather Zone	Annual Run-Time Hours [Hrs]	Coincidence Factor	Annual Savings [kWh/Motor]	Annual Savings [kWh/Ton$_{cooling}$]	Peak Demand Red. [kW/Ton$_{cooling}$]	CDD$_{80}$	HDD$_{65}$
6	1,736	0.4	161	43	0.040	0	1,671
8	2,602	0.4	241	64	0.040	0	1,550
9	2,890	0.5	268	72	0.042	4	1,489
10	3,625	0.4	336	90	0.040	42	1,797
13	4,341	0.7	403	108	0.062	211	2,356
14	4,749	0.4	441	118	0.040	214	3,108
15	5,285	0.4	490	131	0.037	1,270	952
16	4,967	0.5	461	123	0.042	0	5,595

3. Appendix A

We provide in this appendix more detailed information regarding the results of the regression modeling. Table 3.1 lists the regression coefficients, base temperatures, hour offset variable α, and adjusted R^2 for a sub-set of the residences. We also provide as an example Table 3.2 which provides statistical metrics for a select site. Note that these data can be made available for any site upon request. It was determined that their inclusion in this report would add significant length without contributing commensurate value.

Table 3.1: Billing Regression Coefficients, Hour Offsets, and Base Temperatures for a Sample of Residences

Site	β_{Int}	β_1	β_2	β_3	β_4	β_5	β_6	β_7	$Adj.R^2$	CDH_{Base}	α
17	0.47	0.207	-0.0435	0.0704	0.00428	0.1072	0.0072	-0.202	0.180	70	8
32	0.76	0.327	-0.1026	0.1651	0.00546	0.1101	0.0566	-0.227	0.398	70	10
34	0.80	0.196	-0.1379	0.1908	0.01355	0.3551	0.0241	-0.475	0.330	70	8
35	0.44	0.211	-0.0639	0.1007	0.00919	0.0447	0.0180	-0.271	0.320	70	7
40	0.38	0.067	-0.0394	0.0761	0.00202	0.0060	-0.0636	-0.096	0.232	70	10
43	0.86	0.249	-0.0826	0.1370	-0.00742	0.2960	0.0061	-0.381	0.439	70	9
51	0.61	0.081	-0.0824	0.1416	0.00179	0.1660	0.0365	-0.483	0.451	70	5
52	0.82	0.455	-0.1164	0.1799	-0.00296	0.2412	0.0423	-0.708	0.462	70	5
54	1.47	0.507	-0.0846	0.1536	0.01835	0.0538	0.0161	-0.406	0.460	70	11
58	0.60	-0.200	-0.0069	0.0250	-0.00408	-0.0139	0.0196	-0.135	0.204	70	3
70	0.21	0.329	-0.0069	0.0761	0.03570	-0.0068	0.0854	-0.067	0.519	70	10
76	0.30	0.108	-0.0094	0.0175	-0.00151	0.0389	0.0374	-0.096	0.103	70	6
83	0.58	0.071	-0.0524	0.0720	0.00532	0.0242	-0.0220	-0.297	0.224	70	9
87	0.83	0.633	-0.1451	0.2997	0.02996	0.0549	0.0307	-0.729	0.503	68	5
117	0.49	0.124	-0.0541	0.1020	0.00686	0.0350	0.0103	-0.066	0.569	70	7
128	0.46	0.129	-0.0495	0.1144	0.01628	0.1118	0.0343	-0.309	0.621	70	9
129	0.52	0.184	-0.0349	0.0750	-0.00064	0.0943	-0.0215	-0.328	0.305	70	7
149	0.57	0.231	-0.0327	0.0856	0.00250	0.0454	0.0538	-0.260	0.382	70	8
156	0.47	0.085	-0.0916	0.1398	0.00347	0.0846	-0.0355	-0.318	0.229	70	7
159	0.87	0.454	-0.0798	0.1799	0.00326	-0.0951	-0.0240	-0.355	0.480	70	8
166	0.22	0.263	-0.1004	0.1591	0.00334	0.1174	0.0023	-0.138	0.348	70	7
184	0.53	0.419	-0.1256	0.2121	0.01151	0.1080	-0.0438	-0.426	0.446	70	8
212	0.53	0.266	-0.0853	0.1501	0.00271	0.2165	0.0705	-0.235	0.633	70	9
214	0.57	0.246	0.0101	-0.0032	-0.00438	-0.0467	-0.0089	-0.107	0.311	70	8
227	0.66	0.368	-0.0399	0.1093	0.01181	0.0344	0.0990	-0.284	0.418	70	7
233	0.85	0.570	-0.0457	0.0911	-0.01149	0.1270	0.1858	-0.438	0.514	65	8
235	39.23	50.377	0.1691	0.2638	0.11484	4.2626	0.6535	-29.665	0.696	60	6
253	0.60	0.462	-0.1643	0.2845	0.02009	0.4732	0.0178	-0.275	0.609	70	10
256	0.36	0.283	-0.0615	0.1265	0.00700	0.1113	0.0069	-0.174	0.520	70	10
260	0.31	0.151	-0.0368	0.0702	0.00459	-0.0397	-0.0026	-0.059	0.285	70	7
262	0.45	0.037	-0.0124	0.0284	0.00959	-0.1757	0.0063	-0.099	0.086	70	4
263	1.55	-1.235	-0.1539	0.1481	0.10044	-0.0933	0.1307	-1.989	0.396	63	11
278	0.47	0.167	-0.0968	0.1888	0.01059	-0.0492	0.0370	-0.274	0.478	70	7
293	0.63	0.253	-0.0436	0.0909	-0.00701	0.0506	-0.0869	-0.355	0.221	70	8
295	0.95	0.677	-0.1645	0.2574	0.03809	0.9497	-0.0873	-0.804	0.724	70	9

Table 3.2: Regression Statistics for a Select Residence

Coefficient	Variable Name	Value	Standard Error	T Value	Pr(>|t|)
β_{Int}	(Intercept)	0.616	0.0148	41.5	0.0e+00
β_1	Θ	0.680	0.0159	42.9	0.0e+00
β_2	CDH	-0.074	0.0050	-14.8	9.7e-49
β_3	CDH_{n-1}	0.176	0.0050	35.0	1.2e-250
β_4	HDH	0.026	0.0059	4.4	1.2e-05
β_5	SUM	0.168	0.0223	7.5	5.4e-14
β_6	WE	-0.067	0.0183	-3.6	2.7e-04
β_7	NT	-0.045	0.0225	-2.0	4.5e-02
R^2	Adj R-Squared	0.788	NA	NA	NA

Table 3.3: Regression Statistics for a Select Residence

Coefficient	Variable Name	Value	Standard Error	T Value	Pr(>|t|)
β_{Int}	(Intercept)	0.8788	0.00897	98.0	0.0e+00
β_1	Θ	0.4604	0.00772	59.6	0.0e+00
β_2	CDH	-0.0436	0.00263	-16.6	2.7e-61
β_3	CDH_{n-1}	0.0927	0.00256	36.2	3.0e-277
β_4	HDH	0.0081	0.00088	9.1	9.8e-20
β_5	SUM	0.0087	0.01250	0.7	4.9e-01
β_6	WE	0.0418	0.01069	3.9	9.2e-05
β_7	NT	-0.1959	0.01227	-16.0	5.9e-57
R^2	Adj R-Squared	0.7877	NA	NA	NA

4. Appendix B

The following table lists each of the cities for which billing history data was analyzed along with the NOAA weather station associated with the city.

Table 4.1: List of Cities and Weather Stations used in Study

City	Customer Count	Weather Sation	California Weather Zone
Apple Valley	572	KDAG	CZ 14
Calimesa	164	KRIV	CZ 10
Cathedral City	624	KPSP	CZ 15
Corona	226	KRIV	CZ 10
Fontana	34	KRIV	CZ 10
Hemet	1318	KRIV	CZ 10
Hesperia	72	KDAG	CZ 14
Homeland	166	KRIV	CZ 10
Irvine	10	KSNA	CZ 08
Lake Elsinore	14	KRIV	CZ 10
Lancaster	114	KWJF	CZ 14
Loma Linda	18	KRIV	CZ 10
Murrieta	164	KRIV	CZ 10
Nuevo	6	KRIV	CZ 10
Ontario	108	KRIV	CZ 10
Palm Desert	476	KPSP	CZ 15
Palm Springs	226	KPSP	CZ 15
Palmdale	90	KWJF	CZ 14
Perris	62	KRIV	CZ 10
Rancho Cucamonga	90	KRIV	CZ 10
Rancho Mirage	314	KPSP	CZ 15
Redlands	78	KRIV	CZ 10
Riverside	136	KRIV	CZ 10
Rosamond	24	KWJF	CZ 14
San Bernardino	58	KRIV	CZ 10
San Jacinto	98	KRIV	CZ 10
Santa Ana	2	KSNA	CZ 08
Sun City	112	KRIV	CZ 10
Temecula	22	KRIV	CZ 10
Victorville	6	KDAG	CZ 14
Wildomar	72	KRIV	CZ 10
Yucaipa	80	KRIV	CZ 10

5. Appendix C

The following are equipment cut-sheets for the brushless fan motors installed by the program.

Top 5 Reasons to Purchase a RESCUE EcoTech® Motor

☑ Savings
☑ Health
☑ Comfort

1 Save energy! The RESCUE EcoTech Motor can be 25% more efficient in heating and cooling modes and up to 75% more efficient in continuous fan!

Average Savings – For Continuous Fan Operation**

	1/3 HP	1/2 HP	3/4 HP	1 HP
5 Year Savings	$869	$1,148	$1,698	$2,637
10 Year Savings	$1,738	$2,297	$3,396	$5,275

*** Savings estimated when compared to PSC motor operated continuously, electricity cost of $0.12/kWh*

2 Quiet, efficient air filtration. The low continuous fan speed on the RESCUE EcoTech motor provides continuous filtration without the draft or noise of a standard blower motor, all while using less energy than a 100W light bulb.

3 Active airflow management. The RESCUE EcoTech motor's advanced design helps maintain airflow even as your filter becomes full, in turn improving comfort and reducing air stratification.

4 Quiet operation. The soft start feature of the RESCUE EcoTech motor means no more harsh fan noises when your systems starts. In addition, the low air circulation speed produces very little noise in constant fan mode.

5 Reliability. Installation of the RESCUE EcoTech motor eliminates a common failure point, the motor capacitor. In addition, your new motor is backed by 2 year warranty.

WIRING CHART
Suggested lead color at horsepower shown

HP Rating	Speed	Catalog No. 5552ET	Catalog No. 5542ET	Catalog No. 5532ET	Catalog No. 5522ET
1 HP	COOL	BLACK			
	HEAT	YELLOW			
3/4 HP	COOL	YELLOW	BLACK		
	HEAT	BLUE	YELLOW		
1/2 HP	COOL	BLUE	YELLOW	BLACK	
	HEAT	ORANGE	BLUE	YELLOW	
1/3 HP	COOL		BLUE	YELLOW	BLACK
	HEAT		ORANGE	BLUE	YELLOW
1/4 HP	COOL			BLUE	YELLOW
	HEAT			ORANGE	BLUE
1/5 HP	COOL				BLUE
	HEAT				ORANGE

The red lead is for the constant fan/circulation speed

How is the RESCUE EcoTech motor to be connected?

- The RESCUE EcoTech motor is set up as a constant torque motor. Each speed tap has been adjusted to have the torque to match the typical strength needed for the cooling and heating mode for different HP applications.
- By adjusting the strength of each tap, we get a motor that can cover a range of HP and the flexibility to adjust to various home conditions.
- RESCUE EcoTech motor keeps it simple. Using the same connections on the furnace board as the PSC motor, making the attachment for cooling and heating leads. The red lead is for the continuous fan/circulation speed, if desired.
- **Have questions?** Call us at 888-540-5540 for technical support.

RESCUE EcoTech.

† All marks shown within this document are properties of their respective owners.

POS RESCUE EcoTech Rev. 03/13

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www.usmotors.com

RESCUE EcoTech® Motors

The Easy to Install ECM Upgrade for PSC Blowers

SAVE ENERGY
QUIET, EFFICIENT AIR FILTRATION
ACTIVE AIRFLOW MANAGEMENT
QUIET OPERATION
RELIABILITY

US MOTORS

RESCUE EcoTech® ECM Direct Drive Blower Motors
High Efficiency, Multi-Horsepower and Dual Voltage

Horsepower: All ratings now multi-horsepower
1–1/2, 3/4–1/3, 1/2–1/4 or 1/3–1/5 HP

Speed: 1075 RPM applications

Rated Voltage: 115/208-230V (now dual voltage)

Enclosure: Open Air Over (OAO)

Motor Type: ECM for PSC replacement (5.6" dia.)

Warranty: 2 year limited warranty

Catalog Number	HP	RPM	Voltage	Amps	Bearing	Total Length
5522ET	1/3–1/5	1075	115/208-230	4.2 / 2.7	Ball	12.9
5532ET	1/2–1/4	1075	115/208-230	6.2 / 3.9	Ball	14.4
5542ET	3/4–1/3	1075	115/208-230	8.5 / 5.2	Ball	14.4
5552ET	1–1/2	1075	115/208-230	11.5 / 6.9	Ball	14.4


RESCUE EcoTech® Motor

Product Overview and Features

RESCUE EcoTech® motor has the technology to easily improve system performance and make you a successful HVAC problem solver!

The key to offering homeowners improved performance for comfort and energy savings The ECM motor for replacing a PSC blower and taking the system "to the next level".

Features and Benefits:

- Highest Efficiency Available: Up to 82%
  - Saves 25% of the watts in A/C or heating
  - 75% watt reduction in circulation mode
- Now Multi-HP rated for flexibility
- Easy voltage change from 230V to 115V
- Quick installation like the OEM motor
- Works with flex or rigid belly band mountings
- Reversible rotation
- 4.5" shaft with set screw flat
- 6000V surge protection
- 2 year limited warranty

The RESCUE EcoTech® Motor – A Smart Way to Grow Your Business!

Homeowners are looking for ways to improve their comfort:

- Making IAQ equipment work better and more economically
- Reducing hot and cold spots in the home
- Reducing noise from the blower motor
- Improving reliability and reducing operating costs

Easily Installed – The RESCUE EcoTech motor is installed just like a PSC, except no capacitor! It is the "Easy ECM Upgrade" for you to offer your customers.

Very Energy Efficient – The RESCUE EcoTech motor is up to 25% more electrically efficient at high speed compared to a standard blower motor.

Quiet, Efficient Circulation Speed – With a low 600 RPM circulation speed, your customers can cycle air continuously without the noise, draft or electricity cost of a PSC motor. Often using less energy than a 100 watt bulb. Up to 75% watts savings are typical.

Active Airflow Management – The advanced motor control reacts to change in static pressure, helping to maintain airflow as vents are closed or the filter becomes dirty.

Fits a Wide Variety of Applications – The fully reversible motor comes in a range of horsepower sizes to fit your market and is dual voltage so you can provide an indoor blower solution to all your customers.

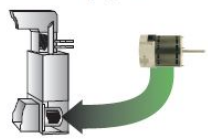
Two Year Warranty – The RESCUE EcoTech motor is warranted, per our limited warranty, for 24 months from the date of installation.

How It Works

- RESCUE EcoTech motor is an ECM motor made to replace a PSC blower and give you the efficiency of an ECM.
- When you need to offer a replacement blower motor, offer RESCUE EcoTech motor as the "comfort upgrade".
- With our training program we can show you how to offer the RESCUE EcoTech motor as the solution to many customers comfort issues.
- Offering RESCUE EcoTech motor will enhance your company's reputation as a "comfort professional".

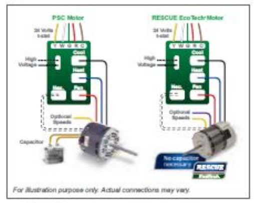
Simple Installation

The RESCUE EcoTech® motor provides an easy-to-drop-in solution for a wide variety of applications.



Installation without modification

Our exclusive motor-control technology allows the RESCUE EcoTech motor to drop into existing PSC blower applications without complex wiring modifications or time-consuming changes to the system controls.



For illustration purpose only. Actual connections may vary.

The RESCUE EcoTech® motor also provides a quiet continuous air circulation in applications where no "Fan" connection is available on the system control.

Mounting Kits

Catalog Number	Diameter	Frame	Mount	Number of Legs
17	5.6"	48 Fr	10" B.C. Blower Mount	3
23	5.6"	48 Fr	11" B.C. Blower Mount	3
24	5.6"	48 Fr	15" B.C. Blower Mount	4
29	5.6"	48 Fr	16" B.C. Blower Mount	4
39	5.6"	48 Fr	10" B.C. Flex Mount	4 Flex
44	5.6"	48 Fr	10" B.C. Flex Mount	3 Flex


24 & 29


17 & 23


39


44