Glacier Consulting Group

State of Wisconsin Department of Administration Division of Energy

Focus on Energy Public Benefits Evaluation

Residential Programs— Home Performance with ENERGY STAR® and Wisconsin ENERGY STAR® Homes

ECM Furnace Impact Assessment Report

June 28, 2004

Evaluation Contractor: PA Government Services Inc.

Prepared by: Tom Talerico and Rick Winch
Glacier Consulting Group, LLC

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This report is the property of the state of Wisconsin, Wisconsin Department of Administration, Division of Energy, and was funded through the Wisconsin Focus on Energy Program.

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1. EXECUTIVE SUMMARY

This study was designed to complement a previous field study funded by the residential program administrator, Wisconsin Energy Conservation Corporation (WECC). The field study addressed the operational characteristics of new furnaces with and without electronically commutated motors (ECMs) to derive technology-based savings estimates for ECM furnaces.[1] Because the way in which people operate their furnace fans has significant ramifications on ECM furnace impacts, the purpose of this study is to examine the behavioral aspects of ECM furnace fan operation and apply these behavioral results to the previously established technology-based savings estimates from the field study; thereby providing a more complete picture of the savings that derive from installing ECM furnaces in Wisconsin homes. This study assesses not only furnace fan operation behavior both before and after the installation of the furnace but also the reasons why changes in behavior occurred.

This assessment is important for two reasons. First, Focus on Energy (Focus) has increased its emphasis on and promotion of ECM furnaces over the past few years as part of its Home Performance with ENERGY STAR® (HPWES)–through the Efficient Heating and Cooling Initiative–and Wisconsin ENERGY STAR Homes (WESH) programs. Through the end of 2003, roughly 11,000 ECM furnaces have been installed as part of Focus efforts, with the Energy Center of Wisconsin's (ECW) annual Furnace and Air Conditioner Tracking (FACTS) data indicating that ECM furnaces comprise about one in five furnaces sold in 2003 by WI distributors participating in FACTS. Second, the potential size of ECM furnace impacts, which relative to other Focus-qualifying measures is large, is highly dependent on customer operational behavior and little, if any, independent research is available documenting the prevalence of various types of furnace fan operational behavior among homeowners in Wisconsin.

As part of the study, we conducted 436 interviews among five groups of homeowners

1. *HPWES Participants with ECMs*. We conducted 150 interviews with owners of existing homes who purchased an ECM furnace through HPWES. The results from this group are used to estimate savings estimates for ECM furnaces installed in existing homes.

2. *Nonparticipant Furnace Replacers*. We conducted 36 interviews with owners of existing homes who recently purchased a new furnace outside of HPWES. The sample for this group was identified through the ECW Appliance Sales Tracking Study.[2] As the control group for HPWES participants with ECMs, the results from this group are used to estimate savings estimates for ECM furnaces installed in existing homes.

3. *WESH Homeowners with ECMs*. We conducted 60 interviews with owners of WESH homes in which an ECM furnace was installed. The results from this group are used to determine savings estimates for ECM furnaces installed in WESH homes.

[1] Wisconsin Department of Administration (DOA). 2003. *Electricity Use by New Furnaces: A Wisconsin Field Study*. Technical Report 230-1. Madison, Wisconsin: Wisconsin Department of Administration. The key inputs from this research that are incorporated in this study are presented in Appendix B.

[2] This study was conducted in July–September of 2003 and identified homeowners who had purchased a new forced air furnace in the past year.

4. *WESH Homeowners without ECMs*. We conducted 90 interviews with owners of WESH homes in which a furnace without an ECM was installed. As the control group for WESH participants with ECMs, results from this group are used to estimate savings estimates for ECM furnaces installed in WESH homes.

5. *Nonparticipant Non-Replacers*. We conducted 100 interviews with owners of existing homes who have not recently purchased a furnace. This was a listed sample of owner-occupied housing in Wisconsin. Results from this group are used to indicate the type of furnace fan operation practices being used in the general population of existing homes.

The focus of the interviews was to assess how homeowners operate their furnace fans throughout the year and understand the reasons why operation practices have changed among those homeowners who modified their practices either subsequent to the installation of the new furnace for existing homeowners or after moving into their new home for WESH homeowners. The interviews also addressed contractor/builder advice on furnace fan operation practices, furnace filter maintenance, housing characteristics, and household demographics.

KEY FINDINGS AND CONCLUSIONS

This study shows that a considerable number of homeowners who purchase ECM furnaces significantly increase the frequency with which they operate their furnace fan subsequent to the installation of the ECM furnace. In particular, these homeowners switched their fan operation behavior from never running their furnace fan independent of the operation of the furnace or CAC (setting the fan switch on their thermostat to “auto”) to running their furnace fans 24 hours per day, every day depending on the time of the year (setting the fan switch on their thermostats to “on”).

The root cause for switching fan operation behavior has substantial ramifications on ECM furnace savings estimates. At one extreme, if switching is due entirely to installation of the ECM furnace (technology-induced), then the savings from the installation of the ECM furnace are entirely negated and energy use actually increases. This is because the increase in operating hours from switching more than offsets the increase in efficiency of the ECM furnace over the non-ECM furnace. At the other extreme, if switching is due entirely to the installation of new furnaces in general and independent of the installation of an ECM furnace (naturally occurring), then savings from the installation of the ECM furnace increase. This is because these homeowners would have switched behavior even if they had installed a non-ECM furnace. Therefore, the degree to which switching fan operation behavior is technology-induced or naturally occurring is crucial for determining ECM furnace savings estimates.

Based on the information we have, namely the practices of participants before and after installation and the practices of a control group before and after installation, we considered using three different baseline scenarios from which to calculate ECM savings for participants who switched fan operation behavior subsequent to the ECM furnace. The first is to use practices of participants before the installation as the baseline. This assumes that all switching is technology-induced. The second is to use the practices of participants after the installation as the baseline. This assumes that all switching is naturally occurring. The third is to use changes in practices among a control group to understand naturally occurring changes in practices. This assumes that the incidence of changes in practices among the control

group is representative of changes in practices that are naturally occurring due to the installation of new furnaces in general.

We recommend using the savings estimates based on the control group baseline assumption. This results in savings estimates of 773 kWh for existing homes and 1,126 kWh for new homes (Table 1–1).

Table 1–1. Alternate Baseline Assumptions

Program	Savings Estimates by Baseline Assumptions		
	Before Installation (All Switching Technology-induced)	Control Group	After Installation (All Switching Naturally Occurring)
HPWES (Existing Homes)	646	773	1,407
WESH[1] (New Homes)	772	1,126	1,363

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

For existing homes, the use of the control group results in a much higher prevalence of technology-induced versus naturally occurring switching. For example, the 773 kWh estimate is much closer to the 646 kWh estimate, which assumes that all changes were technology-induced, than the 1,407 kWh estimate, which assumes that all changes are naturally occurring. In other words, the use of the control group tells us that homeowners who install ECM furnaces are increasing their furnace fan operation much more considerably than would be expected (via the switching behavior of the control group) had they installed a non-ECM furnace.

We assert that the predominance of technology-induced over naturally occurring switching is entirely reasonable. One of the key findings from this study is that advice from HVAC contractors/builders plays a pivotal role in homeowner's decision to change from auto to continuous mode subsequent to the installation of the ECM furnace. In particular, HVAC contractors/builders mention a wide array of benefits (low energy use, even temperature, air circulation, and air filtration), with much of their advice related to running the ECM furnace fan continuously to fully take advantage of these benefits. These findings, which are from the perspective of the homeowner, are corroborated by findings from a recently conducted evaluation study in which interviews were conducted with HVAC contractors actively involved with the Heating and Cooling Initiative.[3] This study found that the type of furnace fan operation advice given by interviewed contractors varies significantly, by whether or not customers have installed an ECM furnace. Sixty percent of interviewed contractors always

[3] The findings from these interviews are reported in detail in the "Focus on Energy Public Benefits Evaluation, Participating HVAC Contractor Interviewer Results–Heating and Cooling Initiative," memorandum to Oscar Bloch, Wisconsin DOA, dated May 2004.

recommend continuous fan operation to customers who install ECM furnaces, with nearly everyone else reporting that they make this recommendation at least half of the time. On the other hand, 10 percent of interviewed contractors always recommend continuous fan operation to customers who install furnaces without ECMs, with 13 percent reporting that they make this recommendation at least half of the time. This finding supports this study's finding on the prevalence of technology-induced switching behavior from auto to continuous mode.

While there are several limitations to this study, the two which we view as most significant are related to the control group.[4] First, the control group is based on a relatively small sample size of nonparticipant replacers. Unfortunately, the budget allocated for this evaluation research was not sufficient to fund the extra cost to identify additional nonparticipant replacers. Second, self-selection issues are inherent in any research that employs a control group. In this study, for example, we cannot say with certainty that participants are not comprised of those who are predisposed to switching furnace fan behavior. While future research can attempt to address self-selection issues, the efforts will be hindered by the fact that the data required from the respondent is based, in part, on responses to hypothetical scenarios and self-reported actions in the absence of information to which they have already been exposed. In other words, the purchase decision process they experienced as a result of the ECM furnace installation has the potential to bias their responses to hypothetical questions about what they would have done in the absence of going through the purchase process in the first place.

The major issue is the extent to which the control group is an adequate representation of naturally occurring changes in switching behavior subsequent to the installation of a new furnace. Despite the study's limitations, the findings clearly demonstrate that (1) a considerable number of homeowners who purchase ECM furnaces significantly increase the frequency with which they operate their furnace fan subsequent to the installation of the ECM furnace, (2) advice from HVAC contractors/builders plays a pivotal role in homeowner's decision to increase fan operation, and (3) HVAC contractors are much more likely to tell homeowners to increase their fan operation if they install an ECM furnace versus a non-ECM furnace. When taken together, these three findings are indicative of technology-induced switching behavior, which is entirely consistent with the representation of the control group. Therefore, we conclude that the control group provides the best possible benchmark currently available for determining the extent to which switching fan operation behavior subsequent to the installation of the ECM furnace is technology-induced versus naturally occurring.

[4] We also have identified three other key limitations to this study. First, while the study provides a snapshot of furnace fan operation practices at a point in time, it is reasonable to expect that furnace fan operation practices in the market may change over time and this study did not address broader market trends over time. Second, the study did not formally address the potential effects of furnace fan operation methods on the run times of furnaces and CACs. Third, although the study identified a number of potential non-energy benefits from increased fan operation, the study did not formally assess the extent to which these benefits accrued to homeowners. These three limitations, as well as the two limitations related to the control group, are discussed more thoroughly in Chapter 6 of this report.

2. BACKGROUND

This study was designed to complement a previous field study funded by the residential program administrator, Wisconsin Energy Conservation Corporation (WECC). The field study addressed the operational characteristics of new furnaces with and without electronically commutated motors (ECMs) to derive technology-based savings estimates for ECM furnaces.[5] The purpose of this study is to examine the behavioral aspects of ECM furnace fan operation and apply these behavioral results to the previously established technology-based savings estimates from the field study; thereby providing a more complete picture of the savings that derive from installing ECM furnaces in Wisconsin homes. This study assesses not only furnace fan operation behavior both before and after the installation of the furnace but also the reasons why changes in behavior occurred.

This assessment is important for two reasons. First, Focus on Energy (Focus) has increased its emphasis on and promotion of ECM furnaces over the past few years as part of its Home Performance with ENERGY STAR® (HPWES)–through the Efficient Heating and Cooling Initiative–and Wisconsin ENERGY STAR Homes (WESH) programs. Through the end of 2003, roughly 11,000 ECM furnaces have been installed as part of Focus efforts, with the Energy Center of Wisconsin's (ECW) annual Furnace and Air Conditioner Tracking (FACTS) data indicating that ECM furnaces comprise about one in five furnaces sold in 2003 by WI distributors participating in FACTS. Second, the potential size of ECM furnace impacts, which relative to other Focus-qualifying measures is large, is highly dependent on customer operational behavior and little, if any, independent research is available documenting the prevalence of various types of furnace fan operational behavior among homeowners in Wisconsin.

In this study, we assess furnace fan operation practices during three periods (heating season, cooling season, and shoulder periods).

1. *Heating season* is the time of the year when temperatures are cold enough that homeowners need to run their furnaces to heat their homes.

2. *Cooling season* is the time of the year when temperatures are warm enough that homeowners decide to run their central air conditioners (CACs) to cool their homes.

3. *Shoulder periods* are the times of the year, particularly spring and fall, when homeowners are not running their furnaces to heat their homes and not running their CACs to cool their homes.

For each of these periods, we classify furnace fan operation into three categories (auto, continuous, sporadic).

1. *Auto mode operation* is when the furnace fan operates only when the furnace or CAC is operating. From the perspective of thermostat operation, this entails leaving the fan switch set to "auto" all of the time during the period in question.

[5] Wisconsin Department of Administration (DOA). 2003. *Electricity Use by New Furnaces: A Wisconsin Field Study*. Technical Report 230-1. Madison, Wisconsin: Wisconsin Department of Administration. The key inputs from this research that are incorporated in this study are presented in Appendix B.

2. *Continuous operation* is when the furnace fan is always operating during the period in question, regardless of whether or not the furnace or CAC is operating. From the perspective of thermostat operation, this entails leaving the fan switch set to "on" all of the time during the period in question.

3. *Sporadic operation* is when the furnace fan is operated independent of furnace and CAC operation at various times during the period in question, but not all of the time during the period in question. From the perspective of thermostat operation, this entails setting the fan switch to "auto" some of the time and to "on" some of the time during the period in question.

The way in which people operate their furnace fans has significant ramifications on ECM furnace impacts. Of the three categories, *auto mode operation* yields the lowest ECM furnace impacts and *continuous operation* yields the highest impacts. This assumes, however, that furnace fan operating characteristics subsequent to the installation of an ECM furnace are the same as they would have been had an ECM furnace not been installed. The extent to which this is not the case has potential ramifications on ECM furnace impacts. For example, the incidence of homeowners changing their behavior from *auto mode operation* to *continuous operation* solely as a result of the ECM technology would result in lower savings potential.

The body of this report is organized as follows.

- Chapter 3 outlines the study approach.
- Chapter 4 presents the derivation of ECM impacts for existing and WESH homes.
- Chapter 5 presents key findings from the other areas that were addressed by the interviews.
- Chapter 6 presents our recommendations on which ECM impacts estimates to apply to existing and new homes. We also discuss the key issues for consideration and identify the limitations inherent in this research, including suggestions for future research efforts to address these limitations.

Ten appendices are included at the end of the report.

- Appendix A presents the step-by-step detailed findings for WESH homes. The step-by-step detailed findings for existing homes are presented in Chapter 4.
- Appendix B presents the key inputs, from the previously conducted ECM field study, for deriving technology-related impacts for ECM furnaces.
- Appendices C–G provide detailed frequency tables of results for each of the five groups of homeowners interviewed as part of the study. While these frequencies are discussed, and appropriately referenced, throughout the report, they are contained in the appendices to reduce the length of the report and increase readability.
- Appendices H–J contain the interview guides used for each homeowner group addressed in the study.

3. STUDY APPROACH

This chapter discusses the study approach. We first present a brief overview of the study's objectives. We then provide a high level discussion of the interview approach that was used. The detailed interview guides used for each homeowner group are presented in Appendices H–J. Finally, we discuss the groups of homeowners that were interviewed to collect the data necessary to meet the study's objectives.

It is important to acknowledge that the approach used in this study has its limitations. We discuss these limitations and other key issues for consideration, as well as propose methods to address identified limitations as part of future research efforts, later in Chapter 6.

3.1 OVERVIEW OF STUDY OBJECTIVES

This study was designed to complement a previous field study funded by the residential program administrator, Wisconsin Energy Conservation Corporation (WECC). The field study addressed the operational characteristics of new furnaces with and without electronically commutated motors (ECMs) to derive technology-based savings estimates for ECM furnaces.[6]

Because the way in which people operate their furnace fans has significant ramifications on ECM furnace impacts, the purpose of this study is to examine the behavioral aspects of ECM furnace fan operation and apply these behavioral results to the previously established technology-based savings estimates from the field study; thereby providing a more complete picture of the savings that derive from installing ECM furnaces in Wisconsin homes. This study assesses not only furnace fan operation behavior both before and after the installation of the furnace but also the reasons why changes in behavior occurred.

3.2 INTERVIEW APPROACH

The focus of the interviews was to assess how homeowners operate their furnace fans throughout the year and understand the reasons why operation practices have changed among those homeowners who modified their practices either subsequent to the installation of the new furnace for existing homeowners or after moving into their new home for WESH homeowners. The interviews also addressed contractor/builder advice on furnace fan operation practices, furnace filter maintenance, housing characteristics, and household demographics.

Figure 3–1 provides an example of the protocol (in matrix form) that we used to assess furnace fan operation practices. The interviews were conducted by Glacier professional staff during the period November 2003–February 2004. The detailed interview guides are presented in Appendices H–J.

[6] Wisconsin Department of Administration (DOA). 2003. *Electricity Use by New Furnaces: A Wisconsin Field Study*. Technical Report 230-1. Madison, Wisconsin: Wisconsin Department of Administration. The key inputs from this research that are incorporated in this study are presented in Appendix B.

Figure 3–1. Example of Furnace Fan Operation Protocol (in matrix form)

Question			Heating Season	Cooling Season	Shoulder Periods
New Furnace	Method		Auto Continuous Sporadic	Auto Continuous Sporadic	Auto Continuous Sporadic
	Continuous/Sporadic	Reasons			
	Sporadic	Situations			
		Days Per Month			
		Hours Per Typical Day			
Old Furnace	Method		Auto Continuous Sporadic	Auto Continuous Sporadic	Auto Continuous Sporadic
	Old Method ≠ New Method	Reasons for change			

Starting with the heating season, we asked respondents about the furnace fan operation method they use on their new furnace and recorded one of the following three categories (auto, continuous, or sporadic). Because the interviews were conducted during the heating season, we asked respondents to go to their thermostat and tell us whether the fan switch was set to “on” or “auto” in order to confirm the method they reported. For those operating their new furnace in continuous or sporadic mode, we asked for the reasons why they operate the new furnace this way. To gauge the extent to which they operate sporadically, we asked respondents who operate sporadically about the situations in which they operate sporadically and for an estimate of the number of days per month and number of hours per day that they operate their furnace fan. We then asked respondents about the furnace fan operation method they used during the heating season on their old furnace and recorded one of the three categories (auto, continuous, or sporadic). If the operation method on the old furnace differed from that on the new furnace, we asked respondents about the reasons for the

change. We then proceeded to follow the same process for the cooling season and shoulder periods.

3.3 HOMEOWNER GROUPS INTERVIEWED

We conducted 436 interviews among five groups of homeowners (Table 3–1). Each of these groups is discussed below.

Table 3–1. Interviews by Homeowner Group

Homeowner Group	Number of Interviews	Response Rate	Precision Level[1]
HPWES Participants with ECM Furnaces	150	75%	± 8%
Nonparticipant Furnace Replacers (*Control Group–HPWES)*	36	45%	± 14%
WESH Homeowners with ECM Furnaces	60	60%	± 10%
WESH Homeowners without ECM Furnaces *(Control Group–WESH ECM)*	90	60%	± 10%
Nonparticipant Non-Replacers *(Control Group–General)*	100	45%	± 10%
Total	**436**		

[1] At 95% confidence level.

HPWES Participants with ECMs. We conducted 150 interviews with owners of existing homes who purchased an ECM furnace through HPWES. The results from this group are used to estimate savings estimates for ECM furnaces installed in existing homes.

Nonparticipant Furnace Replacers. We conducted 36 interviews with owners of existing homes who recently purchased a new furnace outside of HPWES. The sample for this group was identified through the ECW Appliance Sales Tracking Study.[7] As the control group for HPWES participants with ECMs, the results from this group are used to estimate savings estimates for ECM furnaces installed in existing homes.

WESH Homeowners with ECMs. We conducted 60 interviews with owners of WESH homes in which an ECM furnace was installed. The results from this group are used to determine savings estimates for ECM furnaces installed in WESH homes.

WESH Homeowners without ECMs. We conducted 90 interviews with owners of WESH homes in which a furnace without an ECM was installed. As the control group for WESH participants with ECMs, results from this group are used to estimate savings estimates for ECM furnaces installed in WESH homes.

Nonparticipant Non-Replacers. We conducted 100 interviews with owners of existing homes who have not recently purchased a furnace. This was a listed sample of owner-occupied housing in Wisconsin. Results from this group are used to indicate the type of furnace fan operation practices being used in the general population of existing homes.

[7] This study was conducted in July–September of 2003 and identified homeowners who had purchased a new forced air furnace in the past year.

4. ECM FURNACE IMPACT ESTIMATES

This chapter presents the derivation of ECM impacts for existing and WESH homes. For existing homes, we present a very detailed step-by-step explanation of the estimation process. Given that the impacts for WESH homes are derived similarly, we present only the bottom-line results, providing the analogous step-by-step detailed findings in Appendix A.

As discussed in the previous chapter, the approach used in this study has its limitations. We discuss these limitations and other key issues for consideration, as well as propose methods to address identified limitations as part of future research efforts, later in Chapter 6.

4.1 STEP 1: CALCULATE DISTRIBUTION OF OPERATION PRACTICES

To assess ECM impacts in existing homes, we analyzed interview data from HPWES participants who purchased a new ECM furnace and a control group of nonparticipant furnace replacers. The first step in the estimation process is to calculate the distribution of respondents from these two groups across the three operation categories (auto, continuous, sporadic) for each of the three seasons (heating, cooling, and shoulder) both before and after the installation of the new furnace. Table 4–1 presents the distribution for these two groups.

Table 4–1. Operation Practices

Season	Fan Operation Practice	HPWES Participants with ECM Furnace (n=150)		Nonparticipant Furnace Replacers (n=36)	
		Before	After	Before	After
Heating Season	Auto	86.0%	60.7%	94.4%	91.7%
	Continuous	9.3%	33.3%	2.8%	5.6%
	Sporadic	4.7%	6.0%	2.8%	2.8%
Cooling Season	Auto	72.7%	54.0%	83.3%	77.8%
	Continuous	14.7%	35.3%	8.3%	13.9%
	Sporadic	12.7%	10.7%	8.3%	8.3%
Shoulder Periods	Auto	88.0%	72.0%	91.7%	88.9%
	Continuous	5.3%	19.3%	2.8%	5.6%
	Sporadic	6.7%	8.7%	5.6%	5.6%

There are two key findings. First, there is significant movement from auto to continuous operation in each of the three seasons among HPWES participants subsequent to the installation of the ECM furnace. For example during the heating season, 86.0% of HPWES participants operated their furnace fan in auto mode, 9.3% operated continuously, and 4.7% operated sporadically before the installation of the new furnace; whereas after the installation of the new furnace, 60.7% of HPWES participants operated their furnace fan in auto mode, 33.3% operated continuously, and 6.0% operated sporadically. Second, HPWES participants were more likely than nonparticipant replacers to operate their furnace fans continuously in

each of the three seasons before the installation of the new furnace. For example during the heating season, 9.3% of HPWES participants operated their furnace fan continuously before the installation of the new furnace compared to 2.8% of nonparticipant replacers.

4.2 STEP 2: DOCUMENT CHANGES IN PRACTICES

The next step is to document the specific changes in practices among HPWES participants and the control group before and after the installation of the new furnace. This is important because, as discussed in the next section, each of these behavioral changes has ramifications on the savings potential from installing an ECM furnace.

Table 4–2. Changes in Practices

Season	Fan Operation Practice		HPWES Participants with ECM Furnace (n=150)	Nonparticipant Furnace Replacers (n=36)
	Before	After		
Heating Season	Auto		60.0%	91.7%
	Continuous		8.7%	2.8%
	Auto	Continuous	22.7%	2.8%
	Sporadic		2.7%	2.8%
	Auto	Sporadic	3.3%	0.0%
	Other[1]		2.7%	0.0%
Cooling Season	Auto		53.3%	77.8%
	Continuous		14.0%	8.3%
	Auto	Continuous	18.7%	5.6%
	Sporadic		10.0%	8.3%
	Auto	Sporadic	0.7%	0.0%
	Other[1]		3.3%	0.0%
Shoulder Periods	Auto		72.0%	88.9%
	Continuous		5.3%	2.8%
	Auto	Continuous	12.0%	2.8%
	Sporadic		4.7%	5.6%
	Auto	Sporadic	4.0%	0.0%
	Other[1]		2.0%	0.0%

[1] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

Table 4–2 presents the changes in practices for these two groups. For example, during the heating season, 60.0% of HPWES participants operated their furnace in auto mode both

before and after the installation of the ECM furnace; 8.7% operated continuously both before and after, 22.7% operated in auto mode before and continuously after, 2.7% operated sporadically both before and after, and 3.3% operated in auto mode before and sporadically after.

The key finding is that the incidence of switching from auto to continuous fan operation subsequent to the installation of the new furnace (highlighted in Table 4–2) is significantly higher among HPWES participants compared to the control group in each of the three seasons. During the heating season, 22.7% of HPWES participants versus only 2.8% of the control group switched from auto to continuous operation subsequent to the installation of the new furnace. The same general trend in switching from auto to continuous operation subsequent to the installation of the new furnace holds for the cooling season (18.7% of HPWES participants versus only 5.6% of the control group) and the shoulder periods (12.0% of HPWES participants versus only 2.8% of the control group).

4.3 STEP 3: ESTIMATE SAVINGS FOR PRACTICES

The next step is to determine savings estimates for each practice within each of the three seasons. The savings estimates are based on a previous field study funded by the residential program administrator, Wisconsin Energy Conservation Corporation (WECC). The field study addressed the operational characteristics of new ECM and non-ECM furnaces to derive technology-based savings estimates for ECM furnaces.[8] The key inputs for deriving these savings estimates are presented in Appendix B.

Table 4–3 presents the savings estimates for each practice within each of the three seasons and annually. It is important to note that savings in the cooling season depend on whether or not a homeowner has a CAC. Therefore, we present the savings estimates for those without CAC in brackets to differentiate the cooling season and annual estimates. Using the cooling season as an example, furnace fan operation in auto mode both before and after the installation of the ECM furnace yields savings of 87 kWh with a CAC and -10 kWh without a CAC;[9] operation continuously both before and after yields savings of 895 kWh with a CAC and 960 kWh without a CAC; operation in auto mode before and continuously after yields savings of -89 kWh with a CAC and -221 kWh without a CAC; operation sporadically both before and after yields savings of 194 kWh with a CAC and 97 kWh without a CAC; and operation in auto mode before and sporadically after yields savings of 8 kWh with a CAC and -88 kWh without a CAC. Annual savings (illustrated at the bottom of Table 4–3) are simply the sum of savings from the heating season, cooling season, and shoulder periods.

There are two key findings. First, annual savings are significantly higher for those who operated continuously both before and after installation of the new furnace (3,455 with a CAC and 3,520 without a CAC). Second, those who operated in auto mode before the installation and continuously after the installation actually increase their energy use (-186 with a CAC and

[8] Wisconsin Department of Administration (DOA). 2003. *Electricity Use by New Furnaces: A Wisconsin Field Study*. Technical Report 230-1. Madison, Wisconsin: Wisconsin Department of Administration. The key inputs from this research that are incorporated in this study are presented in Appendix B.

[9] ECM furnaces use slightly more electricity than non-ECM furnaces do in *standby* mode. In the absence of a CAC, *standby* is the only operation mode during the entire cooling season, causing negative savings for ECM furnaces. This is explained in more detail in Appendix B.

-318 without a CAC). This is because the increase in operating hours more than offsets the increase in efficiency of the ECM furnace over the non-ECM furnace.

Table 4–3. Savings Estimates for Practices

Season	Fan Operation Practice		Savings Estimate for Type of Practice[1]
	Before	After	
Heating Season	Auto		386
	Continuous		1,800
	Auto	Continuous	78
	Sporadic		786
	Auto	Sporadic	353
	Other[2]		611
Cooling Season	Auto		87 [-10]
	Continuous		895 [960]
	Auto	Continuous	-89 [-221]
	Sporadic		194 [97]
	Auto	Sporadic	8 [-88]
	Other[2]		186 [101]
Shoulder Periods	Auto		-8
	Continuous		760
	Auto	Continuous	-175
	Sporadic		171
	Auto	Sporadic	-37
	Other[2]		-163
Annual	Auto		465 [368]
	Continuous		3,455 [3,520]
	Auto	Continuous	-186 [-318]
	Sporadic		1,151 [1,054]
	Auto	Sporadic	324 [228]
	Other[2]		634 [549]

[1] We present the savings estimates for those without CAC in brackets for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.
[2] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

4.4 STEP 4: DERIVE ESTIMATES FOR BASELINE SCENARIOS

The next step is to determine the most appropriate baseline from which to calculate ECM savings for HPWES participants who changed practices based on the information we have, namely the practices of HPWES participants before and after installation and the practices of nonparticipant replacers before and after installation. We considered three scenarios. The first is to use practices of HPWES participants before the installation as the baseline. This assumes that all changes in practices are due entirely to installation of the ECM furnace (technology-induced). The second is to use the practices of HPWES participants after the installation as the baseline. This assumes that all changes in practices are not technology-induced, but rather entirely due to the installation of new furnaces in general and independent of the installation of an ECM furnace installation (naturally occurring). The third is to use changes in practices among the nonparticipant replacer control group to understand naturally occurring changes in practices. This assumes that the incidence of changes in practices among the control group is representative of changes in practices that are naturally occurring due to the installation of new furnaces in general. The results from each of these three scenarios are discussed below.

4.4.1 Scenario 1: Practices Before Installation as Baseline

Table 4–4 presents savings estimates for each of the three seasons and annually using practices of HPWES participants before the installation as the baseline. The general approach involves bringing together the behavioral data from Table 4–2 and the savings information from Table 4–3. Specifically, for each of the practices within each of the seasons, we multiply the savings estimate for each practice (from Table 4–3) by the percent of participants who use that practice in the season (from Table 4–2) to calculate the relative impact that each practice has on overall savings in a season. We then sum the relative impacts across each of the practices within each season to determine the overall impact in the season. The annual savings are simply the sum of the savings across the three seasons. For example during the heating season, the impact of operating in auto mode both before and after the installation of the furnace (386 kWh) is multiplied by the percent of participants who operated in auto mode both before and after the installation (60.0%) yielding the relative contribution of this practice (232 kWh) to heating season savings. This algorithm is followed for each of the other five practices in the heating season (continuous before and after, auto before and continuous after, sporadic before and after, auto before and sporadic after, and other). Then, the 454 kWh estimate is derived by adding the relative contribution across all six practices. The same process is followed for the cooling season and shoulder periods. The end result of using practices before the installation of the ECM furnace as the baseline is annual savings of 652 kWh for households with a CAC and 572 kWh for households without a CAC. Again, the key assumption for this scenario is that all changes in practices are due entirely to installation of the ECM furnace (technology-induced).

Table 4–4. Practices Before Installation as Baseline

Season	Fan Operation Practice		HPWES Participants with ECM Furnace (n=150)	Savings Estimate for Type of Practice[1]	Savings from Listed Practices[1]	Total Savings[1]
	Before	After				
Heating Season	Auto		60.0%	386	232	454
	Continuous		8.7%	1,800	156	
	Auto	Continuous	22.7%	78	18	
	Sporadic		2.7%	786	21	
	Auto	Sporadic	3.3%	353	12	
	Other[2]		2.7%	611	16	
Cooling Season	Auto		53.3%	87 [-10]	46 [-5]	181 [100]
	Continuous		14.0%	895 [960]	125 [134]	
	Auto	Continuous	18.7%	-89 [-221]	-17 [-41]	
	Sporadic		10.0%	194 [97]	19 [10]	
	Auto	Sporadic	0.7%	8 [-88]	0 [-1]	
	Other[2]		3.3%	186 [101]	6 [3]	
Shoulder Periods	Auto		72.0%	-8	-6	17
	Continuous		5.3%	760	41	
	Auto	Continuous	12.0%	-175	-21	
	Sporadic		4.7%	171	8	
	Auto	Sporadic	4.0%	-37	-1	
	Other[2]		2.0%	-163	-3	
Annual	Auto			465 [368]	272 [221]	**652 [572]**
	Continuous			3,455 [3,520]	322 [331]	
	Auto	Continuous		-186 [-318]	-20 [-45]	
	Sporadic			1,151 [1,054]	48 [39]	
	Auto	Sporadic		324 [228]	10 [10]	
	Other[2]			634 [549]	19 [16]	

[1] We present the savings estimates for those without CAC in brackets for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.
[2] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

4.4.2 Scenario 2: Practices After Installation as Baseline

Table 4–5 presents savings estimates for each of the three seasons and annually using practices of HPWES participants after the installation as the baseline. Impacts for this scenario are estimated in the same manner as that in the previous scenario. Given that we are using behavior after the installation as the baseline, however, affects the savings estimates that are used for practices in which behavior changed from before to after. For example, during the heating season, the savings estimate for auto before and continuous after is 1,800 kWh. This is identical to the savings estimate for those who were continuous before and after, namely because this scenario assumes that all of those who changed from auto to continuous would have done so anyway, regardless of the type of furnace installed. The end result of using practices after the installation of the ECM furnace as the baseline is annual savings of 1,413 kWh for households with a CAC and 1,373 kWh for households without a CAC. Again, the key assumption for this scenario is that all changes in practices are not technology-induced, but rather entirely due to the installation of new furnaces in general and independent of the installation of an ECM furnace installation (naturally occurring).

Table 4–5. Practices After Installation as Baseline

Season	Fan Operation Practice		HPWES Participants with ECM Furnace (n=150)	Savings Estimate for Type of Practice[1]	Savings from Listed Practices[1]	Total Savings[1]
	Before	After				
Heating Season	Auto		60.0%	386	232	873
	Continuous		8.7%	1,800	156	
	Auto	Continuous	22.7%	1,800	408	
	Sporadic		2.7%	786	21	
	Auto	Sporadic	3.3%	538	18	
	Other[2]		2.7%	1,447	39	
Cooling Season	Auto		53.3%	87 [-10]	46 [-5]	386 [346]
	Continuous		14.0%	895 [960]	125 [134]	
	Auto	Continuous	18.7%	895 [960]	167 [179]	
	Sporadic		10.0%	194 [97]	19 [10]	
	Auto	Sporadic	0.7%	449 [352]	3 [2]	
	Other[2]		3.3%	733 [766]	24 [26]	
Shoulder Periods	Auto		72.0%	-8	-6	154
	Continuous		5.3%	760	41	
	Auto	Continuous	12.0%	760	91	
	Sporadic		4.7%	171	8	
	Auto	Sporadic	4.0%	129	5	
	Other[2]		2.0%	760	15	
Annual	Auto			465 [368]	272 [221]	**1,413 [1,373]**
	Continuous			3,455 [3,520]	322 [331]	
	Auto	Continuous		3,455 [3,520]	666 [678]	
	Sporadic			1,151 [1,054]	48 [39]	
	Auto	Sporadic		1,116 [228]	26 [25]	
	Other[2]			2,940 [549]	78 [79]	

[1] We present the savings estimates for those without CAC in brackets for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.
[2] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

4.4.3 Scenario 3: Control Group as Baseline

Table 4–6 presents savings estimates for each of the three seasons and annually using the control group as the baseline. Impacts for this scenario are estimated in the same manner as that used in the previous two scenarios. This method, however, uses the control group to estimate the naturally occurring rate of switching behavior from auto to continuous in each of the three seasons after the purchase of a new furnace. Using the heating season as an example, this rate is estimated by taking the percent of the control group that switched from auto to continuous (2.8%) divided by the percent of the control group that operated in auto mode before the installation (94.4%). The result is a naturally occurring rate of 2.9%. This rate is then applied to the percent of participants that operated in auto mode before the installation (86.0%) to yield 2.5% as the naturally occurring percent of participants that would have switched from auto to continuous. An impact estimate of 1,800 kWh is applied to this estimate, while the lower estimate of 78 kWh is applied to the remaining portion of those switching from auto to continuous (20.1%). The same was done for the cooling season and shoulder periods. The end result of using the control group as the baseline is annual savings of 779 kWh for households with a CAC and 709 kWh for households without a CAC. Again, the key assumption for this scenario is that the incidence of changes in practices among the control group is representative of changes in practices that are naturally occurring due to the installation of new furnaces in general.

Table 4–6. Control Group as Baseline

Season	Fan Operation Practice		HPWES Participants with ECM Furnace (n=150)	Savings Estimate for Type of Practice[1]	Savings from Listed Practices[1]	Total Savings[1]
	Before	After				
Heating Season	Auto		60.0%	386	232	500
	Continuous		8.7%	1,800	156	
	Auto	Continuous	2.5%	1,800	46	
	Auto	Continuous	20.1%	78	16	
	Sporadic		2.7%	786	21	
	Auto	Sporadic	0.0%	538	0	
	Auto	Sporadic	3.3%	353	12	
	Other[2]		2.7%	703	19	
Cooling Season	Auto		53.3%	87 [-10]	46 [-5]	233 [163]
	Continuous		14.0%	895 [960]	125 [34]	
	Auto	Continuous	4.8%	895 [960]	125 [134]	
	Auto	Continuous	13.8%	-89 [-221]	-12 [-31]	
	Sporadic		10.0%	194 [97]	19 [10]	
	Auto	Sporadic	0.0%	449 [352]	0 [0]	
	Auto	Sporadic	0.7%	8 [-88]	0 [-1]	
	Other[2]		3.3%	326 [271]	11 [9]	
Shoulder Periods	Auto		72.0%	-8	-6	46
	Continuous		5.3%	760	41	
	Auto	Continuous	2.7%	760	20	
	Auto	Continuous	9.3%	-175	-16	
	Sporadic		4.7%	171	8	
	Auto	Sporadic	0.0%	129	0	
	Auto	Sporadic	4.0%	-37	-1	
	Other[2]		2.0%	31	1	
Annual	Auto			465 [368]	272 [221]	**779 [709]**
	Continuous			3,455 [3,520]	322 [331]	
	Auto	Continuous		3,455 [3,520]	109 [112]	
	Auto	Continuous		-186 [-318]	-13 [-31]	
	Sporadic			1,151 [1,054]	48 [39]	
	Auto	Sporadic		1,116 [1,019]	0 [0]	
	Auto	Sporadic		324 [228]	10 [10]	
	Other[2]			1,059 [1,005]	30 [28]	

[1] We present the savings estimates for those without CAC in brackets for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.
[2] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

4.5 STEP 5: DETERMINE OVERALL IMPACT ESTIMATES

Because the estimates vary depending on CAC ownership, the final step is to weight CAC and non-CAC estimates by the proportion of CACs among participants to determine the overall impact estimate for ECM furnaces in existing homes. Table 4–7 presents the results for each of the three baseline scenarios.

Table 4–7. Overall Impact Estimates for Existing Homes by Baseline Scenario

CAC Ownership	Percent of HPWES Participants (n=150)	Savings Estimate		
		Scenario 1: Practices Before as Baseline	Scenario 2: Practices After as Baseline	Scenario 3: Control Group as Baseline
CAC	92.0%	652	1,413	779
No CAC	8.0%	572	1,373	709
Savings Weighted by CAC Ownership		**646**	**1,410**	**774**

The end result is a savings estimate of 646 kWh using practices before the installation as the baseline, 1,410 kWh using practices after the installation as the baseline, and 774 kWh using the control group as the baseline.[10]

4.6 WESH IMPACT ESTIMATES

Given that the impacts for WESH homes are derived similarly, we present only the bottom-line results in Table 4–8, providing the analogous step-by-step detailed findings in Appendix A.

Table 4–8. Overall Impact Estimates for WESH Homes by Baseline Scenario

CAC Ownership	Percent of WESH Homeowners (n=150)	Savings Estimate		
		Scenario 1: Practices Before as Baseline[1]	Scenario 2: Practices After as Baseline	Scenario 3: Control Group as Baseline
CAC	97.4%	774	1,364	1,127
No CAC	2.6%	702	1,318	1,079
Savings Weighted by CAC Ownership		**772**	**1,363**	**1,126**

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[10] As discussed at the beginning of this chapter, the approach used in this study has its limitations. We discuss these limitations and other key issues for consideration, as well as propose methods to address identified limitations as part of future research efforts, later in Chapter 6. Then, in Chapter 7, we discuss the implications of the key issues on the findings and make recommendations on which impact estimates to apply

The end result is a savings estimate of 772 kWh using practices before the installation as the baseline, 1,363 kWh using practices after the installation as the baseline, and 1,126 kWh using the control group as the baseline.[11]

[11] As discussed at the beginning of this chapter, the approach used in this study has its limitations. We discuss these limitations and other key issues for consideration, as well as propose methods to address identified limitations as part of future research efforts, later in Chapter 6. Then, in Chapter 7, we discuss the implications of the key issues on the findings and make recommendations on which impact estimates to apply

5. OTHER KEY FINDINGS

This chapter presents key findings from the other areas that were addressed by the interviews. The eight areas are as follows:

- Furnace fan operation methods
- Reasons for using continuous/sporadic operation
- Reasons for changes in operation method subsequent to installation of ECM furnace
- Furnace fan operation advice given by HVAC contractor/builder
- Furnace filter maintenance
- CAC ownership
- Household characteristics
- Demographics

The findings for each of the above eight areas are compared across the five homeowner groups. At various times during the discussion, we collectively refer to HPWES participants, nonparticipant furnace replacers, WESH homeowners with ECM furnaces, and WESH homeowners without ECM furnaces as furnace replacers to simplify terminology, even though WESH homeowners did not technically replace their furnace.

5.1 FURNACE OPERATION METHODS

Table 5–1 shows the furnace fan operation methods before the installation of the new furnace for furnace replacers and the methods used by nonparticipant non-replacers. There are three key findings. First, HPWES participants are more likely than nonparticipants (both replacers and non-replacers) to operate their furnace fans continuously in each of the three seasons before the installation of the new furnace. Second, WESH homeowners, regardless of whether or not they have an ECM furnace, are more likely than HPWES participants and nonparticipants (both replacers and non-replacers) to have operated continuously before. Third, the operation methods of nonparticipant non-replacers are fairly similar to those of nonparticipant replacers. The implication of these findings is that HPWES and WESH are capturing a high percentage of homeowners who were operating their furnace fan continuously prior to the installation of the ECM furnace. This is favorable given that the installation of an ECM furnace yields the highest savings from this group of homeowners.

Table 5–1. Furnace Fan Operation Methods of Furnace Replacers Before the Installation of New Furnace and Nonparticipant Non-Replacers

Season	Fan Operation Practice	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)[1]	WESH Home-owners without ECM Furnace (n=90)[2]	Non-participant Non-Replacers (n=100)
Heating Season	Auto	86.0%	94.4%	80.0%	83.3%	91.0%
	Continuous	9.3%	2.8%	13.3%	12.2%	3.0%
	Sporadic	4.7%	2.8%	6.7%	4.4%	6.0%
Cooling Season	Auto	72.7%	83.3%	73.3%	68.9%	85.0%
	Continuous	14.7%	8.3%	18.3%	21.1%	2.0%
	Sporadic	12.7%	8.3%	8.3%	10.0%	13.0%
Shoulder Periods	Auto	88.0%	91.7%	85.0%	82.2%	87.0%
	Continuous	5.3%	2.8%	8.3%	7.8%	2.0%
	Sporadic	6.7%	5.6%	6.7%	10.0%	11.0%

[1] Previous to their WESH home, 8 of the 60 respondents (13.3%) either owned a home with no forced air furnace (FAF) or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] Previous to their WESH home, 34 of the 90 respondents (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

5.2 REASONS FOR USING CONTINUOUS/SPORADIC OPERATION

We asked furnace replacers who operate their furnace fan continuously/sporadically both before and after the installation of the ECM furnace and nonparticipant non-replacers who operate continuously/sporadically for the reasons why they operate this way.[12] Tables 5–2 through 5–4 present the reasons given by each of the five homeowner groups for each of the three periods.[13] As the tables illustrate, air circulation, even temperature, and air filtration are the most commonly mentioned reasons, with air circulation cited most prevalently. Also, WESH homeowners without ECM furnaces frequently mention moisture control as a reason.

[12] Follow-up probes were not conducted to obtain additional details on the initial responses that were given about the reasons for continuous/sporadic operation. The analysis is based on the interviewee's first response which was recorded verbatim.

[13] The tables present a high level categorization of the responses. The detailed responses that were given by each of the groups of homeowners are presented in Appendices C-G.

Table 5–2. Reasons for Using Continuous/Sporadic Operation–Heating Season*

Reason	HPWES Participants with ECM Furnace (n=17)[1]	Non-participant Furnace Replacers (n=2)	WESH Home-owners with ECM Furnace (n=10)[2]	WESH Home-owners without ECM Furnace (n=14)[3]	Non-participant Non-Replacers (n=9)[4]
Air circulation	58.8%	0.0%	50.0%	71.5%	66.7%
Even temperature	35.3%	0.0%	20.0%	28.5%	22.2%
Air filtration	11.8%	100.0%	20.0%	7.1%	22.2%
More comfortable	11.8%	0.0%	0.0%	0.0%	0.0%
Less energy use	5.9%	0.0%	10.0%	0.0%	0.0%
Better way	5.9%	0.0%	10.0%	7.1%	0.0%
Moisture control	0.0%	0.0%	0.0%	35.7%	0.0%
No specific reason	0.0%	0.0%	10.0%	0.0%	0.0%
Energy efficient	0.0%	0.0%	10.0%	0.0%	0.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.
[1] A total of 22 responses were given by the 17 respondents.
[2] A total of 13 responses were given by the 10 respondents.
[3] A total of 20 responses were given by the 14 respondents.
[4] A total of 10 responses were given by the 9 respondents.

Table 5–3. Reasons for Using Continuous/Sporadic Operation–Cooling Season*

Reason	HPWES Participants with ECM Furnace (n=36)[1]	Non-participant Furnace Replacers (n=6)	WESH Home-owners with ECM Furnace (n=13)[2]	WESH Home-owners without ECM Furnace (n=26)[3]	Non-participant Non-Replacers (n=15)[4]
Air circulation	69.5%	66.7%	53.8%	69.2%	100.0%
Even temperature	27.8%	16.7%	7.7%	11.5%	15.4%
No specific reason	8.3%	0.0%	7.7%	3.8%	0.0%
Air filtration	5.6%	16.7%	15.4%	7.7%	7.7%
More comfortable	5.6%	0.0%	0.0%	0.0%	0.0%
Energy efficient	2.8%	0.0%	15.4%	0.0%	0.0%
Moisture control	0.0%	0.0%	0.0%	30.7%	0.0%
Better way	0.0%	0.0%	7.7%	3.8%	0.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.
[1] A total of 43 responses were given by the 16 respondents.
[2] A total of 14 responses were given by the 13 respondents.
[3] A total of 33 responses were given by the 26 respondents.
[4] A total of 16 responses were given by the 15 respondents.

Table 5–4. Reasons for Using Continuous/Sporadic Operation–Shoulder Periods*

Reason	HPWES Participants with ECM Furnace (n=15)[1]	Non-participant Furnace Replacers (n=6)	WESH Home-owners with ECM Furnace (n=8)[2]	WESH Home-owners without ECM Furnace (n=16)[3]	Non-participant Non-Replacers (n=13)[4]
Air circulation	86.7%	66.7%	50.0%	81.3%	76.9%
Even temperature	20.0%	16.7%	0.0%	12.5%	7.7%
Air filtration	13.3%	16.7%	25.0%	12.6%	15.4%
More comfortable	6.7%	0.0%	0.0%	0.0%	0.0%
No specific reason	6.7%	0.0%	0.0%	0.0%	0.0%
Moisture control	0.0%	0.0%	0.0%	18.8%	7.7%
Energy efficient	0.0%	0.0%	25.0%	0.0%	0.0%
Better way	0.0%	0.0%	12.5%	0.0%	0.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.
[1] A total of 20 responses were given by the 15 respondents.
[2] A total of 9 responses were given by the 8 respondents.
[3] A total of 20 responses were given by the 16 respondents.
[4] A total of 14 responses were given by the 13 respondents.

5.3 REASONS FOR CHANGES FROM AUTO TO CONTINUOUS/SPORADIC OPERATION SUBSEQUENT TO INSTALLATION OF ECM FURNACE

We asked furnace replacers who changed their furnace fan operation method from auto mode before to continuous/sporadic mode after the installation of the ECM furnace for the reasons why they changed.[14] Table 5–5 presents the reasons given by HPWES participants for each of the three periods.[15] As the tables illustrate, air circulation is the most commonly cited reason. For example, 30.8% of HPWES participants mention air circulation as a reason for changing from auto to continuous during the heating season. This is comprised of 10.3% who explicitly mentioned air circulation based on advice from the HVAC contractor and 20.5% who generally cited air circulation with no reference to contractor advice. Although not shown in the table, WESH homeowners frequently mentioned moisture control and integration with their ventilation system as reasons.[16] Finally, advice from HVAC contractors/builders plays a pivotal role in the homeowner's decision to change from auto to continuous/sporadic mode subsequent to the installation of the ECM furnace. During the heating season, for example, 56% of HPWES participants mentioned a reason related to contractor advice, and out of all

[14] Follow-up probes were not conducted to obtain additional details on the initial responses that were given about the reasons for switching. The analysis is based on the interviewee's first response which was recorded verbatim.
[15] The table presents a high level categorization of the responses. The detailed responses are presented in Appendix C.
[16] The analogous tables for the other homeowners groups, as well as the detailed responses, are presented in Appendices D-G.

the responses given, 51 percent pertain to contractor advice.[17] In the table, responses relating to contractor advice are *italicized* and preceded by a √.

Table 5–5. Reasons for Changing from Auto to Continuous/Sporadic Operation

Reason	HPWES Participants with ECM Furnace		
	Heating Season (n=39)[1]	Cooling Season (n=31)[2]	Shoulder Periods (n=24)[3]
Air circulation	20.5%	19.4%	20.8%
√ *Contractor advice: Air circulation*	*10.3%*	*12.9%*	*16.7%*
Even temperature	12.8%	25.8%	12.5%
√ Contractor advice: Even temperature	17.9%	3.2%	16.7%
Energy efficient/High efficiency fan	10.3%	6.5%	4.2%
√ *Contractor advice: Energy efficient*	*15.4%*	*12.9%*	*12.5%*
√ *Contractor advice: No specific reason*	*17.9%*	*9.7%*	*16.7%*
Air filtration	7.7%	12.9%	12.5%
√ *Contractor advice: Air filtration*	*5.1%*	*9.7%*	*12.5%*
Low cost	12.8%	9.7%	4.2%
√ *Contractor advice: Low cost*	*0.0%*	*3.2%*	*0.0%*
Better way	2.6%	0.0%	4.2%
√ *Contractor advice: Better way*	*5.1%*	*3.2%*	*0.0%*
Low energy use	2.6%	0.0%	0.0%
√ *Contractor advice: Low energy use*	*2.6%*	*6.5%*	*0.0%*
Increase comfort	0.0%	3.2%	8.3%
√ *Contractor advice: Increase comfort*	*0.0%*	*0.0%*	*4.2%*
Don't know	2.6%	3.2%	4.2%
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	56%	52%	63%
Percent of *Responses* Relating to Contractor Advice	51%	43%	53%

[1] A total of 57 responses were given by the 39 respondents.
[2] A total of 44 responses were given by the 31 respondents.
[3] A total of 36 responses were given by the 24 respondents.

[17] This probably represents a lower limit regarding the importance of contractor advice given that the question wording did not direct respondents to focus on where they learned about the advantages of continuous fan operation.

5.4 FURNACE FAN OPERATION ADVICE GIVEN BY HVAC CONTRACTOR/BUILDER

We asked the four groups of homeowners that replaced their furnace if their HVAC contractor/builder told them anything about the amount of electricity used by the fan motor of the new furnace or about how to operate the fan on the new furnace. The results are presented in Table 5–6. As the table illustrates, HPWES participants were more likely to receive furnace fan operation advice than their counterparts in the nonparticipant replacer control group (60.7% vs. 25.0%) and both groups of WESH homeowners (60.7% vs. 41.7%/45.6%).

Table 5–6. Received Furnace Fan Operation Advice from HVAC Contractor/Builder*

Received Advice	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)
Yes	60.7%	25.0%	41.7%	45.6%
No	30.7%	50.0%	48.3%	53.3%
Don't Know	8.7%	25.0%	10.0%	1.1%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

Among those who received advice, we asked about what the HVAC contractor/builder told them about the amount of electricity used by the fan motor of the new furnace or about how to operate the fan on the new furnace.[18] The results are presented in Table 5–7.[19] As table illustrates, the HVAC contractors/builders mention a wide array of benefits (low energy use, even temperature, air circulation, and air filtration), with much of their advice related to running the ECM furnace fan continuously to fully take advantage of these benefits. For example, 23.1% of HPWES participants mention that their HVAC contractor talked to them about the low energy use/energy savings from the ECM furnace, with 7.7% saying that their HVAC contractor told them to run their furnace fan continuously because of the ECM furnace's low energy use. Further, 46% of HPWES participants mentioned a reason related to continuous fan operation advice, and out of all the responses given, 50 percent pertain to continuous fan operation.[20] In the table, responses relating to continuous fan operation are *italicized* and preceded by a √.

[18] Follow-up probes were not conducted to obtain additional details on the initial responses that were given about the types of advice received. The analysis is based on the interviewee's first response which was recorded verbatim.

[19] The table presents a high level categorization of the responses. The detailed responses that were given by each of the groups of homeowners are presented in Appendices C-G.

[20] This probably represents a lower limit regarding the continuous fan operation advice given that the question wording did not direct respondents to focus specifically on this.

Table 5–7. Type of Advice Received from HVAC Contractor/Builder*

Reason	HPWES Participants with ECM Furnace (n=91)[1]	Non-participant Furnace Replacers (n=9)[2]	WESH Home-owners with ECM Furnace (n=25)[3]	WESH Home-owners without ECM Furnace (n=41)[4]
Low energy use/Save energy	15.4%	0.0%	12.0%	0.0%
√ Run fan continuously: Low energy use	*7.7%*	*0.0%*	*8.0%*	*17.1%*
DC Motor/Variable Speed	13.2%	0.0%	8.0%	0.0%
√ Run fan continuously: DC Motor /Variable speed	*5.5%*	*0.0%*	*0.0%*	*0.0%*
√ Run fan continuously: No specific reason	*19.8%*	*22.2%*	*0.0%*	*17.1%*
Energy efficient/High efficiency fan/motor	9.9%	55.6%	8.0%	0.0%
√ Run fan continuously: Energy efficient	*3.3%*	*11.1%*	*8.0%*	*0.0%*
Not recall specifics	12.1%	0.0%	8.0%	9.8%
Low cost/Save money	3.3%	0.0%	4.0%	2.4%
√ Run fan continuously: Low cost	*8.8%*	*11.1%*	*4.0%*	*4.9%*
How to operate	8.8%	11.1%	32.0%	22.0%
Even temperature	1.1%	0.0%	0.0%	0.0%
√ Run fan continuously: Even temperature	*6.6%*	*0.0%*	*12.0%*	*4.9%*
Air circulation	1.1%	0.0%	0.0%	0.0%
√ Run fan continuously: Air circulation	*5.5%*	*0.0%*	*0.0%*	*0.0%*
√ Run fan continuously: Increase comfort	*3.3%*	*0.0%*	*0.0%*	*0.0%*
Air filtration	2.2%	0.0%	0.0%	0.0%
√ Run fan continuously: Air filtration	*1.1%*	*0.0%*	*4.0%*	*4.9%*
Better way	2.2%	0.0%	0.0%	0.0%
√ Run fan continuously: Better way	*0.0%*	*0.0%*	*4.0%*	*0.0%*
√ Run fan continuously: Quiet fan/Less noise	*2.2%*	*0.0%*	*0.0%*	*0.0%*
√ Run fan continuously: Increase bill but beneficial	*1.1%*	*0.0%*	*0.0%*	*0.0%*
√ Run fan continuously: Less wear and tear	*1.1%*	*0.0%*	*0.0%*	*0.0%*
√ Run fan continuously: Moisture control	*0.0%*	*0.0%*	*8.0%*	*9.8%*
√ Run fan continuously: First year	*0.0%*	*0.0%*	*0.0%*	*19.5%*
Percent of *Respondents* Giving Reasons Relating to Continuous Fan Operation	46%	33%	40%	65%
Percent of *Responses* Relating to Continuous Fan Operation	50%	40%	40%	70%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

[1] A total of 121 responses were given by the 91 respondents.

[2] A total of 10 responses were given by the 9 respondents.

[3] A total of 30 responses were given by the 25 respondents.

[4] A total of 46 responses were given by the 41 respondents.

5.5 FURNACE FILTER MAINTENANCE

We asked all five homeowner groups about how often the filter is changed on their furnace.[21] Results are presented in Table 5–8.[22] As the table illustrates, the frequency with which HPWES and WESH participants change their furnace filters is comparable, but less than the frequency with which both groups of nonparticipants change their furnace filters. This may be due, in part, to the fact that participants are more likely to have had a high performance filter installed with their new furnace, and these filters do not need to be changed as frequently as standard filters.[23]

Table 5–8. Furnace Filter Maintenance*

Received Advice	HPWES Participants with ECM Furnace (n=138)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Annually	33.3%	5.6%	35.0%	23.3%	22.0%
Twice per year	22.5%	13.9%	35.0%	27.8%	12.0%
3–6 times per year	18.1%	25.0%	11.7%	23.3%	26.0%
Monthly	10.0%	30.6%	0.0%	11.1%	20.0%
Not changed yet	5.8%	0.0%	3.3%	2.2%	0.0%
Every 2+ years	3.6%	2.8%	0.0%	5.6%	5.0%
Other	3.6%	0.0%	0.0%	0.0%	3.0%
Only cleans filter	2.9%	16.7%	8.3%	4.4%	6.0%
Don't know	0.0%	5.6%	6.7%	2.2%	6.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

5.6 CAC OWNERSHIP

Table 5–9 compares CAC ownership before and after the installation of the new furnace. As the table illustrates, HPWES participants are more likely to have a CAC both before and after the installation than their counterparts in the nonparticipant replacer control group (76.0%/92.0% vs. 55.6%/80.6%). Another key finding is that homeowners without a CAC are deciding to add a CAC as part of the furnace replacement. This is occurring across all four groups of furnace replacers and is more prevalent among HPWES and WESH participants. For example, two-thirds of HPWES participants who did not own a CAC before the furnace replacement added a CAC as part of the replacement.

[21] Follow-up probes were not conducted to obtain additional details on the initial responses that were given about furnace filter maintenance.

[22] The tables present a high level categorization of the responses. The detailed responses that were given by each of the groups of homeowners are presented in Appendices C-G.

[23] Detailed responses on furnace filter maintenance, some of which refer to the type of filter that was installed, are presented in Appendices C-G.

Table 5–9. CAC Ownership–Before and After Installation of New Furnace

CAC Ownership	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)[1]	WESH Home-owners without ECM Furnace (n=90)[2]	Non-participant Non-Replacers (n=100)
% Having CAC Before Installation	76.0%	55.6%	76.4%	82.3%	90.0%
% Having CAC After Installation	92.0%	80.6%	96.7%	97.8%	NA
% of Those Not Having CAC Before Installation Who Have CAC After Installation[1]	66.7%	50.0%	86.0%	87.6%	NA

[1] Previous to their WESH home, 5 of the 60 respondents (8.3%) did not own a home.

[2] Previous to their WESH home, 28 of the 90 respondents (31.1%) did not own a home.

[3] The formula for this calculation is as follows: (% Having CAC After Installation - % Having CAC Before Installation) ÷ (1 - % Having CAC Before Installation)

5.7 HOUSEHOLD CHARACTERISTICS

In this subsection, we compare the following household characteristics among the five groups of homeowners:

- Type of residence
- Size of residence
- Number of levels
- Year home built

5.7.1 Type of Residence

Table 5–10 compares the residence type among the five homeowner groups. As the table illustrates, HPWES participants are more likely to live in a single family home than their counterparts in the nonparticipant replacer control group (98.7% vs. 91.7%).

Table 5–10. Type of Residence*

Type of Residence	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Single Family Home	98.7%	91.7%	100.0%	100.0%	94.0%
Duplex or Triplex	1.3%	8.3%	0.0%	0.0%	3.0%
Row or Townhouse	0.0%	0.0%	0.0%	0.0%	3.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

5.7.2 Size of Residence

Table 5–11 compares the residence size among the five homeowner groups. As the table illustrates, HPWES participants are more likely to have larger homes than their counterparts in the nonparticipant replacer control group (1,948 vs. 1,661) and both groups of WESH homeowners are more likely to have larger homes than the other three groups.

Table 5–11. Size of Residence

Size of Residence	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Average Square Feet	1,948	1,661	2,643	2,218	1,953
Average Number of Bedrooms	3.3	3.2	3.5	3.3	3.1

5.7.3 Number of Levels

Table 5–12 compares the number of home levels for the five homeowner groups. As the table illustrates, the number of home levels among HPWES participants and their counterparts in the nonparticipant replacer control group is comparable (e.g., 56.7% vs. 58.3% for two stories). Also, WESH homeowners without ECM furnaces and nonparticipant nonreplacers are more likely to have one story homes than the other three groups.

Table 5–12. Number of Levels*

Number of Levels	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
One Story	37.3%	38.9%	43.3%	46.7%	55.0%
Bi-Level	2.7%	0.0%	3.3%	2.2%	8.0%
Two Story	56.7%	58.3%	51.7%	42.2%	36.0%
Tri-Level	2.7%	0.0%	1.7%	5.6%	1.0%
Three Story	0.7%	0.0%	0.0%	3.3%	0.0%
Refused	0.0%	2.9%	0.0%	0.0%	0.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

5.7.4 Year Home Built

Table 5–13 compares the year of home construction among the three non-WESH homeowner groups.[24] As the table illustrates, the average year of home construction for HPWES participants is more recent than that of their counterparts in the nonparticipant replacer control group (1956 vs. 1945).

Table 5–13. Year Home Built

Year Home Built	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Average Year Home Built	1956	1945	NA	NA	1966

5.8 DEMOGRAPHICS

In this subsection, we compare the following demographics among the five groups of homeowners:

- Home ownership
- Number of years in home
- Household size
- Education
- Income
- Gender

5.8.1 Home Ownership

Table 5–14 compares the prevalence of home ownership among the three non-WESH homeowner groups.[25] As the table illustrates, HPWES participants are more likely to own their home than their counterparts in the nonparticipant replacer control group (100.0% vs. 94.4%).

Table 5–14. Own or Rent

Own or Rent	HPWES Participants with ECM Furnace	Non-participant Furnace Replacers	WESH Home-owners with ECM	WESH Home-owners without ECM	Non-participant Non-Replacers

[24] WESH homeowners were not asked about the year in which their home was built because it had been recently constructed.

[25] WESH homeowners were not asked about whether they own or rent their home because they had recently purchased the home.

	(n=150)	(n=36)	Furnace (n=60)	Furnace (n=90)	(n=100)
Own	100.0%	94.4%	NA	NA	99.0%
Rent	0.0%	2.8%	NA	NA	1.0%
Refused	0.0%	2.8%	NA	NA	0.0%

5.8.2 Number of Years Lived in Home

Table 5–15 compares the number of years residing in the current home among the three non-WESH homeowner groups.[26] As the table illustrates, the average length of residence for HPWES participants is higher than that of their counterparts in the nonparticipant replacer control group (17.5 vs. 14.7).

Table 5–15. Number of Years Lived in Home

Number of Years Lived in Home	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Average Number of Years	17.5	14.7	NA	NA	16.9

5.8.3 Household Size

Table 5–16 compares household size of the five homeowner groups. As the table illustrates, the average household size for HPWES participants and their counterparts in the nonparticipant replacer control group is comparable (2.7 vs. 2.9). Also, household size tends to be largest among WESH homeowners with ECM furnaces (3.5), primarily due to a higher number of household members that are 17 and younger (1.3).

[26] WESH homeowners were not asked about the number of years residing in their home because they had recently moved in.

Table 5–16. Average Household Size

Age Category	Average Number of People in Age Category				
	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
17 and Younger	0.7	0.7	1.3	0.7	0.6
18–65	1.7	1.9	2.1	2.0	1.7
Over 65	0.3	0.4	0.0	0.1	0.4
Overall	2.7	2.9	3.5	2.8	2.7

5.8.4 Education Level

Table 5–17 compares the respondent's highest level of education among the five homeowner groups. As the table illustrates, HPWES participants are more likely to be college graduates than their counterparts in the nonparticipant replacer control group (46.0% vs. 30.6%) and both groups of WESH homeowners are more likely to be college graduates than the other three groups.

Table 5–17. Education Level*

Education Level	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Some High School	2.0%	0.0%	0.0%	0.0%	1.0%
High School Graduate	24.7%	16.7%	23.3%	8.9%	29.0%
Some Technical School or College	18.7%	30.6%	11.7%	15.6%	20.0%
Technical School Graduate	5.3%	16.7%	10.0%	12.2%	11.0%
College Graduate	23.3%	13.9%	30.0%	53.3%	27.0%
Advanced Degree	22.7%	16.7%	25.0%	10.0%	7.0%
Refused	3.3%	5.6%	0.0%	0.0%	5.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

5.8.5 Income Level

Table 5–18 compares the household income levels of the five homeowner groups. As the table illustrates, HPWES participants are more likely to have household incomes greater than

$100,000 than their counterparts in the nonparticipant replacer control group (22.0% vs. 2.8%) and both groups of WESH homeowners tend to have higher incomes than the other three groups. The higher income level of participants is a possible explanation for their higher rate of continuous fan operation before the installation of the ECM furnace given that those with higher incomes are more likely to be able to afford the higher electricity bills associated with continuous operation.

Table 5–18. Income Level*

Income Level	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Less than $10,000	0.0%	0.0%	0.0%	0.0%	1.0%
$10,000–$14,999	2.0%	0.0%	0.0%	0.0%	2.0%
$15,000–$19,999	2.0%	2.8%	0.0%	0.0%	3.0%
$20,000–$29,999	7.3%	8.3%	0.0%	1.1%	10.0%
$30,000–$39,999	8.7%	5.6%	5.0%	1.1%	8.0%
$40,000–$49,999	10.0%	19.4%	10.0%	5.6%	5.0%
$50,000–$74,999	22.0%	22.2%	16.7%	24.4%	19.0%
$75,000–$99,999	12.0%	11.1%	21.7%	31.1%	15.0%
$100,000+	22.0%	2.8%	36.7%	25.6%	5.0%
Refused	14.0%	27.8%	10.0%	11.1%	32.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

5.8.6 Gender

Table 5–19 compares the gender of respondents among the five homeowner groups. As the table illustrates, males comprise a greater proportion of respondents among HPWES participants compared to respondents in the nonparticipant replacer control group (60.0% vs. 52.8%). Further, for all groups, except nonparticipant nonreplacers (48.0%), respondents are more likely to be males, with the highest prevalence among WESH homeowners without ECM furnaces (70.0%).

Table 5–19. Gender*

Gender	HPWES Participants with ECM Furnace (n=150)	Non-participant Furnace Replacers (n=36)	WESH Home-owners with ECM Furnace (n=60)	WESH Home-owners without ECM Furnace (n=90)	Non-participant Non-Replacers (n=100)
Male	60.0%	52.8%	61.7%	70.0%	48.0%
Female	40.0%	47.2%	38.3%	30.0%	52.0%

* The shaded cells highlight the most prevalent responses within each of the homeowner groups.

6. RECOMMENDATIONS AND KEY ISSUES

In this chapter, we present our recommendations on which ECM impacts estimates to apply to existing and new homes. We also discuss the key issues for consideration and identify the limitations inherent in this research, including suggestions for future research efforts to address these limitations. Our suggestions, however, do not imply that we think the study is weak or lacking in substance. To the contrary, we think that the study is strong and the findings are robust, and make suggestions solely to further strengthen the results. Further, we must point out that, for the foreseeable future, Focus evaluation funds are extremely tight, making implementation of these suggestions not feasible for contract year four evaluation efforts.

6.1 RECOMMENDATIONS

We recommend using the savings estimates based on the control group baseline assumption. This results in savings estimates of 773 kWh for existing homes and 1,126 kWh for new homes (Table 6–1). As the table illustrates, savings estimates vary widely depending on the baseline assumptions used–from 646 to 1,407 kWh for existing homes and from 772 to 1,363 kWh for new homes.

Table 6–1. Alternate Baseline Assumptions

Program	Savings Estimates by Baseline Assumptions		
	Before Installation (All Switching Technology-induced)	Control Group	After Installation (All Switching Naturally Occurring)
HPWES (Existing Homes)	646	773	1,407
WESH[1] (New Homes)	772	1,126	1,363

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

The major issue is the extent to which the control group is an adequate representation of naturally occurring changes in furnace fan operation from auto to continuous mode subsequent to the installation of a new furnace. While there are limitations to the use of the control group, which are thoroughly discussed next in the *Key Issues and Limitations* section, we are confident that the control group provides the best possible benchmark available for determining the extent to which changes in operation from auto to continuous mode among participating homeowners subsequent to the installation of the ECM furnace were technology-induced versus naturally occurring.

For existing homes, the use of the control group results in a much higher prevalence of technology-induced versus naturally occurring switching. For example, the 773 kWh estimate is much closer to the 646 kWh estimate, which assumes that all changes were technology-induced, than the 1,407 kWh estimate, which assumes that all changes are naturally

occurring. We assert that the predominance of technology-induced over naturally occurring switching is entirely reasonable given that (1) the advice from HVAC contractors is pivotal in the decision of participating homeowners to switch from auto to continuous mode subsequent to the installation of the ECM furnace and (2) HVAC contractors are much more likely to give continuous fan operation advice to those who buy ECM furnaces than to those who buy non-ECM furnaces. These two findings are discussed in more detail below in the *Key Issues and Limitations* section.

6.2 KEY ISSUES AND LIMITATIONS

6.2.1 Corroboration with HVAC Contractor Results

One of the key findings from this study is that advice from HVAC contractors/builders plays a pivotal role in homeowner's decision to change from auto to continuous mode subsequent to the installation of the ECM furnace. In particular, HVAC contractors/builders mention a wide array of benefits (low energy use, even temperature, air circulation, and air filtration), with much of their advice related to running the ECM furnace fan continuously to fully take advantage of these benefits.

These findings, which are from the perspective of the homeowner, are corroborated by findings from a recently conducted evaluation study in which interviews were conducted with HVAC contractors actively involved with the Heating and Cooling Initiative.[27] Three findings from the HVAC contractor study that bear upon the results from this study are briefly discussed below.

- First, the type of furnace fan operation advice given by interviewed contractors varies significantly by whether or not customers have installed an ECM furnace. Sixty percent of interviewed contractors always recommend continuous fan operation to customers who install ECM furnaces, with nearly everyone else reporting that they make this recommendation at least half of the time. On the other hand, 10 percent of interviewed contractors always recommend continuous fan operation to customers who install furnaces without ECMs, with 13 percent reporting that they make this recommendation at least half of the time. This finding supports this study's finding on the prevalence of technology-induced switching behavior from auto to continuous mode.

- Second, about three-quarters of interviewed contractors think that customers who switch furnace fan operation from auto mode on their old furnace to continuous mode on their new ECM furnace will still decrease their electricity use from installing an ECM furnace. As demonstrated in Chapter 4 of this study, however, the increase in operating hours caused by switching from auto to continuous mode offsets the electricity savings from the ECM furnace and results in an increase in electricity use if operated continuously year-round. Unless continuous fan operation reduces furnace/CAC runs times sufficiently to counter the increase in fan electrical consumption as a result of switching from auto to continuous mode, the HVAC contractors who promise energy savings to customers if they switch from auto to

[27] The findings from these interviews are reported in detail in the "Focus on Energy Public Benefits Evaluation, Participating HVAC Contractor Interviewer Results–Heating and Cooling Initiative," memorandum to Oscar Bloch, Wisconsin DOA, dated May 2004.

continuous mode are providing inaccurate advice which is actually contributing to an increase in electricity use. The issue of continuous fan use effects on furnace/CAC use is discussed later in this section.

- Finally, comfort (through more even temperatures in the house), air quality (consistent filtering), and low cost (inexpensive to run fan on ECM furnace continuously) were the most commonly cited reasons that interviewed contractors give for recommending continuous fan operation to ECM furnace purchasers. These reasons are entirely consistent with what homeowner's reported in this study.

6.2.2 Control Group Issues

A. EXISTING HOMES

The study's use of nonparticipant furnace replacers as the control group for HPWES participants who installed ECM furnaces is based on the following two key assumptions.

1. Nonparticipant furnace replacers did not install an ECM furnace

2. Nonparticipant furnace replacers and HPWES participants who operated their furnace in auto mode prior to the installation of the ECM furnace have the same predisposition to switching their operation from auto to continuous mode subsequent to the installation

Regarding the first assumption, we acknowledge that not receiving a rebate for an ECM furnace through the HPWES program does not preclude the installation of an ECM furnace by nonparticipant furnace replacers and that it is possible that a subset of this group indeed installed an ECM furnace. It is important to note, however, that the HPWES program is heavily promoted by HVAC contractors and that a vast majority of the contractors in WI are involved with the program. Therefore, we expect a low incidence of ECM furnace installations outside of Focus. One way for future research efforts to verify whether or not a nonparticipating customer has an ECM furnace is through collecting make and model number information from the customer through an on-site visit and then checking this information in Gas Appliance Manufacturers Association (GAMA) manuals to determine if it is an ECM furnace. The budget allocated for this evaluation research, however, was not sufficient to fund the extra cost for this verification task.

Regarding the second assumption, we acknowledge that self-selection issues are inherent in any research that employs a control group. In this study, we cannot say with certainty that participants are not comprised of those who are predisposed to changing from auto to continuous mode. The types of information required for future research efforts to adequately gauge the predisposition of switching behavior include, but are not limited to, the following:

- Whether or not respondents who switched from auto to continuous mode knew that they could have run their furnace fan continuously (i.e., set the fan switch on their thermostat to "on" rather than "auto") prior to the purchase of the new furnace.

- Whether or not respondents who switched from auto to continuous mode knew about the benefits of running continuously prior to the purchase of the new furnace

- Whether or not respondents who switched from auto to continuous mode would have still run continuously even if they had installed a non-ECM furnace

In order to be classified as naturally occurring switchers, respondents would have to meet two conditions. First they would need to have been either: (1) aware of their ability to run continuously, but not aware of the benefits; (2) not aware of their ability to run continuously and not aware of the benefits; or (3) not aware of their ability to run continuously, but aware of the benefits. Second they would need to have still run continuously even if they had installed a non-ECM furnace.

While future research can attempt to address this issue, the efforts will be hindered by the fact that the data required from the respondent is based, in part, on responses to hypothetical scenarios and self-reported actions in the absence of information to which they have already been exposed. In other words, the purchase decision process they experienced as a result of the ECM furnace installation has the potential to bias their responses to hypothetical questions about what they would have done in the absence of going through the purchase process in the first place.

B. WESH HOMES

The study's use of WESH homeowners without ECM furnaces as the control group for WESH homeowners with ECM furnaces assumes that WESH does not have an effect on furnace fan behavior. Based on conversations with WESH program staff, there are no a priori reasons to believe that WESH would have an effect, beyond that which is inherent to new construction in general, given that furnace fan operation is not part of the WESH consultant's protocol in working with builders and HVAC contractors.

One way for the future research efforts to assess possible WESH effects is to include interviews with owners of newly constructed, non-WESH homes, both with and without ECM furnaces. This efforts requires not only obtaining a list of newly constructed homes but also collecting furnace make and model number information from the homeowners through an on-site visit and then checking this information in GAMA manuals to determine if the furnace is an ECM furnace. The budget allocated for this evaluation research, however, was not sufficient to fund the extra cost for these tasks.

6.2.3 Sample Sizes

A limitation of the study was the small sample size of nonparticipant replacers. As discussed in Chapter 3, the 80 homeowners who comprised the sample for this group (resulting in 36 completed interviews) was obtained through the ECW Appliance Sales Tracking Study which identified homeowners who had purchased a new forced air furnace in the past year.

One way for the future research efforts to identify additional nonparticipant furnace replacers is through an extensive canvass survey. Based on a four percent replacement rate (from the ECW Appliance Sales Tracking Study), 100 replacers will be identified, on average, for every 2,500 canvass surveys conducted. Unfortunately, the budget allocated for this evaluation research was not sufficient to fund the extra cost to identify additional nonparticipant replacers.

6.2.4 Fan Operation Changes Over Time

Although the interviews conducted as part of this study provide a snapshot of furnace fan operation practices at a point in time, it is reasonable to expect that furnace fan operation practices in the market may change over time. We, therefore, recommend that any future ECM research address measuring market trends in fan operation methods to more fully understand the dynamics of changes in furnace fan operation methods over time and the underlying reasons for any changes that might be occurring.

6.2.5 Effect of Fan Operation on Furnace and CAC Use

This study did not formally address the effects of furnace fan operation methods on the run times of furnaces and CACs; however, as discussed earlier in this chapter, we know that many HVAC contractors that were interviewed believe that switching operation from auto mode to continuous mode will still decrease energy use and think that running the fan continuously increases comfort by providing more even temperatures in the house. This finding raises two issues regarding the effect of furnace fan operation on furnace and CAC use.

- First, to what extent does running the furnace fan continuously increase the comfort of homeowners, and if comfort is increased, does the improved comfort have any effects on how homeowners set their thermostats? In order for there to be less furnace and CAC use (i.e., a positive effect on savings), continuous fan operation would need to increase comfort and this increased comfort, in turn, would need to induce homeowners to decrease their thermostat setting during the heating season and/or increase their thermostat setting during the cooling season.

- Second, to what extent does running the furnace fan continuously provide more even temperature throughout the house, and if the temperature is more even, how does the more even temperature affect the frequency with which the thermostat calls for heating/cooling? In order for there to be less furnace and CAC use (i.e., positive effect on savings), continuous fan operation would need to provide more even temperature and this more even temperature, in turn, would need to cause the thermostat to be satisfied during a longer period of time throughout the day reducing the need to call for heating/cooling.

We, therefore, recommend that any future ECM research address these issues to more fully understand the effects of fan operation practices on furnace and CAC use.

6.2.6 Non-energy Benefits

The study identified a number of potential non-energy benefits from continuous fan operation. These include increased air circulation (comfort-related), more even temperature (comfort-related), and air filtration (health-related). The study, however, did not formally assess the extent to which these benefits accrued to homeowners. We, therefore, recommend that any future ECM research address this issue to ensure that the benefits from installing an ECM furnace are fully quantified.

APPENDIX A: IMPACT TABLES FOR WESH HOMES

Appendix A presents the step-by-step detailed tables of findings used to derive impacts for WESH homes. The impacts for WESH homes are derived similarly to those for existing homes, which are discussed in detail in Chapter 4. Please refer to this discussion for text explaining each of the steps.

A.1 STEP 1: OPERATION PRACTICES

Table A–1. Operation Practices

Season	Fan Operation Practice	WESH Homeowners with ECM Furnaces (n=60)		WESH Homeowners without ECM Furnaces (n=90)	
		Before[1]	After	Before[2]	After
Heating Season	Auto	80.0%	50.0%	83.3%	68.9%
	Continuous	13.3%	33.3%	12.2%	21.1%
	Sporadic	6.7%	16.7%	4.4%	10.0%
Cooling Season	Auto	73.3%	53.3%	68.9%	61.1%
	Continuous	18.3%	31.7%	21.1%	28.9%
	Sporadic	8.3%	15.0%	10.0%	10.0%
Shoulder Periods	Auto	85.0%	68.3%	82.2%	75.6%
	Continuous	8.3%	18.3%	7.8%	13.3%
	Sporadic	6.7%	13.3%	10.0%	11.1%

[1] Previous to their WESH home, 8 of the 60 respondents (13.3%) either owned a home with no forced air furnace (FAF) or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] Previous to their WESH home, 34 of the 90 respondents (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

A.2 STEP 2: CHANGES IN PRACTICES

Table A–2. Changes in Practices

Season	Fan Operation Practice		WESH Homeowners with ECM Furnaces (n=60)	WESH Homeowners without ECM Furnaces (n=90)
	Before[1]	After		
Heating Season	Auto		48.3%	67.8%
	Continuous		13.3%	11.1%
	Auto	Continuous	18.3%	10.0%
	Sporadic		3.3%	4.4%
	Auto	Sporadic	13.3%	5.6%
	Other[2]		3.3%	1.1%
Cooling Season	Auto		51.7%	58.9%
	Continuous		16.7%	18.9%
	Auto	Continuous	11.7%	10.0%
	Sporadic		5.0%	10.0%
	Auto	Sporadic	10.0%	0.0%
	Other[2]		5.0%	2.2%
Shoulder Periods	Auto		66.7%	75.6%
	Continuous		8.3%	7.8%
	Auto	Continuous	10.0%	5.6%
	Sporadic		5.0%	10.0%
	Auto	Sporadic	8.3%	1.1%
	Other[2]		1.7%	0.0%

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

A.3 STEP 3: SAVINGS ESTIMATES FOR PRACTICES

Table A–3. Savings Estimates for Practices

Season	Fan Operation Practice		Savings Estimate for Type of Practice[2]
	Before[1]	After	
Heating Season	Auto		386
	Continuous		1,800
	Auto	Continuous	78
	Sporadic		526
	Auto	Sporadic	364
	Other[3]		246
Cooling Season	Auto		87 [-10]
	Continuous		895 [960]
	Auto	Continuous	-89 [-221]
	Sporadic		121 [25]
	Auto	Sporadic	75 [-22]
	Other[3]		445 [391]
Shoulder Periods	Auto		-8
	Continuous		760
	Auto	Continuous	-175
	Sporadic		8
	Auto	Sporadic	-20
	Other[3]		-5
Annual	Auto		465 [368]
	Continuous		3,455 [3,520]
	Auto	Continuous	-186 [-318]
	Sporadic		655 [559]
	Auto	Sporadic	419 [322]
	Other[3]		686 [632]

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] We present the savings estimates for those without CAC in parenthesis for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.

[3] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

A.4 STEP 4: SAVINGS ESTIMATES FOR PRACTICES

A.4.1 Scenario 1: Practices Before Installation as Baseline

Table A–4. Practices Before Installation as Baseline

Season	Fan Operation Practice		WESH Home-owners with ECM Furnaces (n=60)	Savings Estimate for Type of Practice[2]	Savings from Listed Practices[2]	Total Savings[2]
	Before[1]	After				
Heating Season	Auto		48.3%	386	187	515
	Continuous		13.3%	1,800	240	
	Auto	Continuous	18.3%	78	14	
	Sporadic		3.3%	526	18	
	Auto	Sporadic	13.3%	364	49	
	Other[3]		3.3%	246	8	
Cooling Season	Auto		51.7%	87 [-10]	45 [-5]	220 [148]
	Continuous		16.7%	895 [960]	149 [160]	
	Auto	Continuous	11.7%	-89 [-221]	-10 [-26]	
	Sporadic		5.0%	121 [25]	6 [1]	
	Auto	Sporadic	10.0%	75 [-22]	8 [-2]	
	Other[3]		5.0%	445 [391]	22 [20]	
Shoulder Periods	Auto		66.7%	-8	-5	39
	Continuous		8.3%	760	63	
	Auto	Continuous	10.0%	-175	-18	
	Sporadic		5.0%	8	0	
	Auto	Sporadic	8.3%	-20	-2	
	Other[3]		1.7%	-5	-0	
Annual	Auto			465 [368]	226 [176]	**774 [702]**
	Continuous			3,455 [3,520]	453 [463]	
	Auto	Continuous		-186 [-318]	-14 [-29]	
	Sporadic			655 [559]	24 [19]	
	Auto	Sporadic		419 [322]	54 [45]	
	Other[3]			686 [632]	30 [28]	

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] We present the savings estimates for those without CAC in parenthesis for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.

[3] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

A.4.2 Scenario 2: Practices After Installation as Baseline

Table A–5. Practices After Installation as Baseline

Season	Fan Operation Practice		WESH Home-owners with ECM Furnaces (n=60)	Savings Estimate for Type of Practice[2]	Savings from Listed Practices[2]	Total Savings[2]
	Before[1]	After				
Heating Season	Auto		48.3%	386	187	876
	Continuous		13.3%	1,800	240	
	Auto	Continuous	18.3%	1,800	330	
	Sporadic		3.3%	526	18	
	Auto	Sporadic	13.3%	488	65	
	Other[3]		3.3%	1,093	36	
Cooling Season	Auto		51.7%	87 [-10]	45 [-5]	350 [304]
	Continuous		16.7%	895 [960]	149 [160]	
	Auto	Continuous	11.7%	895 [960]	104 [112]	
	Sporadic		5.0%	121 [25]	6 [1]	
	Auto	Sporadic	10.0%	142 [45]	14 [5]	
	Other[3]		5.0%	626 [637]	31 [32]	
Shoulder Periods	Auto		66.7%	-8	-5	138
	Continuous		8.3%	760	63	
	Auto	Continuous	10.0%	760	76	
	Sporadic		5.0%	8	0	
	Auto	Sporadic	8.3%	50	4	
	Other[3]		1.7%	-8	0	
Annual	Auto			465 [368]	226 [176]	**1,364 [1,318]**
	Continuous			3,455 [3,520]	453 [463]	
	Auto	Continuous		3,455 [3,520]	510 [518]	
	Sporadic			655 [559]	24 [19]	
	Auto	Sporadic		680 [583]	83 [74]	
	Other[3]			1,711 [1,722]	68 [68]	

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.
[2] We present the savings estimates for those without CAC in parenthesis for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.
[3] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

A.4.3 Scenario 3: Control Group as Baseline

Table A–6. Control Group as Baseline

Season	Fan Operation Practice		WESH Home-owners with ECM Furnaces (n=60)	Savings Estimate for Type of Practice[2]	Savings from Listed Practices[2]	Total Savings[2]
	Before[1]	After				
Heating Season	Auto		48.3%	386	187	702
	Continuous		13.3%	1,800	240	
	Auto	Continuous	9.6%	1,800	173	
	Auto	Continuous	8.7%	78	7	
	Sporadic		3.3%	526	18	
	Auto	Sporadic	5.3%	488	26	
	Auto	Sporadic	8.0%	364	29	
	Other[3]		3.3%	684	23	
Cooling Season	Auto		51.7%	87 [-10]	45 [-5]	332 [284]
	Continuous		16.7%	895 [960]	149 [160]	
	Auto	Continuous	10.6%	895 [960]	95 [102]	
	Auto	Continuous	1.0%	-89 [-221]	-1 [-2]	
	Sporadic		5.0%	121 [25]	6 [1]	
	Auto	Sporadic	0.0%	142 [45]	0 [0]	
	Auto	Sporadic	10.0%	75 [-22]	8 [-2]	
	Other[3]		5.0%	601 [605]	30 [30]	
Shoulder Periods	Auto		66.7%	-8	-5	94
	Continuous		8.3%	760	63	
	Auto	Continuous	5.7%	760	44	
	Auto	Continuous	4.3%	-175	-7	
	Sporadic		5.0%	8	0	
	Auto	Sporadic	1.1%	50	1	
	Auto	Sporadic	7.2%	-20	-1	
	Other[3]		1.7%	-7	0	
Annual	Auto			465 [368]	226 [176]	**1,127 [1,079]**
	Continuous			3,455 [3,520]	453 [463]	
	Auto	Continuous		3,455 [3,520]	312 [319]	
	Auto	Continuous		-186 [-318]	-2 [-3]	
	Sporadic			655 [1,054]	24 [19]	
	Auto	Sporadic		680 [1,019]	27 [27]	
	Auto	Sporadic		419 [228]	35 [25]	
	Other[3]			1,279 [1,005]	53 [53]	

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

[2] We present the savings estimates for those without CAC in parenthesis for the cooling season and annual estimates because savings in the cooling season depend on whether or not a homeowner has a CAC.

[3] The "other" category includes changes from sporadic to continuous, sporadic to auto, continuous to sporadic, and continuous to auto.

A.5 STEP 5: OVERALL IMPACT ESTIMATES

Table A–7. Overall Impact Estimates for WESH Homes by Baseline Scenario

CAC Ownership	Percent of WESH Homeowners (n=150)	Savings Estimate		
		Practices Before as Baseline[1]	Practices After as Baseline	Control Group as Baseline
CAC	97.4%	774	1,364	1,127
No CAC	2.6%	702	1,318	1,079
Savings Weighted by CAC Ownership		**772**	**1,363**	**1,126**

[1] Previous to their WESH home, 8 of the 60 WESH homeowners with ECM furnaces (13.3%) and 34 of the 90 WESH homeowners without ECM furnaces (37.8%) either owned a home with no FAF or did not own a home. Furnace fan operation for these respondents previous to their WESH home, therefore, is assumed to be the same as that used in the WESH home.

APPENDIX B: IMPACT ESTIMATE ASSUMPTIONS

As mentioned in the body of the report, this study was designed to complement a previous field study funded by the residential program administrator, Wisconsin Energy Conservation Corporation (WECC). The field study addressed the operational characteristics of new furnaces with and without electronically commutated motors (ECMs) to derive technology-based savings estimates for ECM furnaces.[28] The purpose of this study is to examine the behavioral aspects of ECM furnace fan operation and apply these behavioral results to the previously established technology-based savings estimates from the field study; thereby providing a more complete picture of the savings that derive from installing ECM furnaces in Wisconsin homes.

Appendix B presents the key inputs from the field study research that are incorporated in this study to derive technology-based impacts, independent of behavioral effects, for ECM furnaces.

B.1 TECHNOLOGY-BASED ESTIMATES

B.1.1 Hours of Fan Operation

The field study estimated hours of furnace fan operation by three periods within the year.

1. *Heating season* is the time of the year when temperatures are cold enough that homeowners need to run their furnaces to heat their homes.

2. *Cooling season* is the time of the year when temperatures are warm enough that homeowners decide to run their central air conditioners (CACs) to cool their homes.

3. *Shoulder periods* are the times of the year, particularly spring and fall, when homeowners are not running their furnaces to heat their homes and not running their CACs to cool their homes.

Within each of the above three periods, the field study further differentiated hours by four furnace operation types.

1. The *furnace* operation type is when the fan is running when the furnace is running. This occurs only during the heating season.

2. The *CAC* operation type is when the fan is running when the CAC is running. This occurs only during the cooling season.

3. *Standby* is when the fan is not running at all. From the perspective of thermostat operation, this occurs when the fan switch is set to “auto” and the furnace/CAC is not running.

[28] Wisconsin Department of Administration (DOA). 2003. *Electricity Use by New Furnaces: A Wisconsin Field Study*. Technical Report 230-1. Madison, Wisconsin: Wisconsin Department of Administration.

4. *Fan only* is when the fan is running independent of the furnace or CAC running. From the perspective of thermostat operation, this occurs when the fan switch is set to "on" and the furnace/CAC is not running

In this study, we classify furnace fan operation into three categories.

1. *Auto mode operation* is when the furnace fan operates only when the furnace or CAC is operating. From the perspective of thermostat operation, this entails leaving the fan switch set to "auto" all of the time during the period in question.

2. *Continuous operation* is when the furnace fan is always operating during the period in question, regardless of whether or not the furnace or CAC is operating. From the perspective of thermostat operation, this entails leaving the fan switch set to "on" all of the time during the period in question.

3. *Sporadic operation* is when the furnace fan is operated independent of furnace and CAC operation at various times during the period in question, but not all of the time during the period in question. From the perspective of thermostat operation, this entails setting the fan switch to "auto" some of the time and to "on" some of the time during the period in question.

Each of the above three categories used in this study relates directly to the four furnace operation types defined in the field study. Specifically, *auto mode operation* during an entire period results in 0 *fan only* hours and, depending on the period and the presence of a CAC, a significant number of *standby* hours during that period. *Continuous mode operation* during an entire period, on the other hand, results in 0 *standby* hours and, depending on the period and the presence of a CAC, a significant number of *fan only* hours during that period.

Table B–1 presents the field study estimates of fan operation hours for *auto* and *continuous* modes of operation within each of the three periods across each of the four furnace operation types. As the table illustrates, the field study assumes that the heating season has a total of 4,500 hours, the cooling season has 2,400 hours, and the shoulder periods have 1,900 hours. The allocation of these hours is discussed below.

- The field study assumes that the 4,500 hours within the heating season are allocated for *auto mode operation* as 1,000 *furnace* hours, 0 *CAC* hours, 3,500 *standby* hours, and 0 *fan only* hours and for *continuous mode operation* as 1,000 *furnace* hours, 0 *CAC* hours, 0 *standby* hours, and 3,500 *fan only* hours, regardless of the presence of a CAC.

- The field study assumes that the 2,400 hours within the cooling season are allocated for *auto mode operation* as 0 *furnace* hours, 400 *CAC* hours (or 0 *CAC* hours if no CAC), 2,000 *standby* hours (or 2,400 *standby* hours if no CAC), and 0 *fan only* hours and for *continuous mode operation* as 0 *furnace* hours, 400 *CAC* hours (or 0 *CAC* hours if no CAC), 0 *standby* hours, and 2,000 *fan only* hours (or 2,400 *fan only* hours if no CAC).

- The field study assumes that the 1,900 hours within the shoulder periods are allocated for *auto mode operation* as 0 *furnace* hours, 0 *CAC* hours, 1,900 *standby* hours, and 0 *fan only* hours and for *continuous mode operation* as 0 *furnace* hours, 0 *CAC* hours, 0 *standby* hours, and 1,900 *fan only* hours, regardless of the presence of a CAC.

Table B–1. Hours of Fan Operation

Season	Type of Operation	Total Hours	Auto Mode Operation		Continuous Mode Operation	
			CAC	No CAC	CAC	No CAC
Heating Season	Furnace	4,500	1,000		1,000	
	CAC		0		0	
	Standby		3,500		0	
	Fan Only		0		3,500	
Cooling Season	Furnace	2,400	0		0	
	CAC		400	0	400	0
	Standby		2,000	2,400	0	
	Fan Only		0		2,000	2,400
Shoulder Periods	Furnace	1,900	0		0	
	CAC		0		0	
	Standby		1,900		0	
	Fan Only		0		1,900	

B.1.2 Energy Savings

The field study estimated the energy consumption of the typical non-ECM and ECM furnace fan for the *furnace* and *CAC* operation types, and based on these estimates, calculated energy savings for these two types of furnace fan operation (Table B–2). Over the course of the average heating season, the field study found that the typical non-ECM and ECM furnace fan consumes about 800 and 400 kWh of electricity, respectively, resulting in savings of 400 kWh for the *furnace* operation type. Over the course of the average cooling season, the field study found that the typical non-ECM and ECM furnace fan consumes about 250 and 155 kWh of electricity, respectively, resulting in savings of 95 kWh for the *CAC* operation type.

Table B–2. Energy Savings for *Furnace* and *CAC* Operation Types

Type of Operation	Type of Furnace		kWh Savings
	Non-ECM	ECM	
Furnace	800	400	400
CAC	250	155	95

The savings estimates for the *furnace* and *CAC* operation types are independent of the homeowner's furnace fan operation behavior. Savings for the *standby* and *fan only* types of operation, on the other hand, depend entirely on how the homeowner operates the fan. Therefore, to estimate kWh savings for the *standby* and *fan only* types of operation, we need to apply the hours of operation, which are dependent upon homeowner furnace fan practices, to the associated connected load for each type.

The field study estimated the connected loads of the typical non-ECM and ECM furnace fan for the *standby* and *fan only* operation types (Table B–3). As the table illustrates, the field study found that the typical non-ECM and ECM furnace fan draws about 8 and 12 W of electricity, respectively, resulting in savings of -4 W for the *standby* operation type. For the *fan only* operation type, the field study found that the typical non-ECM and ECM furnace fan draws about 500 and 100W of electricity, respectively, resulting in savings of 400 W.

Table B–3. *Standby* and *Fan Only* Connected Loads (in Watts)

Type of Operation	Type of Furnace		Difference
	Non-ECM	ECM	
Standby	8	12	-4
Fan Only	500	100	400

B.2 BEHAVIORAL-BASED IMPACTS

The impact estimates used in this study are the result of incorporating the technology-based results from Tables B–1 through B–3 to derive behavioral-based savings estimates. Tables B–4 through B–6 show results for three types of behavior: (1) auto mode operation both before and after the installation of the ECM furnace, (2) continuous mode operation both before and after the installation of the ECM furnace, and (3) auto mode operation before the installation of the ECM furnace and continuous mode operation after the installation.

B.2.1 Auto Mode–Before and After

As Table B–4 illustrates, auto mode operation both before and after the installation of the ECM furnace results in overall savings of 465 kWh with a CAC and 368 kWh without a CAC. The overall savings are the result of adding the savings across the heating season (386 kWh, regardless of CAC), the cooling season (87 kWh with a CAC and -10 kWh without a CAC) and the shoulder periods (-8 kWh, regardless of CAC). Savings for each of the three periods, in turn, are the result of adding the savings across the four furnace fan operation types. Finally, savings for each of the four furnace fan operation types within each season are the result of incorporating the technology-based results from Tables B–1 through B–3. The estimates for the *furnace* operation type within the heating season and the *CAC* operation type within the cooling season are those presented in Table B–2. The *standby* and *fan only* estimates are derived by applying the hours of operation from Table B–1 to the associated connected load from Table B–3. During the heating season, for example, the *standby* energy consumption of a non-ECM and ECM furnace fan is 28 kWh (3,500 hours x 8 W) and 42 kWh (3,500 hours x 12 W), respectively, resulting in energy savings of -14 kWh (28 kWh–42 kWh).

The *fan only* energy consumption of a non-ECM and ECM furnace fan is 0 kWh (0 hours x 500 W) and 0 kWh (0 hours x 100 W), respectively, resulting in energy savings of 0 kWh.

Table B–4. Savings–Auto Mode Before and After

Season	Type of Operation	CAC			No CAC		
		Non-ECM	ECM	Savings	Non-ECM	ECM	Savings
Heating Season	Furnace	800	400	400	800	400	400
	CAC	0	0	0	0	0	0
	Standby	28	42	-14	28	42	-14
	Fan Only	0	0	0	0	0	0
	Total	828	443	386	828	443	386
Cooling Season	Furnace	0	0	0	0	0	0
	CAC	250	155	95	0	0	0
	Standby	16	24	-8	19	29	-10
	Fan Only	0	0	0	0	0	0
	Total	266	179	87	19	29	-10
Shoulder Periods	Furnace	0	0	0	0	0	0
	CAC	0	0	0	0	0	0
	Standby	15	23	-8	15	23	-8
	Fan Only	0	0	0	0	0	0
	Total	15	23	-8	15	23	-8
Total		**1,110**	**645**	**465**	**863**	**495**	**368**

B.2.2 Continuous Mode–Before and After

As Table B–5 illustrates, continuous mode operation both before and after the installation of the ECM furnace results in overall savings of 3,455 kWh with a CAC and 3,520 kWh without a CAC. The overall savings are the result of adding the savings across the heating season (1,800 kWh, regardless of CAC), the cooling season (895 kWh with a CAC and 960 kWh without a CAC) and the shoulder periods (760 kWh, regardless of CAC). Savings for each of the three periods, in turn, are the result of adding the savings across the four furnace fan operation types. Finally, savings for each of the four furnace fan operation types within each season are the result of incorporating the technology-based results from Tables B–1 through B–3. The estimates for the *furnace* operation type within the heating season and the *CAC* operation type within the cooling season are those presented in Table B–2. The *standby* and *fan only* estimates are derived by applying the hours of operation from Table B–1 to the associated connected load from Table B–3. During the heating season, for example, the *standby* energy consumption of a non-ECM and ECM furnace fan is 0 kWh (0 hours x 8 W)

and 0 kWh (0 hours x 12 W), respectively, resulting in energy savings of 0 kWh. The *fan only* energy consumption of a non-ECM and ECM furnace fan is 1,750 kWh (3,500 hours x 500 W) and 350 kWh (3,500 hours x 100 W), respectively, resulting in energy savings of 1,400 kWh (1,750 kWh–350 kWh).

Table B–5. Savings–Continuous Mode Operation Before and After

Season	Type of Operation	CAC			No CAC		
		Non-ECM	ECM	Savings	Non-ECM	ECM	Savings
Heating Season	Furnace	800	400	400	800	400	400
	CAC	0	0	0	0	0	0
	Standby	0	0	0	0	0	0
	Fan Only	1,750	350	1,400	1,750	350	1,400
	Total	2,550	750	1,800	2,550	750	1,800
Cooling Season	Furnace	0	0	0	0	0	0
	CAC	250	155	95	0	0	0
	Standby	0	0	0	0	0	0
	Fan Only	1,000	200	800	1,200	240	960
	Total	1,250	355	895	1,200	240	960
Shoulder Periods	Furnace	0	0	0	0	0	0
	CAC	0	0	0	0	0	0
	Standby	0	0	0	0	0	0
	Fan Only	950	190	760	950	190	760
	Total	950	190	760	950	190	760
Total		**4,750**	**1,295**	**3,455**	**4,700**	**1,180**	**3,520**

B.2.3 Auto Mode Before and Continuous Mode After

As Table B–6 illustrates, auto mode operation before the installation of the ECM furnace and continuous mode operation after the installation results in overall savings of -185 kWh with a CAC and -317 kWh without a CAC. The overall savings are the result of adding the savings across the heating season (78 kWh, regardless of CAC), the cooling season (-89 kWh with a CAC and -221 kWh without a CAC) and the shoulder periods (-175 kWh, regardless of CAC). Savings for each of the three periods, in turn, are the result of adding the savings across the four furnace fan operation types. Finally, savings for each of the four furnace fan operation types within each season are the result of incorporating the technology-based results from Tables B–1 through B–3. The estimates for the *furnace* operation type within the heating season and the *CAC* operation type within the cooling season are those presented in Table B–2. The *standby* and *fan only* estimates are derived by applying the hours of operation from

Table B–1 to the associated connected load from Table B–3. During the heating season, for example, the *standby* energy consumption of a non-ECM and ECM furnace fan is 28 kWh (3,500 hours x 8 W) and 0 kWh (0 hours x 12 W), respectively, resulting in energy savings of -28 kWh (28 kWh–0 kWh). The *fan only* energy consumption of a non-ECM and ECM furnace fan is 0 kWh (0 hours x 500 W) and 350 kWh (3,500 hours x 100 W), respectively, resulting in energy savings of -350 kWh (0 kWh–350 kWh).

Table B–6. Savings–Auto Mode Before and Continuous Mode After

Season	Type of Operation	CAC			No CAC		
		Non-ECM	ECM	Savings	Non-ECM	ECM	Savings
Heating Season	Furnace	800	400	400	800	400	400
	CAC	0	0	0	0	0	0
	Standby	28	0	28	28	0	28
	Fan Only	0	350	-350	0	350	-350
	Total	828	750	78	828	750	78
Cooling Season	Furnace	0	0	0	0	0	0
	CAC	250	155	95	0	0	0
	Standby	16	0	16	19	0	19
	Fan Only	0	200	-200	0	240	-240
	Total	266	355	-89	19	240	-221
Shoulder Periods	Furnace	0	0	0	0	0	0
	CAC	0	0	0	0	0	0
	Standby	15	0	15	15	0	15
	Fan Only	0	190	-190	0	190	-190
	Total	15	190	-175	15	190	-175
Total		**1,110**	**1,295**	**-185**	**863**	**1,180**	**-317**

APPENDIX C: HPWES PARTICIPANT INTERVIEW RESULTS–DETAILS

Appendix C provides detailed results from interviews with HPWES participants who installed an ECM furnace that support the analysis in the report.

Table C–1. Furnace Fan Operation Method during Heating Season

Operation Method	Percent of Respondents (n=150)	
	After Installation of ECM Furnace	Before Installation of ECM Furnace
Auto	60.7%	86.0%
Continuous	33.3%	9.3%
Sporadic	6.0%	4.7%

Table C–2. Furnace Fan Operation Method during Heating Season before and after Installation of ECM Furnace

Operation Method		Percent of Respondents (n=150)
Before Installation of ECM Furnace	After Installation of ECM Furnace	
Auto		60.0%
Auto	Continuous	22.7%
Continuous		8.7%
Auto	Sporadic	3.3%
Sporadic		2.7%
Sporadic	Continuous	2.0%
Continuous	Auto	0.7%

Table C–3. Reasons for Changing Operation Method during Heating Season after Installation of ECM Furnace

Reasons
Changed from Auto to Continuous (n=34)
Based on advice from contractor *(Contractor advice: No specific reason)*
Because it is a variable speed unit. Cost of operating it all the time is very low. Doesn't cost much to run all the time and it distributes the heat/cooling very evenly. Only costs about $20 per month *(Lower cost/Even temperature)*
The contractor said that one of the benefits of the new furnace was that it could be run all of the time to keep air moving and provide more even temperature *(Contractor advice: Air circulation/Even temperature)*
Contractor recommended that run the fan all the time. It keeps the heat more even throughout the house causing the furnace to run less often. More efficient this way *(Contractor advice: Even temperature/More efficient way)*
Contractor said that it is more efficient to always run the fan during the times when using furnace *(Contractor advice: More efficient way)*
Contractor said that it is much better to run it all of the time during the heating season *(Contractor advice: Better way)*

Reasons
Contractor said this was the most efficient way to operate it *(Contractor advice: More efficient way)*
Contractor said to operate it all the time throughout the year because it was better and would not use more energy *(Contractor advice: Better way/Low energy use)*
Contractor said to run it all the time *(Contractor advice: No specific reason)*
Contractor said to run it all the time when heating *(Contractor advice: No specific reason)*
Contractor said to run the fan continuously during the winter *(Contractor advice: No specific reason)*
Had a SpaceGuard Aprilaire filter (it is big and pleated) installed with the new furnace. It is understanding that running the fan all of the time helps with filtration and creates healthier air quality. It also gets the air circulating through the house. Was told that it only costs $30/year to run the fan on the new furnace all of the time compared to $30/month on old furnace *(Air filtration/Air circulation /Low cost)*
Has a breathing problem and had an air purifier attached to new furnace to remove pollen and dust from the air *(Air filtration)*
Have an air purifier and humidifier attached. The contractor initially set it this way and said to leave it set this way all year long *(Contractor advice: Air filtration)*
Initially ran fan on new furnace in auto mode (same as old furnace); except when the new furnace kicked in the fan blew such that it caused duct work to rattle and make noise (said that this did not happen with old furnace). Called contractor and was told to run the fan all of the time to always keep air moving through the ducts to limit the rattle. Was told that this would also help moderate the temperature. Has found that this has worked so far *(Contractor advice: Even temperature)*
Installed an electronic filtering system with the new furnace. The contractor said that it was best to run the fan all of the time to remove allergens from air *(Contractor advice: Air filtration)*
New furnace has a high efficiency fan *(High efficiency fan)*
It keeps the temperature more even between the upstairs and downstairs and contractor said that the fan was efficient. Thinks the house is far more comfortable since made the change *(Contractor advice: Even temperature /More efficient way)*
Contractor suggested to run the new furnace all the time *(Contractor advice: No specific reason)*
It's better for the furnace and for the air circulation to keep it running *(Better way/Air circulation)*
Keeps the temperature more even throughout the house. It only cost a couple of dollars more a year to leave it on. Also have less dust in the house because the air is constantly filtered *(Even temperature/Low cost/Air filtration)*
Now have more of an understanding of what the furnace can do. Contractor explained how the furnace can work and that it's more energy efficient *(Contractor advice: Energy efficient)*
Recommended by contractor to help keep heat circulated in the house *(Contractor advice: Air circulation)*
Runs the fan all the time to keep even temperatures throughout the house and keep the air fresh *(Even temperature/Air circulation)*
The contractor said to run it continuously 24/7/365 *(Contractor advice: No specific reason)*
The contractor said to run the fan continuously *(Contractor advice: No specific reason)*
The furnace has a AC/DC motor. Fan only costs pennies a day to run compared to the old one. Saving a lot of money by running it constantly *(Low cost)*

Reasons
Thinks that (1) the efficiency level of multi-speed blowers is higher when run continually rather than intermittently, (2) operating this way is less hard on the blower motor and (3) it reduces variations in room-to-room temperatures. This is based on own research and what has heard from others, including co-workers at an A&E firm. Has found that uses less energy and has more even room temperatures in the last year with the new furnace *(More efficient/Even temperature)*
To improve comfort by keeping more even heat throughout the house. The old fan was more costly to run *(Even temperature/low cost)*
Was told by the contractor to operate the fan all of the time because it was better to keep the air moving to keep the air temp even throughout the house *(Contractor advice: Air circulation/Even temperature)*
Was told to leave it on all the time as it would circulate the air throughout the house better. House is a quad level so running it all the time keeps the temperature more even and the furnace does not run as often because the heat is more evenly distributed *(Contractor advice: Air circulation/Even temperature/More efficient)*
Was told to run it all the time by dealer. Dealer said it would distribute the heat more evenly and give better comfort *(Contractor advice: Even temperature)*
When the fan is on continuously it doesn't get chilly between the heat kicking on and off. Circulates the air better *(Air circulation)*
Don't know
Changed from Auto to Sporadic (n=5)
To circulate air throughout the house, especially when the house is too warm in areas. There was never enough heat in the house with the old system to have to turn the fan on *(Air circulation)*
Thinks that will use less energy if runs the fan all of the time during the coldest periods when the furnace is operating most often *(Less energy use)*
To circulate air throughout the house when the basement (where the furnace is located) is warm. Feels more comfortable turning the new fan on because it has multiple speeds and is efficient *(Air circulation/More efficient)*
Have a fireplace and occasionally run the fan to circulate the warm air from the fireplace throughout the house when the house gets heated up. Do this on the new furnace, but not the old, because were told that the new fan is more efficient *(Air circulation/More efficient)*
To move air around the house if it seems cold in one part of the house. Seems to keep the house warmer by moving warm air from one part of the house to another. The old fan was too gusty to turn on *(Air circulation)*
Changed from Sporadic to Continuous (n=3)
It is the manufacturer's recommendation to run the fan all of the time when heating. Also read some homeowner tips in a magazine or newspaper article that said it was best to run the fan all of the time when heating *(Better way)*
Provides more uniform temperatures throughout the house *(Even temperature)*
To circulate the air better and to keep a more constant temperature. Vents are up high on the wall and running the fan all of the time helps keep the air circulated. Has noticed that house is less dusty and at a more constant temperature because of this *(Air circulation/Even temperature/Filtration)*

Reasons
Changed from Continuous to Auto (n=1)
Needed to run the old furnace fan all the time in order to keep the temperature throughout the house even. Don't need to do that with the new furnace fan *(Even temperature)*

Table C–4. Reasons for Using Continuous/Sporadic Operation Method during Heating Season BOTH before and after Installation of ECM Furnace

Reasons
Continuous Before and After (n=13)
Always run it because it keeps the air circulating in the house *(Air circulation)*
Bought the home and put the new furnace in (and a new CAC as the home didn't have CAC before) before moved in. Operate the fan continuously all year long because daughter has really bad asthma. The doctor said to get an air purifier system and a UV purifier system. Bought both (at a cost of $10K) and had it installed before moved in. Was pretty clear that, even if had not moved, would have made this change *(Air filtration)*
Employee of the HVAC company that installed new furnace and knows that supposed to run the new fans all the time *(Best way)*
Has dogs and the house really stinks if not run the fan continuously. Thinks running the fan continuously keeps the air fresh and the temperature consistent. Also likes the fact that does not hear the furnace coming on and off. Said this new furnace is perfect because has always run the fan continuously *(Air circulation/Even temperature)*
Have a finished basement with only a few heat ducts and have dehumidifier in the basement. Running the fan continually keeps the temperature more even throughout the house and ensures that enough air circulates in basement *(Air circulation/Even temperature)*
Have a two story house and have always found it difficult to circulate the air *(Air circulation)*
It seems like it keeps a much more even temperature throughout the house *(Even temperature)*
It seems to heat the house more evenly, especially a south facing room that gets hot if the fan is not circulating air *(Even temperature)*
Keeps the air temperature throughout the house more even *(Even temperature)*
Thinks it is more comfortable to have it running all the time, especially since home all the time *(More comfortable)*
To circulate air in the house. Is a smoker and has an air cleaner. Had an air cleaner on the old furnace also *(Air circulation/Air filtration)*
To keep good air exchange *(Air circulation)*
Try to keep the air circulating through the house. Have found that the heat clicks on less often if leave the fan running and the air temperature is more even throughout the house *(Air circulation/Even temperature/Less energy use)*
Sporadic Before and After (n=4)
To circulate air throughout the house if there are a lot of people in the house or the oven has been on a lot *(Air circulation)*
When the outside temperature is moderate, sets the fan to auto mode, but when it gets extremely cold runs the fan all of the time *(Comfort)*
Have two furnaces; a new one and an old one. New furnace was installed to heat an addition that includes a salon. Old one heats the original part of the home. Occasionally, the salon gets too hot from the lights so the fan is operated to circulate air. Used to do this on the old furnace also when using wood stove *(Air circulation)*
Runs the fan when everyone is in the family room because it gets warm and need to circulate the air. Also have had some problems with condensation on windows, and runs the fan when this happens *(Air circulation)*

Table C–5. Heating Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	0	Sporadic	4	1 to 2 days per month	Half an hour per day	1.5 days/month x 6 months x 0.5 hours/day x 78% furnace cycling adjustment factor
Auto	0	Sporadic	14	2 days per month	1 to 2 hours	2 days/month x 6 months x 1.5 hours/day x 78% furnace cycling adjustment factor
Auto	0	Sporadic	63	3 days per month	3 to 4 hours per day	3 days/month x 6 months x 3.5 hours/day
Auto	0	Sporadic	864	1–2 days per week	All day	1.5 days/week x 4 weeks/month x 6 months x 24 hours/day
Auto	0	Sporadic	936	All of January, half of February, and half of March	24 hours/day	50 days x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	47	Sporadic	47	1 day per month	10 hours per day	1 day/month x 6 months x 10 hours/day x 78% furnace cycling adjustment factor
Sporadic	878	Sporadic	878	It's really hard to say because each situation varies	When running the fan continuously because of the window condensation, it's running 24 hours per day, otherwise, it's sporadic	25% x 4,500 hours x 78% furnace cycling adjustment factor
Sporadic	1,348	Sporadic	1,348	12 days per month	24 hours per day	12 days/month x 6 months x 24 hours/day x 78% furnace cycling adjustment factor

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Sporadic	1,684	Sporadic	1,684	Runs continuously all day, every day during January, February, and March	24 hours per day	90 days x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	35	Continuous	0	10 days per month	4–5 hours per day	10 days x 4.5 hours/day x 78% furnace cycling adjustment factor
Sporadic	75	Continuous	0	Here and there throughout the year	Couple of hours per day	8 days/month x 6 months x 2 hours/day x 78% furnace cycling adjustment factor
Sporadic	94	Continuous	0	10 times per year equally in the summer and winter	All day	5 days x 24 hours/day x 78% furnace cycling adjustment factor

Table C–6. Central Air Conditioner Ownership

Owned Central Air Conditioner	Percent of Respondents (n=150)	
	After Installation of ECM Furnace	Before Installation of ECM Furnace
Yes	92.0%	76.0%
No	8.0%	24.0%

Table C–7. Furnace Fan Operation Method during Cooling Season

Operation Method	Percent of Respondents (n=150)	
	After Installation of ECM Furnace	Before Installation of ECM Furnace
Auto	54.0%	72.7%
Continuous	35.3%	14.7%
Sporadic	10.7%	12.7%

Table C–8. Changes in Furnace Fan Operation Method during Cooling Season after Installation of ECM Furnace

Operation Method		Percent of Respondents (n=150)
Before Installation of ECM Furnace	After Installation of ECM Furnace	
Auto		53.3%
Auto	Continuous	18.7%
Continuous		14.0%
Sporadic		10.0%
Sporadic	Continuous	2.7%
Auto	Sporadic	0.7%
Continuous	Auto	0.7%

Table C–9. Reasons for Changing Operation Method during Cooling Season after Installation of ECM Furnace

Reasons
Changed from Auto to Continuous (n=28)
Contractor said that it is more efficient to always run the fan during the times when using furnace *(Contractor advice: More efficient)*
Contractor said that it is not expensive and does not use a lot of energy to run fan all of the time when cooling home *(Contractor advice: Low cost/Low energy use)*
Contractor said this was the most efficient way to operate it *(Contractor advice: More efficient way)*
Contractor said to operate it all the time throughout the year because it was better and would not use more energy *(Contractor advice: Better way/Low energy use)*
Contractor said to run it all the time *(Contractor advice: No specific reason)*
Contractor said to run it all the time in the summer because it would circulate the air better *(Contractor advice: Air circulation)*
Had a SpaceGuard Aprilaire filter (it is big and pleated) installed with the new furnace. It is understanding that running the fan all of the time helps with filtration and creates healthier air quality. It also gets the air circulating through the house. Was told that it only costs $30/year to run the fan on the new furnace all of the time compared to $30/month on old furnace *(Air filtration/Air circulation/Low cost)*
Has a breathing problem and had an air purifier attached to new furnace to remove pollen and dust from the air *(Air filtration)*
Have an air purifier and humidifier attached. The contractor initially set it this way and said to leave it set this way all year long *(Contractor advice: Air filtration)*
House was built in 1910 and is a two story. Contractor said the best way to get the cool air upstairs to the top floors is to run the fan all the time when using CAC *(Contractor advice: Air circulation)*
Installed an electronic filtering system with the new furnace. The contractor said that it was best to run the fan all of the time to remove allergens from air *(Contractor advice: Air filtration)*
It keeps the temperature more even between the upstairs and downstairs and contractor said that the fan was efficient. Thinks the house is far more comfortable since made the change *(Even temperature/More efficient)*

Reasons
It's better for the furnace and for the air circulation to keep it running *(Air circulation)*
Keeps the temperature more even throughout the house. It only cost a couple of dollars more a year to leave it on. Also have less dust in the house because the air is constantly filtered *(Even temperature/Low cost/Air filtration)*
Now have more of an understanding of what the furnace can do. Contractor explained how the furnace can work and that it's more energy efficient *(Contractor advice: Energy efficient)*
Recommended by contractor to help keep heat circulated in the house *(Contractor advice: Air circulation)*
Runs the fan all the time to keep even temperatures throughout the house and keep the air fresh *(Even temperature/Air circulation)*
The contractor said to run it continuously 24/7/365 *(Contractor advice; No specific reason)*
The contractor said to run the fan continuously *(Contractor advice; No specific reason)*
The furnace has a AC/DC motor. Fan only costs pennies a day to run compared to the old one. Saving a lot of money by running it constantly *(Low cost)*
The new furnace has the ability to run at lower speeds to keep the air moving. Likes to keep the air moving during the times when running CAC. Uses CAC very little *(Air circulation)*
Thinks it is more comfortable to have it running all the time, especially since home all the time *(Increase comfort)*
Thinks that (1) the efficiency level of multi-speed blowers is higher when run continually rather than intermittently, (2) operating this way is less hard on the blower motor and (3) it reduces variations in room-to-room temperatures. This is based on own research and what has heard from others, including co-workers at an A&E firm. Has found that uses less energy and has more even room temperatures in the last year with the new furnace *(More efficient/Even temperature)*
To improve comfort by keeping more even temperature throughout the house. The old fan was more costly to run *(Even temperature)*
Was told to run it all the time by dealer. Dealer said it would distribute the heat more evenly and give better comfort *(Contractor advice: Even temperature/Better comfort)*
Were told to leave it on all the time as it would circulate the air throughout the house better. House is a quad level so running it all the time keeps the temperature more even and the furnace does not run as often because the heat is more evenly distributed *(Contractor advice: Air circulation/Even temperature/More efficient)*
When the fan is on continuously the temperature does not fluctuate as much between the CAC kicking in and out Circulates the air better *(Even temperature/Air circulation)*
Don't know
Changed from Sporadic to Continuous (n=3)
Contractor recommended it, plus for air filtration *(Contractor advice: Air filtration)*
Provides more uniform temperatures throughout the house *(Even temperature)*
To circulate the air better and to keep a more constant temperature. Vents are up high on the wall and running the fan all of the time helps keep the air circulated. Has noticed that house is less dusty and at a more constant temperature because of this *(Air circulation/Even temperature/ Air filtration)*
Changed from Auto to Sporadic (n=1)
Because it is a variable speed unit. Cost of operating it all the time is very low. Doesn't cost much to run all the time and it distributes the heat/cooling very evenly. Only costs about $20 per month *(Low cost/Even temperature)*

Reasons
Changed from Continuous to Auto (n=1)
Needed to run the old furnace fan all the time in order to keep the temperature throughout the house even. Don't need to do that with the new furnace fan *(Even temperature)*

Table C–10. Reasons for Using Continuous/Sporadic Operation Method during Cooling Season BOTH before and after Installation of ECM Furnace

Reasons
Continuous Before and After (n=21)
Always run it because it keeps the air circulating in the house *(Air circulation)*
Bought the home and put the new furnace in (and a new CAC as the home didn't have CAC before) before moved in. Operate the fan continuously all year long because daughter has really bad asthma. The doctor said to get an air purifier system and a UV purifier system. Bought both (at a cost of $10K) and had it installed before moved in. Was pretty clear that, even if had not moved, would have made this change *(Air filtration)*
Contractor said to run the fan all of the time when cooling because it was not cool enough on second floor. This recommendation came before the new system was installed *(Air circulation)*
Done in the past to cool air because of the heat pump *(No specific reason)*
Employee of the HVAC company that installed new furnace and know that supposed to run the new fans all the time *(No specific reason)*
Has dogs and the house really stinks if not run the fan continuously. Thinks running the fan continuously keeps the air fresh and the temperature consistent. Also likes the fact that does not hear the furnace coming on and off. Said this new furnace is perfect because has always run the fan continuously *(Air circulation/Even temperature)*
Have a finished basement with only a few heat ducts and have dehumidifier in the basement. Running the fan continually keeps the temperature more even throughout the house and ensures that enough air circulates in basement *(Even temperature/Air circulation)*
Have a two story house and have always found it difficult to circulate the air *(Air circulation)*
Helps to distribute the heat that collects in the upstairs bedrooms *(Air circulation)*
In the summer, the fan is running almost all the time to help circulate the cool air *(Air circulation)*
It seems like it keeps a much more even temperature throughout the house *(Even temperature)*
It seems to heat the house more evenly, especially a south facing room that gets hot if the fan is not circulating air *(Even temperature)*
It seems to work better this way. It seems to help keep the upstairs cooler *(Even temperature)*
Keeps the air temperature throughout the house more even *(Even temperature)*
Seems more comfortable when running it all the time during the summer *(More comfortable)*
The contractor said that one of the benefits of the new furnace was that it could be run all of the time to keep air moving and provide more even temperature *(Contractor advice: Air circulation/Even temperature)*
To circulate air in the house. Is a smoker and has an air cleaner. Had an air cleaner on the old furnace also *(Air circulation/Air filtration)*
To circulate air so there is consistently cool air throughout the house, otherwise some rooms get warmer than others *(Air circulation/Even temperature)*
To keep the air circulating and the temperature throughout the house more even *(Air circulation/Even temperature)*

Reasons
Wants to bring cooler air from downstairs to the upstairs *(Air circulation)*
Was told a long time ago that running the fan all of the time helps keep the temperature steady when cooling *(Even temperature)*
Sporadic Before and After (n=15)
Have several room air conditioners that are operated when it gets really hot. Will run the furnace fan continuously at times to circulate the air and keep entire house cooler *(Air circulation)*
When feels like there is a lot of humidity and the CAC might be icing up, runs the fan continually to de-ice it *(More efficient)*
When the CAC is turned off, but it is a little warmer outside, will run to circulate the air and increase comfort *(Air circulation/More comfort)*
To move the air around when it is particularly humid out, but the AC does not kick in *(Air circulation)*
On moderately warm days, when not running the air conditioner, but wants to move warmer, stale air *(Air circulation)*
To draw cool air from the basement to cool the house when it is not hot enough outside to kick in the AC, but warm in the house *(Air circulation)*
When it's borderline air conditioning weather and wants the house cooler, but don't want to run the AC *(Air circulation)*
On nights when it has been warm during the day but cooler at night, opens the windows and runs the fan continuously all night to bring cool air in from outside to cool down the house. When running CAC, the fan in auto mode *(Air circulation)*
When it is very, very hot *(No specific reason)*
To help remove humidity from the air when it is not very hot out, but there is a fair amount of humidity in the house *(Air circulation)*
Runs fan continuously at times rather than running the CAC to move the air around, usually when it is not quite hot enough to run the CAC *(Air circulation)*
To move cool air throughout the house if the house is warm and there is cool air in the basement *(Air circulation)*
On marginally hot and humid days to move damp moist air from the basement *(Air circulation)*
Runs fan continuously when the house is closed on hot and sticky days *(Air circulation)*
The basement is 8 degrees cooler than main floor so will run the fan sometimes to circulate cool air from basement throughout the house *(Air circulation)*

Table C–11. Cooling Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	896	Sporadic	896	15 days per month	24 hours per day	5 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	12	Sporadic	12	5–7 days in all	2 hours per day	6 days x 2 hours/day
Sporadic	30	Sporadic	30	1 day per month	12 hours per day	1 day/month x 3 months x 12 hours/day x 83% CAC cycling adjustment factor
Sporadic	30	Sporadic	30	5 days per year	6 hours per day	5 days x 6 hours/day
Sporadic	36	Sporadic	36	2 days per month	6 hours per day	2 days/month x 3 months x 6 hours/day
Sporadic	40	Sporadic	40	20 days per year	2 hours per day	20 days x 2 hours/day
Sporadic	48	Sporadic	48	2 days per month	8 hours per day	2 days/month x 3 months x 8 hours/day
Sporadic	80	Sporadic	80	20 days per year	4 hours per day	20 days x 4 hours/day
Sporadic	180	Sporadic	180	2 or 3 days per month	24 hours per day	2.5 days/month x 3 months x 24 hours/day
Sporadic	324	Sporadic	324	Don't Know	Don't Know	27 days (between 80–84 degrees during Jun–Aug) x 12 hours per day
Sporadic	360	Sporadic	360	5 days per month	24 hours per day	5 days/month x 3 months x 24 hours/day
Sporadic	385	Sporadic	385	Don't Know	10–12 hours at night	35 days (at or above 85 degrees) x 11 hours/day
Sporadic	400	Sporadic	400	20% of the time	During the hottest part of the day, generally	20% x 2000 hours

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Sporadic	648	Sporadic	648	Every day in the summer when didn't want to run the air conditioner	24 hours/day	27 days (between 80–84 degrees during Jun–Aug) x 24 hours per day
Sporadic	697	Sporadic	697	Don't Know	All day	35 days (at or above 85 degrees) x 24 hours per day x 83% CAC cycling adjustment factor
Sporadic	697	Sporadic	697	Don't Know	24 hours per day	35 days (at or above 85 degrees) x 24 hours per day x 83% CAC cycling adjustment factor
Sporadic	48	Continuous	0	Here and there throughout the year	Couple of hours per day	8 days/month x 3 months x 2 hours/day
Sporadic	100	Continuous	0	10 times per year equally in the summer and winter	All day	5 days x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	144	Continuous	0	Occasionally	Occasionally	8 days/month x 3 months x 6 hours/day
Sporadic	144	Continuous	0	Occasionally	Occasionally	8 days/month x 3 months x 6 hours/day

Table C–12. Furnace Fan Operation Method during Shoulder Periods

Operation Method	Percent of Respondents (n=150)	
	After Installation of ECM Furnace	**Before Installation of ECM Furnace**
Auto	72.0%	88.0%
Continuous	19.3%	5.3%
Sporadic	8.7%	6.7%

Table C–13. Changes in Furnace Fan Operation Method during Shoulder Periods after Installation of ECM Furnace

Operation Method		Percent of Respondents (n=150)
Before Installation of ECM Furnace	After Installation of ECM Furnace	
Auto		72.0%
Auto	Continuous	12.0%
Continuous		5.3%
Sporadic		4.7%
Auto	Sporadic	4.0%
Sporadic	Continuous	2.0%

Table C–14. Reasons for Changing Operation Method during Shoulder Periods after Installation of ECM Furnace

Reasons
Changed from Auto to Continuous (n=18)
Based on advice from contractor *(Contractor advice: No specific reason)*
Contractor said to run it all the time *(Contractor advice: No specific reason)*
Had a SpaceGuard Aprilaire filter (it is big and pleated) installed with the new furnace. It is understanding that running the fan all of the time helps with filtration and creates healthier air quality. It also gets the air circulating through the house. Was told that it only costs $30/year to run the fan on the new furnace all of the time compared to $30/month on old furnace *(Air filtration/Air circulation)*
Has a breathing problem and had an air purifier attached to new furnace to remove pollen and dust from the air *(Air filtration)*
Has asthma and can breathe better when the air is filtered *(Air filtration)*
Have an air purifier and humidifier attached. The contractor initially set it this way and said to leave it set this way all year long *(Contractor advice: Air filtration)*
It keeps the temperature more even between the upstairs and downstairs and contractor said that the fan was efficient. Thinks the house is far more comfortable since made the change *(Contractor advice: Even temperature/More efficient)*
It's better for the furnace and for the air circulation to keep it running *(Better way/Air circulation)*
Now have more of an understanding of what the furnace can do. Contractor explained how the furnace can work and that it's more energy efficient *(Contractor advice: More energy efficient)*
Runs the fan all the time to keep even temperatures throughout the house and keep the air fresh *(Even temperature/Air circulation)*
The contractor said that one of the benefits of the new furnace was that it could be run all of the time to keep air moving and provide more even temperature. Likes to pull cool air out of the basement when not running CAC *(Contractor advice: Air circulation/Even temperature)*
The contractor said to run it continuously 24/7/365 *(Contractor advice: No specific reason)*
The contractor said to run the fan continuously *(Contractor advice: No specific reason)*
Thinks it is more comfortable to have it running all the time, especially since home all the time *(More comfortable)*

Reasons
Thinks that (1) the efficiency level of multi-speed blowers is higher when run continually rather than intermittently, (2) operating this way is less hard on the blower motor and (3) it reduces variations in room-to-room temperatures. This is based on own research and what has heard from others, including co-workers at an A&E firm. Has found that uses less energy and has more even room temperatures in the last year with the new furnace *(More efficient/Even temperature)*
Was told by the contractor to operate the fan all of the time because it was better to keep the air moving to keep the air temp even throughout the house *(Contractor advice: Air circulation/Even temperature)*
Was told to run it all the time by dealer. Dealer said it would distribute the heat more evenly and give better comfort *(Contractor advice: Even temperature/Better comfort)*
Don't know
Changed from Auto to Sporadic (n=6)
If it is kind of hot or cold, but do not want to turn the furnace or CAC on will turn the fan on to move the air around the house to even temperature out from one room to another *(Air circulation/Even temperature)*
Contractor recommended it to move air around the house and for filtration. Will run the fan when the sun heats up parts of the house like the sun porch *(Contractor advice: Air circulation/Air filtration)*
Because was told that the new fan is more efficient, will run the fan to move air if it is hot, but not hot enough where would need to run the CAC *(Contractor advice: More efficient/Air circulation)*
Installed an electronic filtering system with the new furnace. The contractor said that it was best to run the fan all of the time to remove allergens from air. Runs the fan all of the time if the windows are closed and will turn the fan off when open up the windows so not end up circulating exterior air through the filter *(Contractor advice: Air filtration)*
To improve comfort by keeping more even temperature throughout the house. The fan is only shut off when the windows are open. The old fan was more costly to run *(Improve comfort/Low cost)*
To bring in cool air from outside when it is cool in the evening. New system has an external intake that brings in outside air. Old system did not have this feature *(Air circulation)*
Changed from Sporadic to Continuous (n=3)
Contractor said to operate it all the time throughout the year because it was better and would not use more energy *(Contractor advice: Better way/Less energy use)*
Provides more uniform temperatures throughout the house *(Even temperature)*
Recommended by contractor to help keep heat circulated in the house *(Contractor advice: Air circulation)*

Table C–15. Reasons for Using Continuous/Sporadic Operation Method during Shoulder Periods BOTH before and after Installation of ECM Furnace

Reasons
Continuous Before and After (n=8)
Always run it because it keeps the air circulating in the house *(Air circulation)*
Bought the home and put the new furnace in (and a new CAC as the home didn't have CAC before) before moved in. Operate the fan continuously all year long because daughter has really bad asthma. The doctor said to get an air purifier system and a UV purifier system. Bought both (at a cost of $10K) and had it installed before moved in. Even if had not moved, would have made this change *(Air filtration)*
Employee of the HVAC company that installed new furnace and know that supposed to run the new fans all the time *(No specific reason)*
Has dogs and the house really stinks if not run the fan continuously. Thinks running the fan continuously keeps the air fresh and the temperature consistent. Also likes the fact that does not hear the furnace coming on and off. Said this new furnace is perfect because has always run the fan continuously *(Air circulation/Even temperature)*
Have a finished basement with only a few heat ducts and have dehumidifier in the basement. Running the fan continually keeps the temperature more even throughout the house and ensures that enough air circulates in basement *(Even temperature/Air circulation)*
To help move the air around a bit, and maybe lessen the need for the air conditioner *(Air circulation)*
To keep the air circulating and the temperature throughout the house more even *(Air circulation/Even temperature)*
Wants to bring cooler air from downstairs to the upstairs *(Air circulation)*
Sporadic Before and After (n=7)
Circulates the air once in awhile to increase comfort during shoulder months. Typically keeps the windows closed during these times. When does open the windows, does not open as many as otherwise would which also helps because, given age, it is difficult to open and close them *(Air circulation/Increase comfort)*
To circulate air and draw cool air up from the basement when it is not too hot, but a little warm *(Air circulation)*
To circulate air in the house. Is a smoker and has an air cleaner. Had an air cleaner on the old furnace also *(Air circulation/Air filtration)*
The basement is 8 degrees cooler than main floor so will run the fan sometimes to circulate cool air from basement throughout the house *(Air circulation)*
When it's getting a little warm in the house but do not want to run the air conditioner will run the fan to help move the air around *(Air circulation)*
On some days during the spring and fall, likes to run the fan to circulate the air through the house *(Air circulation)*
To move air around in the house, usually because it is warm in the house or the air seems kind of stale *(Air circulation)*

Table C–16. Shoulder Period Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	0	Sporadic	23	2 to 3 days per month	3 hours per day	2.5 days/month x 3 months x 3 hours/day
Auto	0	Sporadic	27	1–2 days per month	Part of the day	1.5 days/month x 3 months x 6 hours/day
Auto	0	Sporadic	30	12 days in all	2–3 hours per day	12 days x 2.5 hours/day
Auto	0	Sporadic	48	Don't Know	Don't Know	8 days/month x 3 months x 2 hours/day
Auto	0	Sporadic	950	Don't Know	Don't Know	50% x 1900 hours
Auto	0	Sporadic	950	Don't Know	Don't Know	50% x 1900 hours
Sporadic	36	Sporadic	36	4 days per month	3 hours per day	4 days/month x 3 months x 3 hours/day
Sporadic	72	Sporadic	72	12 days per year	Not all day, but part of the day	12 days x 6 hours/day
Sporadic	72	Sporadic	72	Don't Know	It would only be during the daylight hours, because it would cool off enough at night that would turn the fan back to auto	6 days (between 80–84 degrees during May and Sep) x 12 hours per day
Sporadic	72	Sporadic	72	Don't Know	Don't Know	6 days (between 80–84 degrees during May and Sep) x 12 hours per day
Sporadic	270	Sporadic	270	About 1/2 the days during the spring and fall	It varies. Sometimes for a few hours and sometimes for 24 hours	45 days x 6 hours/day
Sporadic	864	Sporadic	864	12 days per month	24 hours per day	12 days/month x 3 months x 24 hours/day
Sporadic	1,710	Sporadic	1,710	90% of time during shoulder months	90% of time during shoulder months	90% x 1900 hours
Sporadic	6	Continuous	0	Couple of times per year	Few hours per day	2 days x 3 hours/day
Sporadic	14	Continuous	0	1–2 days per month	Few hours per day	1.5 days/month x 3 months x 3 hours/day
Sporadic	48	Continuous	0	Here and there throughout the year	Couple of hours per day	8 days/month x 3 months x 2 hours/day

Table C–17. Furnace Fan Operation Method across All Seasons

Operation Method			Percent of Respondents (n=150)	
Heating Season	**Cooling Season**	**Shoulder Periods**	**After Installation of ECM Furnace**	**Before Installation of ECM Furnace**
Auto			44.0%	66.7%
Continuous			18.7%	4.7%
Continuous		Auto	7.3%	3.3%
Auto	Sporadic	Auto	6.7%	8.7%
Auto	Continuous	Auto	5.3%	5.3%
Continuous	Auto		4.0%	0.7%
Auto		Sporadic	2.7%	4.0%
Continuous		Sporadic	2.7%	0.7%
Sporadic		Auto	2.0%	2.0%
Sporadic	Auto		1.3%	0.7%
Sporadic	Auto	Sporadic	1.3%	0.0%
Sporadic			0.7%	1.3%
Sporadic	Continuous	Auto	0.7%	0.7%
Auto		Continuous	0.7%	0.7%
Auto	Sporadic		0.7%	0.7%
Continuous	Sporadic	Auto	0.7%	0.0%
Auto	Continuous	Sporadic	0.7%	0.0%

Table C–18. Changes in Furnace Fan Operation Method across All Seasons after Installation of ECM Furnace

Operation Method						Percent of Respondents (n=150)
Before Installation of ECM Furnace			After Installation of ECM Furnace			
Heating Season	Cooling Season	Shoulder Periods	Heating Season	Cooling Season	Shoulder Periods	
Auto			Auto			43.3%
Auto			Continuous			9.3%
Auto	Sporadic	Auto	Auto	Sporadic	Auto	6.7%
Continuous			Continuous			4.7%
Auto			Continuous		Auto	3.3%
Auto			Continuous	Auto		3.3%
Auto	Continuous	Auto	Auto	Continuous	Auto	3.3%
Continuous		Auto	Continuous		Auto	2.7%
Auto		Sporadic	Auto		Sporadic	2.0%
Auto			Auto	Continuous	Auto	2.0%
Auto			Continuous		Sporadic	1.3%
Auto			Sporadic	Auto	Sporadic	1.3%
Auto			Sporadic	Auto		1.3%
Auto		Sporadic	Continuous			1.3%
Auto	Continuous	Auto	Continuous			1.3%
Sporadic		Auto	Sporadic		Auto	1.3%
Auto			Continuous	Sporadic	Auto	0.7%
Auto			Auto		Continuous	0.7%
Auto			Auto		Sporadic	0.7%
Continuous	Auto		Continuous			0.7%
Sporadic	Auto		Continuous	Auto		0.7%
Continuous		Sporadic	Continuous		Sporadic	0.7%
Sporadic	Continuous	Auto	Sporadic	Continuous	Auto	0.7%
Auto	Sporadic		Auto	Sporadic		0.7%
Auto		Sporadic	Auto	Continuous	Sporadic	0.7%
Auto	Continuous	Auto	Continuous		Auto	0.7%
Auto	Sporadic	Auto	Continuous			0.7%
Auto	Sporadic	Auto	Continuous		Sporadic	0.7%
Auto	Sporadic	Auto	Sporadic		Auto	0.7%
Sporadic		Auto	Continuous		Auto	0.7%
Sporadic			Continuous			0.7%
Sporadic			Sporadic			0.7%
Continuous		Auto	Auto			0.7%

Table C–19. Homeowner Received Furnace Fan Operation Advice from HVAC Contractor or Salespeople

Received Furnace Fan Operation Advice	Percent of Respondents (n=150)
Yes	60.7%
No	30.7%
Don't Know	8.7%

Table C–20. Type of Advice Received from HVAC Contractor or Salespeople

Type of Advice	Percent of Respondents (n=91)
Does not remember exactly what contractor said *(Not recall specifics)*	12.1%
Run the fan all of the time *(Continuous operation: No specific reason)*	12.1%
How to operate the fan *(How to operate fan)*	5.5%
By running the fan all the time it would increase monthly utility bill slightly, but that it would still be beneficial to do so *(Continuous operation: Increase bill but beneficial)*	1.1%
Can filter the air by running the fan more *(Continuous operation: Air filtration)*	1.1%
Contractor found out that operated fan continuously on old furnace and recommended this unit as it would save the most energy. Also calculated amount of electricity could expect to save compared to the old furnace *(Continuous operation: Save energy)*	1.1%
Didn't say much about the electricity the fan would use but did talk about the fact that it used a DC motor *(DC motor)*	1.1%
Fan motor was efficient *(Efficient)*	1.1%
Furnace has a variable speed motor and that the fan uses the same amount of electricity as an 80 W light bulb. It costs next to nothing to operate all of the time ($30/year vs. $360/year on old) *(Continuous operation: Low energy use/Low cost/Variable speed)*	1.1%
Furnace would save money because it had a DC motor *(Save money/DC motor)*	1.1%
Highlighted the part about the variable fan furnace and the benefits of that *(Variable fan)*	1.1%
How much electricity the fan uses. Compared it to a light bulb and said could run the fan in either auto or continuous mode. It didn't matter *(Low energy use)*	1.1%
How much it costs to run the furnace fan all year. Also that the furnace has two speeds and that the fan runs at a lower speed at the times when the AC or furnace is not running *(Variable speed/Energy cost)*	1.1%
How to operate the fan all of the time. Also the fan is more energy efficient and that it was easier on the motor to leave it running rather that letting it kick in and out *(Continuous operation: Energy efficient/Less motor wear and tear)*	1.1%
How to use the fan with the filtering system *(Air filtration)*	1.1%
It costs pennies to run the fan continuously and that doing this heats the home for consistently *(Continuous operation: Low cost/Even temperature)*	1.1%
It is a top of the line furnace and the fan uses as much juice as a 100 watt light bulb *(High quality/Low energy use)*	1.1%

Type of Advice	Percent of Respondents (n=91)
It is a two stage furnace *(Two stage)*	1.1%
It is a variable speed fan. It costs less to run. Might want to leave it run 24/7/365 to make the house more comfortable *(Continuous operation: Variable speed/Low cost/More comfort)*	1.1%
It is a very unique fan *(Efficient fan)*	1.1%
It is best not to run the furnace fan continuously, unless one is worried about filtering the air *(How to operate)*	1.1%
It uses less energy to run the fan *(Use less energy)*	1.1%
It will save money and is most appropriate because had always run fan on old furnace *(Continuous operation: Save money)*	1.1%
It would save electricity *(Save energy)*	1.1%
Leave the fan in the on position to help keep air moving and provide a more even temperature. It is a low voltage fan with three speeds that runs cheaper than the old fan *(Continuous operation: Air circulation/Even temperature/Three speeds/Low cost)*	1.1%
Leave the fan on all of the time during the summer *(Continuous operation: No specific reason)*	1.1%
Leave the fan on all of the time when heating and cooling to circulate air *(Continuous operation: Air circulation)*	1.1%
Leave the fan on all the time because it is cost effective, especially during the heating and cooling season as this will keep the heating and cooling equipment from kicking on as often. Also addressed basic operation *(Continuous operation: Cost effective)*	1.1%
Leave the fan on to circulate the air and stabilize the temperature and that it is a variable speed fan *(Continuous operation: Air circulation/Even temperature/Variable speed fan*	1.1%
Operate the fan all of the time when the AC is on *(Continuous operation: When cooling)*	1.1%
Operate the fan all of the time to help keep the temperature in the house more uniform. Also mentioned the quietness of the furnace *(Continuous operation: Even temperature/Quiet fan)*	1.1%
Run it continually and it will provide better comfort. It wouldn't cost significantly more than the old furnace fan *(Continuous operation: Better comfort/Low cost)*	1.1%
Run the fan all of the time to help circulate air in the house *(Continuous operation: Air circulation)*	1.1%
Run the fan all of the time when heating *(Continuous operation: When heating)*	1.1%
Run the fan all of the time when heating and cooling the home *(Continuous operation: When heating and cooling)*	1.1%
Run the furnace fan all of the time because it uses very little electricity *(Continuous operation: Low energy use)*	1.1%
Running the fan improves circulation and is not costly *(Continuous operation: Air circulation/Low cost)*	1.1%
Set it on auto so it runs on demand *(How to operate)*	1.1%
Showed how to operate, turn on and off *(How to operate)*	1.1%

Type of Advice	Percent of Respondents (n=91)
Spent some time tell providing information on the furnace and said to run it all the time *(Continuous operation: No specific reason)*	1.1%
Switch the fan to manual (continuous) operation instead of auto *(Continuous operation: No specific reason)*	1.1%
The contractor who installed the unit said to run it all the time. Another contractor who came out to check the unit later said that did not have to run it that way *(Continuous operation: No specific reason)*	1.1%
The efficiency of the fan and fan motor *(Efficiency)*	1.1%
The fan could be run all of the time *(Continuous operation: No specific reason)*	1.1%
The fan has a dual stage motor with a low and high speed and that the motor uses less power *(Dual stage motor/Multiple speed/Save energy)*	1.1%
The fan has a low voltage motor which saves energy *(Low voltage motor/Save energy*	1.1%
The fan has a very, very efficient motor that has dual speeds. Cost to operate the motor for an entire year was less than running the old one for a single month *(Efficient motor/Dual speeds/Low cost)*	1.1%
The fan has an efficient motor and it does not hurt the motor to run it *(Efficient motor)*	1.1%
The fan has two different blower speeds *(Multiple speed)*	1.1%
The fan motor is energy efficient and should be left on continuously *(Continuous operation: Energy efficient)*	1.1%
The fan motor uses a lot less energy because the motor runs at a reduced speed *(Less energy use)*	1.1%
The fan of the new furnace was more efficient, but was not given any tutoring on how to operate the fan *(More efficient)*	1.1%
The fan speed is variable and has 2 speeds. The low speed uses less energy *(Variable speed/Less energy use)*	1.1%
The fan uses less than 100W light bulb and has a DC motor. Also, should run it all the time for comfort and this was a very economical way to run it *(Continuous operation: Low energy use/DC motor/Comfort)*	1.1%
The fan will blow more air if it needs to put more heat or cool air into the house. The fan only costs a couple of dollars more to run all the time *(Continuous operation: Low cost)*	1.1%
The fan's electricity use and that the fan did not make a lot of noise *(Electricity use/Noise level)*	1.1%
The furnace has a continuous fan feature in which the fan runs all of the time to equalize the temperature in the house *(Continuous fan operation: Even temperature)*	1.1%
The furnace has a special fan that hardly takes any electricity to operate *(Special fan/Low electricity use)*	1.1%
The furnace should save a significant amount of electricity and provide more constant heat because of more air circulation *(Save electricity/Air circulation/Even temperature)*	1.1%
The furnace uses less energy and the fan uses a DC motor current *(Less energy/DC motor)*	1.1%

Type of Advice	Percent of Respondents (n=91)
The motor is designed to use very little electricity, 50% less than the old fan *(Low electricity use)*	1.1%
The new fan uses less energy if it is run continuously and the old fan was also run continuously. Also it would provide more even heating and cooling *(Continuous operation: Less energy use/Even temperature)*	1.1%
The new furnace will save electricity *(Save electricity)*	1.1%
To operate the fan continuously. Also if operated continuously it will not use any more energy then the old one *(Continuous operation: Less energy use)*	1.1%
Variable speed fan is much more efficient than old motor in terms of electricity usage *(Variable speed/More efficient/Less electricity use)*	1.1%
Went through the basics *(Basic operation)*	1.1%
Will get electrical savings from the motor if run it continuously or if run in auto model *(Continuous operation: Electricity savings)*	1.1%

Table C–21. Likelihood to Purchase Same Furnace in Absence of $150 Rebate

Received Furnace Fan Operation Advice	Percent of Respondents (n=150)
Very Likely	64.0%
Somewhat Likely	24.7%
Not Very Likely	6.7%
Not at All Likely	1.3%
Don't Know	3.3%

Table C–22. How Often Furnace Filter Is Changed

Frequency	Percent of Respondents (n=138)
Plans to every 3–4 years (Has not changed, yet. Has a thick filter, 4 or more inches, that is vacuumed 1 or 2 times each week)	0.7%
Every 2–3 years (It is a special filter)	0.7%
Every 2 years	1.4%
Every 2 years (Has a big Aprilaire filter)	0.7%
Annually	19.6%
Annually (Checks it every six months)	0.7%
Annually (Contractor installed a filter on the new furnace that only needs to be changed once per year. Called the contractor last week to change it)	0.7%
Annually (Done before winter. Has an electronic filter. Vacuums it every 2 months)	0.7%
Annually (Done in October)	0.7%
Annually (Done in the fall)	0.7%
Annually (Done in the fall. Has an electronic filter)	0.7%
Annually (Has a better filter with a germicidal/UV light so it helps with air purification)	0.7%

Frequency	Percent of Respondents (n=138)
Annually (Has a service contract and believes that the contractor checks the furnace twice each year, but only changes it once)	0.7%
Annually (Has an Aprilaire filter)	0.7%
Annually (Has an electronic filter that checks monthly)	0.7%
Annually (Installed a filter that costs $30–$35)	0.7%
Annually (It is a SpaceGuard filter)	0.7%
Annually (It is a very large filter that the contractor said to change annually)	0.7%
Annually (It is an electronic filter)	0.7%
Annually (Just changed it last month and it was not terribly dirty. Has a bigger, thicker filter (4"–5") than the real thin ones compared to the those that used before)	0.7%
Annually (Looks at it every couple of months to see if it is dirty and needs cleaning. Just looked at it this weekend and vacuumed it. Uses a $50 filter with the new furnace. The contractor said to change it every 6–12 months depending on fan use. Will c	0.7%
Annually (The contractor changes it)	0.7%
Annually (The filter is about one foot thick and electrically charged)	0.7%
Annually (When the heating contractor comes to clean the furnace before the heating season)	0.7%
Plans to annually (Has not changed, yet. Had an Aprilaire filter installed–Model 2200)	0.7%
Plans to annually (Has not changed, yet. Installed a special furnace filter system with new furnace. Plans to have contractor change it. Thinks filter costs $60)	0.7%
Plans to annually (Has not changed, yet. Paid extra for a better 6 inch filter. Will replace when furnace is serviced)	0.7%
Plans to annually (Has not changed, yet. Plans to change it before the winter months as part of annual maintenance with HVAC contractor)	0.7%
Plans to annually (Has not changed, yet. The contractor installed a "great big" filter and recommended that it be changed once a year when the furnace is serviced)	0.7%
Plans to annually (Has not changed, yet. Will change next month)	0.7%
Once or twice per year	0.7%
Plans to every 8 months (Has not changed, yet)	0.7%
Twice per year	17.4%
Twice per year (Cleans weekly if necessary)	0.7%
Twice per year (Contractor installed a different, bigger type of filter with the new furnace. Used to change old filter monthly. With the new filter, the contractor said it would be changed when the contractor comes out to check the system before the sum	0.7%
Twice per year (Had to vacuum the filter 3–4 times in between changes this year because had ducts cleaned with the new furnace. This loosened up more dust which was coming through the filter more often because the new fan had more power)	0.7%
Twice per year (Has a service contract where the contractor changes it)	0.7%

Frequency	Percent of Respondents (n=138)
Twice per year (The contractor was there in June, changed the filter, and will be back in December to change/check it again)	0.7%
Twice per year (Under a service contract)	0.7%
Plans to twice per year (Had a SpaceGuard filer, made by Aprilaire, installed with the new furnace. Just changed filter for the first time)	0.7%
2–3 times per year	0.7%
3 times per year	0.7%
3 times per year (It is a 4 inch filter)	0.7%
3–4 times per year	0.7%
3–4 times per year (Checked monthly)	0.7%
4 times per year	5.8%
4 times per year (Checks every couple of months. It is a 4 inch filter)	0.7%
4 times per year (Uses really good 3M filters)	0.7%
4 times per year (Vacuums it monthly)	0.7%
5 times per year	0.7%
6 times per year	3.6%
6 times per year (Changes it every month during the winter, but not as much during the rest of the year)	0.7%
6 times per year (Changes it more often during the winter and less often during the spring and fall)	0.7%
6 times per year (It is an electronic filter with an light that indicates when to clean it)	0.7%
8 times per year	0.7%
Monthly	9.4%
Monthly (It collects a lot of hair from the dogs)	0.7%
It is an electronic filter that plans to wash annually	0.7%
It is an electrostatic filter that is cleaned 3 times per year	0.7%
It is an electronic filter that is cleaned every 4 times per year	0.7%
Has an electronic filter that is cleaned about 5 times per year	0.7%
Contractor said that the filter has no need to be changed	0.7%
Just changed it for the first time a couple of weeks ago. Thinks should change it more often because it was black	0.7%
Not sure of plans (Has not changed, yet)	1.4%

Table C–23. Own or Rent Residence

Own or Rent	Percent of Respondents (n=150)
Own	100.0%

Table C–24. Type of Residence

Type	Percent of Respondents (n=150)
Single Family Home	98.7%
Duplex or Triplex	1.3%

Table C–25. Size of Residence

Size	Percent of Respondents (n=150)
900	1.3%
913	0.7%
990	0.7%
1,000	2.0%
1,050	1.3%
1,100	4.0%
1,125	0.7%
1,150	0.7%
1,200	6.0%
1,201	0.7%
1,250	2.0%
1,300	2.0%
1,350	0.7%
1,400	4.7%
1,450	0.7%
1,470	0.7%
1,500	4.7%
1,600	3.3%
1,625	0.7%
1,630	0.7%
1,700	3.3%
1,760	0.7%
1,800	2.7%
1,880	0.7%
2,000	11.3%
2,050	0.7%
2,100	1.3%
2,150	0.7%
2,200	4.7%
2,250	0.7%
2,264	0.7%
2,300	0.7%

Size	Percent of Respondents (n=150)
2,340	0.7%
2,400	4.7%
2,500	6.0%
2,600	2.0%
2,700	1.3%
2,800	0.7%
2,900	0.7%
3,000	2.0%
3,100	0.7%
3,200	0.7%
3,400	0.7%
3,600	0.7%
3,850	0.7%
3,870	0.7%
4,000	2.0%
5,300	0.7%
Don't Know	9.3%
Mean	1,948

Table C–26. Number of Levels

Number of Levels	Percent of Respondents (n=150)
One Story	37.3%
Bi-Level	2.7%
Two Story	56.7%
Tri-Level	2.7%
Three Story	0.7%

Table C–27. Number of Bedrooms

Number of Bedrooms	Percent of Respondents (n=150)
2	10.0%
3	54.7%
4	28.7%
5	4.0%
6	2.0%
Refused	0.7%
Mean	3.3

Table C–28. Number of Years in Home

Number of Years	Percent of Respondents (n=150)
1	4.7%
2	7.3%
3	4.7%
4	2.7%
5	2.0%
6	2.7%
7	4.7%
8	2.0%
9	2.7%
10	6.0%
11	4.0%
12	1.3%
13	2.0%
14	1.3%
15	4.0%
16	4.7%
17	4.7%
18	1.3%
19	2.7%
20	1.3%
21	1.3%
22	0.7%
23	1.3%
24	1.3%
25	2.7%
26	4.7%
27	2.7%
28	0.7%
29	0.7%
30	2.0%
31	0.7%
33	1.3%
35	2.0%
36	1.3%
37	.7%
38	.7%
40	2.0%
45	0.7%
46	0.7%

Number of Years	Percent of Respondents (n=150)
47	0.7%
50	1.3%
51	0.7%
53	0.7%
59	0.7%
62	0.7%
70	0.7%
Mean	17.5

Table C–29. Year Home Built

Year	Percent of Respondents (n=150)
1860	0.7%
1881	0.7%
1884	0.7%
1887	0.7%
1890	0.7%
1893	0.7%
1895	1.3%
1896	0.7%
1900	2.7%
1901	0.7%
1910	2.7%
1912	0.7%
1914	0.7%
1920	2.0%
1926	0.7%
1929	0.7%
1931	0.7%
1934	0.7%
1935	2.0%
1938	2.7%
1940	2.0%
1941	0.7%
1942	1.3%
1944	1.3%
1948	0.7%
1949	1.3%
1950	5.3%

Year	Percent of Respondents (n=150)
1951	0.7%
1952	1.3%
1953	0.7%
1954	0.7%
1955	2.0%
1956	0.7%
1957	1.3%
1958	1.3%
1960	1.3%
1963	2.7%
1964	0.7%
1965	1.3%
1967	2.0%
1968	1.3%
1970	1.3%
1971	0.7%
1973	2.0%
1974	0.7%
1975	2.7%
1976	3.3%
1977	4.0%
1978	4.0%
1979	2.7%
1980	1.3%
1981	1.3%
1982	1.3%
1983	1.3%
1984	0.7%
1985	2.7%
1986	0.7%
1987	3.3%
1988	2.7%
1989	2.0%
1991	0.7%
1992	1.3%
1993	1.3%
Don’t Know	4.0%
Refused	0.7%
Mean	1956

Table C–30. Number of People in Household–Total

Number of People	Percent of Respondents (n=150)
1	12.7%
2	44.0%
3	15.3%
4	17.3%
5	6.7%
6	2.7%
Refused	1.3%
Mean	2.7

Table C–31. Number of People in Household–17 Years Old or Younger

Number of People	Percent of Respondents (n=150)
0	65.3%
1	8.7%
2	16.7%
3	6.0%
4	2.0%
Refused	1.3%
Mean	0.7

Table C–32. Number of People in Household–Between 18–65 Years Old

Number of People	Percent of Respondents (n=150)
0	15.3%
1	16.0%
2	57.3%
3	7.3%
4	2.0%
5	0.7%
Refused	1.3%
Mean	1.7

Table C–33. Number of People in Household–Over 65 Years Old

Number of People	Percent of Respondents (n=150)
0	76.0%
1	12.0%
2	10.7%
Refused	1.3%
Mean	0.3

Table C–34. Highest Level of Education

Education Level	Percent of Respondents (n=150)
Some High School	2.0%
High School Graduate	24.7%
Some Technical School or College	18.7%
Technical School Graduate (Associates Degree)	5.3%
College Graduate (Bachelors Degree)	23.3%
Advanced Degree (Masters Degree or Higher)	22.7%
Refused	3.3%

Table C–35. Income Level

Income Level	Percent of Respondents (n=150)
$10,000–$14,999	2.0%
$15,000–$19,999	2.0%
$20,000–$29,999	7.3%
$30,000–$39,999	8.7%
$40,000–$49,999	10.0%
$50,000–$74,999	22.0%
$75,000–$99,999	12.0%
$100,000 or More	22.0%
Refused	14.0%

Table C–36. Gender

Gender	Percent of Respondents (n=150)
Male	60.0%
Female	40.0%

APPENDIX D: WESH HOMEOWNER WITH ECM FURNACE INTERVIEW RESULTS– DETAILS

Appendix D provides detailed results from interviews with WESH homeowners who have an ECM furnace that support the analysis in the report.

Table D–1. Owned Home with Forced Air Furnace (FAF) Previous to WESH Home

Owned Home with FAF	Percent of Respondents (n=60)
Owned Home with FAF	86.7%
Owned Home with No FAF	5.0%
Not Owned Home	8.3%

Table D–2. Furnace Fan Operation Method during Heating Season

Operation Method	Percent of Respondents (n=60)	
	WESH Home	Previous Home*
Auto	50.0%	80.0%
Continuous	33.3%	13.3%
Sporadic	16.7%	6.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home

Table D–3. Furnace Fan Operation Method during Heating Season in Previous and WESH Home

Operation Method		Percent of Respondents (n=60)
Previous Home*	WESH Home	
Auto		48.3%
Auto	Continuous	18.3%
Auto	Sporadic	13.3%
Continuous		13.3%
Sporadic		3.3%
Sporadic	Continuous	1.7%
Sporadic	Auto	1.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home

Table D–4a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Heating Season–High Level Categorization

Reason	Percent of Respondents (n=19)[1]
Air circulation	26.3%
√ *Contractor advice: Air circulation*	*10.5%*
Even temperature	21.1%
√ *Contractor advice: Even temperature*	*10.5%*
√ *Contractor advice: No specific reason*	*15.8%*
Air filtration	0.0%
√ *Contractor advice: Air filtration*	*5.3%*
Better way	5.3%
√ *Contractor advice: Better way*	*0.0%*
Integration with ventilation system	15.8%
√ *Contractor advice: Integration with ventilation system*	*0.0%*
Moisture control	10.5%
√ *Contractor advice: Moisture control*	*5.3%*
Don't know	5.3%
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	32%
Percent of *Responses* Relating to Contractor Advice	36%

[1] A total of 25 responses were given by the 19 respondents.

Table D–4b. Reasons for Changing Operation Method during Heating Season from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=11)
Because of advice from builder *(Builder advice: No specific reason)*
Distributes the temperature more evenly around the house. Has been trying it different ways (auto, sporadic, continuous), but run it continuous now when heating or cooling *(Even temperature)*
Don't Know
For moisture and to circulate the air and to move the heat around the house. Have an air to air exchanger on all the time *(Air circulation/Moisture control)*
For more even heat throughout the house and to balance the heat in the house from room to room *(Even temperature)*
Have an 18-foot ceiling in great room and that requires running the fan almost all the time to help keep air circulating and the temperature even throughout the house *(Air circulation/Even temperature)*

Reasons
Have ceiling fans that go full time as well. Due to how home was built, need to keep it running all the time. There's a bedroom on the 2nd floor that doesn't have anything under it, and the builder didn't insulate it well enough *(Even temperature)*
It is a concrete house. Leave the fan on to remove moisture and to move air around. Their HVAC contractor said to leave the fan running this year to see what impact it has on the bills. Will be talking with him again now to see what should be done in the future *(Contractor advice: Moisture control/Air circulation)*
It is a variable speed fan and that is the way the furnace is designed *(Best way)*
Not sure why it is on continuously. Thinks it should be on auto and will be calling the HVAC contractor to ask why and what should be done. It has not been changed since moved in *(Contractor advice: No specific reason)*
Not sure why. Thinks it might be because of the Aprilaire system. The builder didn't say anything, he just set the thermostat and it hasn't been touched since *(Builder advice: No specific reason)*
Changed from Auto to Sporadic (n=8)
Runs the fan on occasion to help get the moisture off the windows and to circulate air *(Moisture control/Air circulation)*
To keep the temperature more equalized and to circulate the air better because of the large size of the house. Were told by HVAC contractor not to run the fan continuously, but does so on days in which the temperature is very cold *(Contractor advice: Even temperature/Air circulation)*
When burning the fireplace it moves the heat from the main floor to other levels *(Air circulation)*
Have an air exchanger now. It's programmed for the comfort zone, so whenever the system detects it, that is when the fan kicks in *(Integration with ventilation system)*
Have an air exchanger that brings in fresh air twice a day. It requires the furnace fan to run *(Integration with ventilation system)*
Every once in a while will turn the fan on to help circulate air, like when the sun is shining in because have more south-facing windows *(Air circulation)*
It was recommended by the consultant to help with air purifying and filtering. Have zone heating in new home with 3 zones, so having the programmable thermostat allows better control of the temperature in the house, which includes running the fan only. It's programmed in the thermostat, so that's what triggers it *(Consultant advice: Air filtration/More even temperature)*
Also have a heat recovery ventilator system, so that kicks in four times a day for 20 minutes each time *(Integration with ventilation system)*
Changed from Sporadic to Continuous (n=1)
Has a DC motor that runs in low mode. Keeps the temperature even in all areas of the house. Keeps moisture off the windows in the winter *(Even temperature/Moisture control)*
Changed from Sporadic to Auto (n=1)
Ran the fan to move heat around when running fireplace in previous home. There is no fireplace in new home *(Air circulation)*

Table D–5. Reasons for Using Continuous/Sporadic Operation Method during Heating Season in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=8)
Advised that furnace fan will use very little energy *(Uses less energy)*
Because the manual says to run continuously during the heating season to circulate air better *(Air circulation)*
Furnace has an energy efficient furnace fan so it doesn't cost me much. Also have a 2-story great room so it helps move the air through there better *(Energy efficient/Air circulation)*
Have two furnaces. The fan on one runs all winter long and the fan on the other is set to auto mode *(No specific reason)*
Have allergies and are filtering the air *(Air filtration)*
The heating guy who worked on previous home said to leave it on, but cannot remember why. Thinks it is just better to leave it on *(Best way)*
To filter the air because of mild allergies *(Air filtration)*
To help circulate the air and keep more even temperature. Have three zones that are operated differently. The lower level is off, the main level is continuous, and the upper level is auto *(Air circulation/Even temperature)*
Sporadic Before and After (n=2)
To circulate the air when it is really cold out. The contractor said it would even the temperature throughout the house *(Air circulation/Even temperature)*
Runs the fan when have the fireplace going so it helps circulate the warm air *(Air circulation)*

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–6. Heating Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Sporadic	48	Auto	0	2 days per month	4 hours per day	2 days/month x 6 months x 4 hours/day
Auto	0	Sporadic	19	4 days per month	1 hour per day	4 days/month x 6 months x 1 hour/day x 78% furnace cycling adjustment factor
Auto	0	Sporadic	54	2 days per month	4–5 per day	2 days/month x 6 months x 4.5 hours/day
Auto	0	Sporadic	112	2 days per month	12 hours per day	2 days/month x 6 months x 12 hours/day x 78% furnace cycling adjustment factor

D. WESH Homeowner with ECM Furnace Interview Results—Details…

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	0	Sporadic	187	Every day	80 minutes per day	180 days x 80 minutes/day x 1 hour/60 minutes x 78% furnace cycling adjustment factor
Auto	0	Sporadic	360	Every day	5 minutes per hour	180 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Auto	0	Sporadic	360	Probably every day	Don't Know	180 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Auto	0	Sporadic	360	Don't Know	Don't Know	180 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Auto	0	Sporadic	562	5 days per month	24 hours per day	5 days/month x 6 months x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	168	Sporadic	168	3 days per month	12 hours per day	3 days/month x 6 months x 12 hours/day x 78% furnace cycling adjustment factor
Sporadic	528	Sporadic	528	10–12 days per year	8 hours per day	11 days/month x 6 months x 8 hours/day
Sporadic	7	Continuous	0	1 day per month	1–2 hours per day	1 day/month x 6 months x 1.5 hours/day x 78% furnace cycling adjustment factor

Table D–7. Central Air Conditioner Ownership

Owned Central Air Conditioner	Percent of Respondents	
	WESH Home (n=60)	**Previous Home* (n=55)**
Yes	96.7%	76.4%
No	3.3%	23.6%

* 5 respondents did not own a home previous to WESH.

Table D–8. Furnace Fan Operation Method during Cooling Season

Operation Method	Percent of Respondents (n=60)	
	WESH Home	Previous Home*
Auto	53.3%	73.3%
Continuous	31.7%	18.3%
Sporadic	15.0%	8.3%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–9. Furnace Fan Operation Method during Cooling Season in Previous and WESH Home

Operation Method		Percent of Respondents (n=60)
Previous Home*	WESH Home	
Auto		51.7%
Continuous		16.7%
Auto	Continuous	11.7%
Auto	Sporadic	10.0%
Sporadic		5.0%
Sporadic	Continuous	3.3%
Continuous	Auto	1.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–10a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Cooling Season–High Level Categorization

Reason	Percent of Respondents (n=13)[1]
Air circulation	15.4%
√ *Contractor advice: Air circulation*	*7.7%*
Even temperature	7.7%
√ *Contractor advice: Even temperature*	*7.7%*
Air filtration	0.0%
√ *Contractor advice: Air filtration*	*7.7%*
√ *Contractor advice: No specific reason*	*23.1%*
Better way	7.7%
Advice: Better way	*0.0%*
Moisture control	0.0%
√ *Contractor advice: Moisture control*	*7.7%*
Integration with ventilation system	23.1%
√ *Contractor advice: Integration with ventilation system*	*0.0%*

Reason	Percent of Respondents (n=13)[1]
Don't know	7.7%
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	38%
Percent of *Responses* Relating to Contractor Advice	47%

[1] A total of 15 responses were given by the 13 respondents.

Table D–10b. Reasons for Changing Operation Method during Cooling Season from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=7)
Because of advice from builder *(Builder advice: No specific reason)*
Don't Know
Have ceiling fans that go full time as well. Due to how home was built, need to keep it running all the time. There's a bedroom on the 2nd floor that doesn't have anything under it, and the builder didn't insulate it well enough *(Even temperature)*
It is a concrete house. Leave the fan on to remove moisture and to move air around. Their HVAC contractor said to leave the fan running this year to see what impact it has on the bills. Will be talking with him again now to see what should be done in the future *(Contractor advice: Moisture control/Air circulation)*
It is a variable speed fan and that is the way the furnace is designed *(Best way)*
Not sure why it is on continuously. Thinks it should be on auto and will be calling the HVAC contractor to ask why and what should be done. It has not been changed since moved in *(Contractor advice: No specific reason)*
Not sure why. Thinks it might be because of the Aprilaire system. The builder didn't say anything, he just set the thermostat and it hasn't been touched since *(Builder advice: No specific reason)*
Changed from Auto to Sporadic (n=6)
Only on really warm, humid days. It helps to draw cooler air in and circulates the cool air better. The house seems to stay cooler when this is done. A neighbor suggested this *(Air circulation)*
Generally, it is in auto mode, but will turn the fan on if have a party or something like that *(Air circulation)*
Have an air exchanger now. It's programmed for the comfort zone, so whenever the system detects it, that is when the fan kicks in *(Integration with ventilation system)*
Have an air exchanger that brings in fresh air twice a day. It requires the furnace fan to run *(Integration with ventilation system)*
It was recommended by the consultant to help with air purifying and filtering. Have zone heating in new home with 3 zones, so having the programmable thermostat allows better control of the temperature in the house, which includes running the fan only. It's programmed in the thermostat, so that's what triggers it *(Consultant advice: Air filtration/More even temperature)*
Also have a heat recovery ventilator system, so that kicks in four times a day for 20 minutes each time *(Integration with ventilation system)*

Reasons
Changed from Sporadic to Continuous (n=2)
Has a DC motor that runs in low mode. Keeps the temperature even in all areas of the house *(Even temperature)*
To circulate air and to move cool air around *(Air circulation)*
Changed from Continuous to Auto (n=1)
Someone provided advice while in previous home to run fan all the time in the summer *(No specific reason)*

Table D–11. Reasons for Using Continuous/Sporadic Operation Method during Cooling Season in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=10)
Advised that furnace fan will use very little energy *(Energy efficient)*
Because it helps bring the cool air up from the basement *(Air circulation)*
Distributes the temperature more evenly around the house. Has been trying it different ways (auto, sporadic, continuous), but run it continuous now when heating or cooling *(Even temperature)*
Furnace has an energy efficient furnace fan so it doesn't cost me much. Also have a 2-story great room so it helps move the air through there better *(Energy efficient/Air circulation)*
Have allergies and are filtering the air *(Air filtration)*
Haven't been through a cooling season yet, but will probably run both furnace fans the same way as during the heating season *(No specific reason)*
It seems to help keep the humidity down and keep the house cooler *(Air circulation)*
The heating guy who worked on previous home said to leave it on, but cannot remember why. Thinks it is just better to leave it on *(Best way)*
To filter the air because of mild allergies *(Air filtration)*
To move air from the cool basement and circulate air better *(Air circulation)*
Sporadic Before and After (n=3)
Turns the fan on to make sure air is circulating when have company *(Air circulation)*
Turns the fan on to help circulate the air when the house is full of people *(Air circulation)*
If it's a humid day and the windows are shut, turn the fan on to help move the air around. That will change once have the AC in. Then probably leave the fan in auto mode *(Air circulation)*

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–12. Cooling Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
A	0	S	25	2 days per month	4–6 hours per day	2 days/month x 3 months x 5 hours/day x 83% CAC cycling adjustment factor
A	0	S	100	Every day	80 minutes per day	90 days x 80 minutes/day x 1 hour/60 minutes x 83% furnace cycling adjustment factor
A	0	S	149	2–3 days per year	24 hours per day	2.5 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
A	0	S	180	Probably every day	Don't Know	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
A	0	S	180	Every day	5 minutes per hour	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
A	0	S	180	Don't Know	Don't Know	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
S	30	S	30	Only minimal	3 hours per day	4 days/month x 3 months x 3 hours/day x 83% CAC cycling adjustment factor
S	50	S	50	Don't Know	4–6 hours per day	4 days/month x 3 months x 5 hours/day x 83% CAC cycling adjustment factor
S	175	S	175	Don't Know	4–6 hours per day	35 days (at or above 85 degrees) x 5 hours per day
S	4	C	0	1 day per month	1–2 hours per day	1 day/month x 3 months x 1.5 hours/day x 83% CAC cycling adjustment factor
S	896	C	0	15 days per month	24 hours per day	15 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor

Table D–13. Furnace Fan Operation Method during Shoulder Periods

Operation Method	Percent of Respondents (n=60)	
	WESH Home	Previous Home*
Auto	68.3%	85.0%
Continuous	18.3%	8.3%
Sporadic	13.3%	6.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home

Table D–14. Furnace Fan Operation Method during Shoulder Periods in Previous and WESH Home

Operation Method		Percent of Respondents (n=60)
Previous Home*	WESH Home	
Auto		66.7%
Auto	Continuous	10.0%
Continuous		8.3%
Auto	Sporadic	8.3%
Sporadic		5.0%
Sporadic	Auto	1.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home

Table D–15a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Shoulder Periods–High Level Categorization

Reason	Percent of Respondents (n=11)[1]
Air circulation	9.1%
√ *Contractor advice: Air circulation*	*9.1%*
Even temperature	9.1%
√ *Contractor advice: Even temperature*	*9.1%*
Air filtration	0.0%
√ *Contractor advice: Air filtration*	*9.1%*
Contractor advice: No specific reason	*18.2%*
Better way	9.1%
√ *Contractor advice: Better way*	*0.0%*
Integration with ventilation system	27.3%
√ *Contractor advice: Integration with ventilation system*	*0.0%*
Moisture control	9.1%
√ *Contractor advice: Moisture control*	*9.1%*

Reason	Percent of Respondents (n=11)[1]
Don't know	9.1%
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	36%
Percent of *Responses* Relating to Contractor Advice	43%

[1] A total of 14 responses were given by the 11 respondents.

Table D–15b. Reasons for Changing Operation Method during Shoulder Periods from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=6)
Don't Know
Have ceiling fans that go full time as well. Due to how home was built, need to keep it running all the time. There's a bedroom on the 2nd floor that doesn't have anything under it, and the builder didn't insulate it well enough *(Even temperature)*
It is a concrete house. Leave the fan on to remove moisture and to move air around. Their HVAC contractor said to leave the fan running this year to see what impact it has on the bills. Will be talking with him again now to see what should be done in the future *(Contractor advice: Moisture control/Air circulation)*
It is a variable speed fan and that is the way the furnace is designed *(Best way)*
Not sure why it is on continuously. Thinks it should be on auto and will be calling the HVAC contractor to ask why and what should be done. It has not been changed since moved in *(Contractor advice: No specific reason)*
Not sure why. Thinks it might be because of the Aprilaire system. The builder didn't say anything, he just set the thermostat and it hasn't been touched since *(Builder advice: No specific reason)*
Changed from Auto to Sporadic (n=5)
Have an air exchanger now. It's programmed for the comfort zone, so whenever the system detects it, that is when the fan kicks in *(Integration with ventilation system)*
Have an air exchanger that brings in fresh air twice a day. It requires the furnace fan to run *(Integration with ventilation system)*
It was recommended by the consultant to help with air purifying and filtering. Have zone heating in new home with 3 zones, so having the programmable thermostat allows better control of the temperature in the house, which includes running the fan only. It's programmed in the thermostat, so that's what triggers it *(Consultant advice: Air filtration/Even temperature)*
Also have a heat recovery ventilator system, so that kicks in four times a day for 20 minutes each time *(Integration with ventilation system)*
When it is warm enough outside that need some air circulation, but not the AC. Didn't have the excess moisture in previous home that have now *(Air circulation/Moisture control)*
Changed from Sporadic to Auto (n=1)
Turned it on to circulate the air if there were things like cooking smells in the house *(Air circulation)*

Table D–16. Reasons for Using Continuous/Sporadic Operation Method during Shoulder Periods in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=5)
Advised that furnace fan will use very little energy *(Energy efficient)*
Furnace has an energy efficient furnace fan so it doesn't cost me much. Also have a 2-story great room so it helps move the air through there better *(Energy efficient/Air circulation)*
Have allergies and are filtering the air *(Air filtration)*
The heating guy who worked on previous home said to leave it on, but cannot remember why. Thinks it is just better to leave it on *(Best way)*
To filter the air because of mild allergies *(Air filtration)*
Sporadic Before and After (n=3)
When want to circulate fresh air, especially in the Spring *(Air circulation)*
Every once in a while will turn the fan on to help circulate air, like when the sun is shining in because have more south-facing windows *(Air circulation)*
If it's a humid day and the windows are shut, turn the fan on to help move the air around. That will change once have the AC in. Then probably leave the fan in auto mode *(Air circulation)*

Table D–17. Shoulder Period Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Sporadic	5	Auto	0	1 day per month	1–2 hours per day	1 day/month x 3 months x 1.5 hours/day
Auto	0	Sporadic	54	Don't Know	8–10 hours per day	6 days (between 80–84 degrees during May and Sep) x 9 hours per day
Auto	0	Sporadic	120	Every day	80 minutes per day	90 days x 80 minutes/day x 1 hour/60 minutes
Auto	0	Sporadic	180	Probably every day	Don't Know	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Auto	0	Sporadic	180	Every day	5 minutes per hour	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Auto	0	Sporadic	180	Don't Know	Don't Know	90 days x 5 minutes/hour x 1 hour/60 minutes x 24 hours/day
Sporadic	12	Sporadic	12	4 days per month	1 hour per day	4 days/month x 3 months x 1 hour/day

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Sporadic	30	Sporadic	30	Don't Know	4–6 hours per day	6 days (between 80–84 degrees during May and Sep) x 5 hours per day
Sporadic	75	Sporadic	75	5 days per month	4–6 hours per day	5 days/month x 3 months x 5 hours/day

Table D–18. Furnace Fan Operation Method across All Seasons

Operation Method			Percent of Respondents (n=60)	
Heating Season	**Cooling Season**	**Shoulder Periods**	**WESH Home**	**Previous Home***
Auto			40.0%	63.3%
Continuous			18.3%	8.3%
Sporadic			6.7%	1.7%
Continuous		Auto	8.3%	1.7%
Sporadic	Auto		6.7%	5.0%
Continuous	Auto		5.0%	3.3%
Auto	Sporadic		3.3%	1.7%
Auto	Sporadic	Auto	3.3%	5.0%
Auto	Continuous	Auto	1.7%	6.7%
Auto		Sporadic	1.7%	1.7%
Continuous	Sporadic	Auto	1.7%	0.0%
Sporadic	Continuous	Sporadic	1.7%	0.0%
Sporadic	Continuous	Auto	1.7%	0.0%
Auto	Continuous	Sporadic	0.0%	1.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–19. Changes in Furnace Fan Operation Method across All Seasons from Previous and WESH Home

Operation Method						Percent of Respondents (n=60)
Previous Home*			WESH Home			
Heating Season	Cooling Season	Shoulder Periods	Heating Season	Cooling Season	Shoulder Periods	
Auto			Auto			36.7%
Auto			Continuous			10.0%
Continuous			Continuous			8.3%
Auto			Sporadic			6.7%
Sporadic	Auto		Sporadic	Auto		3.3%
Continuous	Auto		Continuous	Auto		3.3%
Auto			Sporadic	Auto		3.3%
Auto	Sporadic	Auto	Auto	Sporadic	Auto	1.7%
Sporadic			Continuous		Auto	1.7%
Auto			Continuous		Auto	1.7%
Auto			Continuous	Auto		1.7%
Sporadic	Auto		Auto			1.7%
Auto	Continuous	Auto	Auto			1.7%
Auto	Sporadic	Auto	Continuous		Auto	1.7%
Auto	Continuous	Auto	Continuous		Auto	1.7%
Auto	Continuous	Auto	Sporadic	Continuous	Auto	1.7%
Auto	Continuous	Sporadic	Sporadic	Continuous	Sporadic	1.7%
Auto	Continuous	Auto	Auto	Continuous	Auto	1.7%
Continuous		Auto	Continuous		Auto	1.7%
Auto		Sporadic	Auto		Sporadic	1.7%
Auto			Continuous	Sporadic	Auto	1.7%
Auto			Auto	Sporadic	Auto	1.7%
Auto	Sporadic		Auto	Sporadic		1.7%
Auto	Sporadic	Auto	Auto	Sporadic		1.7%

* For the 8 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table D–20. Homeowners Received Furnace Fan Operation Advice from Builder or HVAC Contractor

Received Furnace Fan Operation Advice	Percent of Respondents (n=60)
Yes	41.7%
No	38.3%
Builder in WESH Home	8.3%
HVAC Contractor in WESH Home	1.7%
Don't Know	10.0%

Table D–21. Type of Advice Received from Builder or HVAC Contractor

Type of Advice	Percent of Respondents (n=25)
Does not remember exactly what was said *(Not recall specifics)*	8.0%
About the low amount of electricity used by the fan *(Energy efficient)*	4.0%
Builder helped figure the whole system out *(Explained system)*	4.0%
Did a good job explaining system and the settings. Haven't touched settings since moved in *(Explained system)*	4.0%
Had a problem with the humidity in home and they suggested running the fan all the time. Did that for a little while, but it didn't help and didn't like the noise of the fan. Now have a ventilator and that's working just fine *(Continuous operation: Moisture control)*	4.0%
Had an ENERGY STAR consultant come in. He helped balance the air duct flow and with how to set thermostat and humidity levels *(Explained system)*	4.0%
How to operate it, but have questions now and can't remember what was said on how to operate *(Explained system)*	4.0%
HVAC contractor talked about the operating functions and recommended that the fan be run all the time and that it wouldn't cost that much to run *(Continuous operation: Not cost much)*	4.0%
It only costs pennies to run. Also showed how to use the thermostat *(Explained system/Not cost much)*	4.0%
It uses less energy and should run the fan to help with air purifying and filtering *(Continuous operation: Energy efficient/Air filtration)*	4.0%
It wouldn't use that much more electricity to run the fan all the time *(Continuous operation: Not use much more electricity)*	4.0%
Said something about the energy efficiency and that it will run on low and higher speeds if it needs to *(Energy efficient/Multiple speeds)*	4.0%
Said that would get more even heat throughout the house and gave an estimate of the cost for operating this way *(Continuous operation: Even temperature)*	4.0%
Said to run the fan all the time because of the type of system it is *(Continuous operation: Best way)*	4.0%
Said to run the fan when there's excess moisture *(Continuous operation: Moisture control)*	4.0%
Talked about energy efficiency. Said that the electricity draw is significantly less than a regular fan. It is a DC electrical fan and is meant and capable to run continuously *(Continuous operation: Energy efficient)*	4.0%

Type of Advice	Percent of Respondents (n=25)
The builder said that furnace fan will use very little energy *(Uses less energy)*	4.0%
The fan motor uses less energy because it steps down *(Uses less energy)*	4.0%
The fan uses the equivalent of an 80 watt light bulb to run continuously. HVAC contractor said to run continuously to keep a more even temperature throughout the house *(Continuous operation: Less energy/Even temperature)*	4.0%
The heating contractor talked about the basic operation and maybe about the efficiency *(Explained operation)*	4.0%
The HVAC contractor said not to run continuously *(Explained operation)*	4.0%
The variable speed fan uses less energy than a single speed fan *(Variable speed fan/Less energy)*	4.0%
Turn the fan on when it is really cold to even the heat out in the house *(Continuous operation: Even temperature)*	4.0%
Went over the basic operation, but made no recommendations *(Explained operation)*	4.0%

Table D–22. How Often Furnace Filter Is Changed

Frequency	Percent of Respondents (n=60)
Annually	20.0%
Annually (Has an Aprilaire filter)	5.0%
Annually (Has a 4 inch high performance filter)	3.3%
Annually (Has a high performance filter)	3.3%
Annually (Has a 4 inch SpaceGuard filter)	1.7%
Annually (The heat recovery system filter is cleaned monthly)	1.7%
1–2 times per year	1.7%
Twice per year	25.0%
Twice per year (Has a 4 inch high performance filter)	3.3%
Twice per year (Also cleans every 3 months)	1.7%
Twice per year (Has an Aprilaire filter)	1.7%
Twice per year (Uses high performance media)	1.7%
2–3 times per year	1.7%
3–4 times per year	6.7%
4 times per year (Cleans every month. Has an Aprilaire Media air cleaner which is electrostatic)	1.7%
6 times per year	1.7%
Cleans 4 times per year (Has an electronic filter)	1.7%
Cleans 4 times per year (They are permanent filters)	1.7%
It's an electronic filter that only needs to be washed, not changed	1.7%
The filter just needs cleaning, not replacing	1.7%
Not sure how often it will be cleaned (Has an electronic filter. It has been done once thus far since moved in during March 2003)	1.7%

Frequency	Percent of Respondents (n=60)
Haven't changed it yet	1.7%
Haven't changed it yet, and it's been almost a year	1.7%
Don't Know	6.7%

Table D–23. Bought New Refrigerator for WESH Home

New Refrigerator	Percent of Respondents (n=60)
Bought New	88.3%
Brought from Previous Home	11.7%
Bought Used	0.0%

Table D–24. Bought New Clothes Dryer for WESH Home

New Clothes Dryer	Percent of Respondents (n=60)
Bought New	63.3%
Brought from Previous Home	35.0%
Bought Used	1.7%

Table D–25. Clothes Dryer Fuel Type

Clothes Dryer Fuel Type	Percent of Respondents			
	Overall (n=60)	Bought New (n=38)	Brought from Previous Home (n=21)	Bought Used (n=1)
Electric	73.3%	73.7%	71.4%	100.0%
Gas	26.7%	26.3%	28.6%	0.0%

Table D–26. Bought New Clothes Washer for WESH Home

New Clothes Washer	Percent of Respondents (n=60)
Bought New	68.3%
Brought from Previous Home	30.0%
Bought Used	1.7%

Table D–27. Bought New Dishwasher for WESH Home

New Dishwasher	Percent of Respondents (n=60)
Bought New	98.3%
Brought from Previous Home	0.0%
Bought Used	0.0%
No Dishwasher	1.7%

Table D–28. Builder Discussed Types of Appliances for WESH Home

Builder Discussed Types of Appliances	Percent of Respondents (n=60)
Yes	31.7%
No	60.0%
Builder in WESH Home	8.3%
Don't Know	0.0%

Table D–29. Builder Encouraged Purchase of Energy Efficient Appliances for WESH Home

Builder Encouraged Energy Efficient Appliances	Percent of Respondents (n=19)
Yes	100.0%
No	0.0%
Don't Know	0.0%

Table D–30. Size of WESH Home

Size	Percent of Respondents (n=60)
1,365	1.7%
1,375	1.7%
1,400	1.7%
1,455	1.7%
1,550	1.7%
1,700	3.3%
1,800	3.3%
1,850	1.7%
1,900	3.3%
2,000	6.7%
2,100	3.3%
2,130	1.7%
2,200	8.3%
2,261	1.7%

Size	Percent of Respondents (n=60)
2,300	1.7%
2,330	1.7%
2,400	6.7%
2,500	5.0%
2,600	1.7%
2,630	1.7%
2,700	3.3%
2,800	10.0%
2,822	1.7%
2,858	1.7%
3,000	5.0%
3,300	1.7%
3,700	3.3%
3,800	1.7%
3,850	1.7%
3,900	3.3%
4,400	1.7%
4,800	1.7%
5,000	1.7%
7,000	1.7%
Mean	2,643

Table D–31. Number of Levels

Number of Levels	Percent of Respondents (n=60)
One Story	43.3%
Two Story	51.7%
Bi-Level	3.3%
Tri-Level	1.7%
Three Story	0.0%

Table D–32. Number of Bedrooms

Number of Bedrooms	Percent of Respondents (n=60)
2	5.0%
3	51.7%
4	36.7%
5	6.7%
Mean	3.5

Table D–33. Number of People in Household–Total

Number of People	Percent of Respondents (n=60)
1	3.3%
2	26.7%
3	20.0%
4	28.3%
5	15.0%
6	6.7%
Mean	3.5

Table D–34. Number of People in Household–17 Years Old or Younger

Number of People	Percent of Respondents (n=60)
0	36.7%
1	18.3%
2	25.0%
3	16.7%
4	3.3%
Mean	1.3

Table D–35. Number of People in Household–Between 18–65 Years Old

Number of People	Percent of Respondents (n=60)
0	1.7%
1	3.3%
2	81.7%
3	10.0%
4	3.3%
Mean	2.1

Table D–36. Number of People in Household–Over 65 Years Old

Number of People	Percent of Respondents (n=60)
0	98.3%
1	0.0%
2	1.7%
Mean	0.03

Table D–37. Highest Level of Education

Education Level	Percent of Respondents (n=60)
High School Graduate	23.3%
Some Technical School or College	11.7%
Technical School Graduate (Associates Degree)	10.0%
College Graduate (Bachelors Degree)	30.0%
Advanced Degree (Masters Degree or Higher)	25.0%

Table D–38. Income Level

Income Level	Percent of Respondents (n=60)
$10,000–$14,999	0.0%
$15,000–$19,999	0.0%
$20,000–$29,999	0.0%
$30,000–$39,999	5.0%
$40,000–$49,999	10.0%
$50,000–$74,999	16.7%
$75,000–$99,999	21.7%
$100,000 or More	36.7%
Refused	10.0%

Table D–39. Gender

Gender	Percent of Respondents (n=60)
Male	61.7%
Female	38.3%

APPENDIX E: WESH HOMEOWNER WITHOUT ECM FURNACE INTERVIEW RESULTS–DETAILS

Appendix E provides detailed results from interviews with WESH homeowners who do not have an ECM furnace that support the analysis in the report.

Table E–1. Owned Home with Forced Air Furnace (FAF) Previous to WESH Home

Owned Home with FAF	Percent of Respondents (n=90)
Owned Home with FAF	62.2%
Owned Home with No FAF	6.7%
Not Owned Home	31.1%

Table E–2. Furnace Fan Operation Method during Heating Season

Operation Method	Percent of Respondents (n=90)	
	WESH Home	Previous Home*
Auto	68.9%	83.3%
Continuous	21.1%	12.2%
Sporadic	10.0%	4.4%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–3. Furnace Fan Operation Method during Heating Season in Previous and WESH Home

Operation Method		Percent of Respondents (n=90)
Previous Home*	WESH Home	
Auto		67.8%
Continuous		11.1%
Auto	Continuous	10.0%
Auto	Sporadic	5.6%
Sporadic		4.4%
Continuous	Auto	1.1%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–4a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Heating Season—High Level Categorization

Reason	Percent of Respondents (n=14)[1]
Air circulation	21.4%
√ *Contractor advice: Air circulation*	*14.3%*
Even temperature	0.0%
√ *Contractor advice: Even temperature*	*7.1%*
Air filtration	14.3%
√ *Contractor advice: Air filtration*	*0.0%*
Integration with ventilation system	0.0%
√ *Contractor advice: Integration with ventilation system*	*7.1%*
√ *Contractor advice: Dual system*	*7.1%*
Moisture control	21.4%
√ *Contractor advice: Moisture control*	*28.6%*
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	50%
Percent of *Responses* Relating to Contractor Advice	53%

[1] A total of 17 responses were given by the 14 respondents.

Table E–4b. Reasons for Changing Operation Method during Heating Season from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=9)
Because of moisture build up on the windows during the winter. Did not have moisture problem in previous home *(Moisture control)*
Builder said should leave it on during the heating season for the first couple of years to remove moisture. Will switch to auto next year *(Builder advice: Moisture control)*
Builder said to run it continually in order to control moisture. Builder recommended doing this only in the winter and plan to continue doing this every winter *(Builder advice: Moisture control)*
Has a "special" fan that runs efficiently (a DC motor). It is a variable speed fan that runs a bit slower when heating the home. It keeps the air fresh and is always filtering the air *(Air filtration)*
Heating contractor said to run the fan all the time because house has a dual system (thermostat upstairs and downstairs) *(Contractor advice: Dual system)*
Run the fan continuously because have an air to air exchanger. Builder said to keep it on all the time for the first year in order to remove moisture. Not sure if will continue to run continuously because haven't thought about it until now *(Builder advice: Integration with ventilation system/Moisture control)*

Reasons
To circulate the air based on contractor advice. Keeps the air fresher and filters the air. Temperature is more even from room to room *(Contractor advice: Air circulation/Air filtration/Even temperature)*
To keep fresh air circulating in the house. The builder recommended doing this. Will continue this long-term *(Builder advice: Air circulation)*
Was told to run continuously by the contractor. It vents out the humidity. The installer of Aprilaire system recommended to run continuously all the time, not just first year *(Contractor advice: Moisture control)*
Changed from Auto to Sporadic (n=5)
To humidify the air (have an Aprilaire humidifier) when the house gets dry. Did not have a problem with humidity in previous home and did not have an Aprilaire humidifier at the time *(Moisture control)*
To move heat from the basement to the rest of the house when have the woodstove in the basement going. Did not have a woodstove before *(Air circulation)*
To remove dust from the air when vacuuming the floors as suggested by the Aprilaire cleaner filter instructions. Did not know about filtering the air while vacuuming the floors until read the Aprilaire instructions *(Air filtration)*
On the very coldest days during the winter when have guests to keep guest bedrooms in the basement warmer *(Air circulation)*
To circulate the heat more and bring the humidity down when in the house for extended periods of time *(Air circulation/Moisture control)*
Changed from Continuous to Auto (n=1)
Used to run fan all of the time in old home to keep a more balanced temperature. In new home, have an air-to-air exchanger that has a separate fan that runs all of the time during the heating season to circulate air so are able to keep furnace fan in auto mode *(Different ventilation system)*

Table E–5. Reasons for Using Continuous/Sporadic Operation Method during Heating Season in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=10)
Advised by the builder to leave it on for circulation. Intends to continue to run the fan always 365/7/24 *(Builder advice:/ Air circulation)*
Builder recommended leaving the fan on to remove moisture. Ran fan all of the time in previous home because liked having the air circulate around the house to keep the temperature more even *(Builder advice: Moisture control/Air circulation/Even temperature)*
Developer said that it would be a good way to keep moisture down in new house. Not sure if will continue practice. Will be asking developer in a meeting set up for next week *(Builder advice: Moisture control)*
For air movement and circulation *(Air circulation)*
Heard that that is the better way to do it. Can't remember were heard it (was not the builder or a contractor) and doesn't really understand why it is better *(Better way)*
Keeps the air circulating and the heat more evenly distributed *(Air circulation/Even temperature)*
Not exactly sure why, but remembers the contractor saying to leave it on for the first year to remove extra construction dust. Not sure if will change operation in the future, but will be looking into it with builder *(Contractor advice: Air filtration)*

Reasons
Recommended by the builder that should run fan 24/7/365. The idea that it would be better for circulating the air for more even air flow and temperature *(Builder advice: Air circulation/Even temperature)*
Advised by the builder to leave it on for circulation. Intends to continue to run the fan always 365/7/24 *(Builder advice: Air circulation)*
Builder recommended to leave the fan on to remove moisture. Ran fan all of the time in previous home because liked having the air circulate around the house to keep the temperature more even *(Builder advice: Moisture control/Air circulation/Even temperature)*
Sporadic Before and After (n=4)
Contractor advised leaving the fan on all of the time to circulate the air, ventilate the house, and deal with moisture. Does not like the cold air coming through the vents so will run on auto next year *(Contractor advice: Air circulation/Moisture control)*
Told to leave the fan on all the time for the first year, but do not like the way it cools the house down in the winter, so turns it on when notice condensation on the windows *(Moisture control)*
Occasionally will turn the fan on toward the end of the day to move air around the house without turning the furnace up *(Air circulation)*
When fireplace is running and it is very warm in the room that has the fireplace will run the fan to move the warm air throughout the house. Had a wood burning stove in old house and did the same thing there *(Air circulation)*

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–6. Heating Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Auto	0	Sporadic	12	1 day per month	2 hours per day	1 day/month x 6 months x 2 hours/day
Auto	0	Sporadic	14	1–2 days per month	2 hours per day	1.5 days/month x 6 months x 2 hours/day x 78% furnace cycling adjustment factor
Auto	0	Sporadic	49	1 to 2 days per month	6 to 8 hours per day	1.5 days/month x 6 months x 7 hours/day x 78% furnace cycling adjustment factor
Auto	0	Sporadic	337	9 days per month	8 hours per day	9 days/month x 6 months x 8 hours/day x 78% furnace cycling adjustment factor

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	0	Sporadic	1,123	10 days per month	24 hours per day	10 days/month x 6 months x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	12	Sporadic	12	2 to 3 days per month	1 hour per day	2.5 days/month x 6 months x 1 hour/day x 78% furnace cycling adjustment factor
Sporadic	360	Sporadic	360	Everyday during the winter	2 hours per day	180 days x 2 hours/day
Sporadic	597	Sporadic	597	15 days per month	8–9 hours per day	15 days/month x 6 months x 8.5 hours/day x 78% furnace cycling adjustment factor
Sporadic	1,310	Sporadic	1,310	20 days per month	12–16 hours per day	20 days/month x 6 months x 14 hours/day x 78% furnace cycling adjustment factor

Table E–7. Central Air Conditioner Ownership

Owned Central Air Conditioner	Percent of Respondents	
	WESH Home (n=90)	**Previous Home* (n=62)**
Yes	97.8%	82.3%
No	2.2%	17.7%

* 28 respondents did not own a home previous to WESH.

Table E–8. Furnace Fan Operation Method during Cooling Season

Operation Method	Percent of Respondents (n=90)	
	WESH Home	**Previous Home***
Auto	61.1%	68.9%
Continuous	28.9%	21.1%
Sporadic	10.0%	10.0%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–9. Furnace Fan Operation Method during Cooling Season in Previous and WESH Home

Operation Method		Percent of Respondents (n=90)
Previous Home*	WESH Home	
Auto		58.9%
Continuous		18.9%
Sporadic		10.0%
Auto	Continuous	10.0%
Continuous	Auto	2.2%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–10a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Cooling Season—High Level Categorization

Reason	Percent of Respondents (n=9)[1]
Air circulation	0.0%
√ *Contractor advice: Air circulation*	*33.3%*
Even temperature	0.0%
√ *Contractor advice: Even temperature*	*22.2%*
Air filtration	22.2%
√ *Contractor advice: Air filtration*	*11.1%*
Energy efficient/High efficiency fan	11.1%
√ *Contractor advice: Energy efficient*	*0.0%*
√ *Contractor advice: No specific reason*	*11.1%*
Moisture control	11.1%
√ *Contractor advice: Moisture control*	*11.1%*
Integration with ventilation system	0.0%
√ *Contractor advice: Integration with ventilation system*	*11.1%*
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	77%
Percent of *Responses* Relating to Contractor Advice	69%

[1] A total of 13 responses were given by the 9 respondents.

Table E–10b. Reasons for Changing Operation Method during Cooling Season from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=9)
Advised to operate continuously to keep dust out of the house and to circulate the air *(Builder advice: Air filtration/Air circulation)*
Contractor recommended because it would keep the temperature throughout the house more even *(Contractor advice: Even temperature)*
Has a "special" fan that runs efficiently (a DC motor). It is a variable speed fan that runs a bit slower when heating the home. It keeps the air fresh and is always filtering the air *(Energy efficient/Air filtration)*
Run the fan continuously because have an air to air exchanger. Builder said to keep it on all the time for the first year in order to remove moisture. Not sure if will continue to run continuously because haven't thought about it until now *(Builder advice: Integration with ventilation system/Moisture control)*
They were told to leave it on for the first year by the contractor. Will switch to back to auto *(Contractor advice: No specific reason)*
To circulate the air based on contractor advice. Keeps the air fresher and filters the air. Temperature is more even from room to room *(Contractor advice: Air filtration/Even temperature)*
To clean the dust out of the furnace and air. Will run auto next year *(Air filtration)*
To keep fresh air circulating in the house. The builder recommended to do this. Will continue this long-term *(Builder advice: Air circulation)*
Was told to run continuously by the contractor. It vents out the humidity. The installer of Aprilaire system recommended to run continuously all the time, not just first year *(Contractor advice: Moisture control)*
Changed from Continuous to Auto (n=2)
Needed to move the air around the previous house more, especially to move the cool air from the basement *(Air circulation)*
Ran it all the time because old home was quite a bit older and the basement was very cool. Therefore, running it all the time helped circulate the cool basement air around the house *(Air circulation)*

Table E–11. Reasons for Using Continuous/Sporadic Operation Method during Cooling Season in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=17)
Advised by the builder to leave it on for circulation. Intends to continue to run the fan always 365/7/24 *(Builder advice: Air circulation)*
Because the house just doesn't feel cool enough otherwise. Thinks that running the fan continually when CAC is turned on helps the home feel more comfortable/cooler. Also did this in old house *(Air circulation)*
Builder said to run the fan continuously at first to help pull moisture out of the building materials. Not sure how long will continue doing this *(Builder advice: Moisture control)*
Contractor advised leaving the fan on all of the time to circulate the air, ventilate the house, and deal with moisture. Does not like the cold air coming through the vents so will run on auto next year *(Contractor advice: Air circulation/Moisture control)*

Reasons
Contractor said it is better to run the fan all of the time to reduce the humidity in the house and it is better for the furnace to run it, especially during the first year. Do not do it during the heating season because do not like the cool air that is pushed out when the furnace is not running. Not sure how supposed to, or will, run the fan after the first year *(Contractor advice: Moisture control)*
Developer said that it would be a good way to keep moisture down in new house. Not sure if will continue practice. Will be asking developer in a meeting set up for next week *(Contractor advice: Moisture control)*
For air movement and circulation *(Air circulation)*
Heard that that is the better way to do it. Can't remember were heard it (was not the builder or a contractor) and doesn't really understand why it is better *(Better way)*
Not exactly sure why, but remembers the contractor saying to leave it on for the first year to remove extra construction dust. Not sure if will change operation in the future, but will be looking into it with builder *(Contractor advice: Air filtration)*
Recommended by the builder that should run fan 24/7/365. The idea that it would be better for circulating the air for more even air flow and temperature *(Builder advice: Air circulation/Even temperature)*
Run it continually because that is what the builder recommended. Said that next year plans to run it in auto during the cooling season *(Builder recommendation: No specific reason)*
To keep a more balance temperature. Do not run air-to-air exchanger during the cooling season so need to run furnace fan instead *(Even temperature)*
To move air around and balance the temperature throughout the house *(Air circulation)*
To move the cool air from the basement to the rest of the house *(Air circulation)*
Told to leave the fan on for the first year to remove moisture. Will probably switch to auto mode after there is no more condensation appearing on the windows *(Moisture control)*
Builder recommended leaving the fan on to remove moisture. Ran fan all of the time in previous home because liked having the air circulate around the house to keep the temperature more even *(Builder advice: Moisture control/Air circulation/Even temperature)*
To circulate air throughout the house. Also has dust allergies and has found that running the fan all of the time helps *(Air circulation/Air filtration)*
Sporadic Before and After (n=9)
Save energy by leaving the fan on when it is really hot out because circulating air and removing humidity *(Air circulation/Moisture control)*
To help circulate air *(Air circulation)*
To help keep the home feeling cooler and to circulate the air *(Air circulation)*
To circulate cool air from the basement up to the first floor during periods of sustained warm weather *(Air circulation)*
To circulate air every now and then if it is not a real hot day *(Air circulation)*
Only run it continually on very hot and humid days. Does this to keep the air moving and make the home more comfortable *(Air circulation)*
To circulate the cool air more and bring the humidity down when in the house for extended periods of time *(Air circulation/Moisture control)*
Move air around the house and cool the air temperature in the evenings when it is cooler outside *(Air circulation)*
To circulate the air and make the rooms more comfortable by bringing up cooler air from the basement on days when not necessarily need to have the CAC on. Did the same thing in old house *(Air circulation)*

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–12. Cooling Season Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Sporadic	11	Sporadic	11	1–2 days per month	Few hours per day	1.5 days/month x 3 months x 3 hours/day x 83% CAC cycling adjustment factor
Sporadic	28	Sporadic	28	4–5 days per year	2–3 hours per day	4.5 days/month x 3 months x 2.5 hours/day x 83% CAC cycling adjustment factor
Sporadic	108	Sporadic	108	1 to 2 days per month	24 hours per day	1.5 days/month x 3 months x 24 hours/day
Sporadic	149	Sporadic	149	2–3 days per month	24 hours per day	2.5 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	248	Sporadic	248	15 days per month	5 to 6 hours per day	15 days/month x 3 months x 5.5 hours/day
Sporadic	320	Sporadic	320	Don't Know	10–12 hours per day	35 days (at or above 85 degrees) x 11 hours/day x 83% CAC cycling adjustment factor
Sporadic	418	Sporadic	418	12 days per month	14 hours per day	12 days/month x 3 months x 14 hours/day x 83% CAC cycling adjustment factor
Sporadic	598	Sporadic	598	10 days per month	24 hours per day	10 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	648	Sporadic	648	Don't Know	Don't Know	27 days (between 80–84 degrees during Jun–Aug) x 24 hours per day

Table E–13. Furnace Fan Operation Method during Shoulder Periods

Operation Method	Percent of Respondents (n=90)	
	WESH Home	Previous Home*
Auto	75.6%	82.2%
Continuous	13.3%	7.8%
Sporadic	11.1%	10.0%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–14. Furnace Fan Operation Method during Shoulder Periods in Previous and WESH Home

Operation Method		Percent of Respondents (n=90)
Previous Home*	WESH Home	
Auto		75.6%
Sporadic		10.0%
Continuous		7.8%
Auto	Continuous	5.6%
Auto	Sporadic	1.1%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–15a. Reasons for Changing from Auto to Continuous/Sporadic Operation during Shoulder Periods–High Level Categorization

Reason	Percent of Respondents (n=6)[1]
Air circulation	0.0%
Contractor advice: Air circulation	*33.3%*
Air filtration	16.7%
Contractor advice: Air filtration	*16.7%*
Integration with ventilation system	0.0%
Contractor advice: Integration with ventilation system	*16.7%*
Contractor advice: Run continuous first year	*16.7%*
Moisture control	0.0%
Contractor advice: Moisture control	*33.3%*
Percent of *Respondents* Giving Reasons Relating to Contractor Advice	83%
Percent of *Responses* Relating to Contractor Advice	88%

[1] A total of 8 responses were given by the 6 respondents.

Table E–15b. Reasons for Changing Operation Method during Shoulder Periods from Previous to WESH Home

Reasons
Changed from Auto to Continuous (n=5)
Advised to operate continuously to keep dust out of the house and to circulate the air *(Builder advice: Air filtration/Air circulation)*
Contractor said it is better to run the fan all of the time to reduce the humidity in the house and it is better for the furnace to run it, especially during the first year. Do not do it during the heating season because do not like the cool air that is pushed out when the furnace is not running. Not sure how supposed to, or will, run the fan after the first year *(Contractor advice: Moisture control)*
Has a "special" fan that runs efficiently (a DC motor). It is a variable speed fan that runs a bit slower when heating the home. It keeps the air fresh and is always filtering the air *(Air filtration)*
Run the fan continuously because have an air to air exchanger. Builder said to keep it on all the time for the first year in order to remove moisture. Not sure if will continue to run continuously because haven't thought about it until now *(Builder advice: Moisture control/Integration with ventilation system)*
They were told to leave it on for the first year by the contractor. Will switch to back to auto *(Contractor advice: Run continuous first year)*
Changed from Auto to Sporadic (n=1)
To keep the air feeling fresher mainly on a few days in the spring and fall. Made change because of heating contractor's advice *(Contractor advice: Air circulation)*

Table E–16. Reasons for Using Continuous/Sporadic Operation Method during Shoulder Periods in BOTH Previous and WESH Home*

Reasons
Continuous Before and After (n=7)
Advised by the builder to leave it on for circulation. Intends to continue to run the fan always 365/7/24 *(Builder advice: Air circulation)*
Builder recommended leaving the fan on to remove moisture. Ran fan all of the time in previous home because liked having the air circulate around the house to keep the temperature more even *(Builder advice: Moisture control/Air circulation/Even temperature)*
Developer said that it would be a good way to keep moisture down in new house. Not sure if will continue practice. Will be asking developer in a meeting set up for next week *(Builder advice: Moisture control)*
For air movement and circulation *(Air circulation)*
Not exactly sure why, but remembers the contractor saying to leave it on for the first year to remove extra construction dust. Not sure if will change operation in the future, but will be looking into it with builder *(Contractor advice: Air filtration)*
Recommended by the builder that should run fan 24/7/365. The idea that it would be better for circulating the air for more even air flow and temperature *(Builder advice: Air circulation/Even temperature)*
Told to leave the fan on for the first year to remove moisture. Will probably switch to auto mode after there is no more condensation appearing on the windows *(Builder advice: Moisture control)*

Reasons
Sporadic Before and After (n=9)
To circulate the air in the house when it is not hot enough to justify turning the AC on but kind of warm *(Air circulation)*
To circulate air *(Air circulation)*
To circulate air around the house and to move cool or warm air from one room to another if some rooms are hot or cool *(Air circulation)*
To circulate the air so it doesn't get stale and to cool the air down a bit *(Air circulation)*
To move the air around a little. Try to keep the air from feeling like it is getting stale on days when the temperature is on the border of being "hot" *(Air circulation)*
To circulate cool air from the basement up to the first floor during periods of sustained warm weather *(Air circulation)*
To help regulate the temperature of the house without turning on CAC or furnace when the weather is getting a little warm or cool out. Typically run overnight *(Air circulation)*
To circulate air throughout the house. Also has dust allergies and has found that running the fan all of the time helps. Runs fan continuously when the windows are closed. Turns the fan off (auto mode) when the windows are open *(Air circulation/Air filtration)*
To exchange the air in the house with fresh air during rainy days especially *(Air circulation)*

Table E–17. Furnace Fan Operation Method across All Seasons

Operation Method			Percent of Respondents (n=90)	
Heating Season	**Cooling Season**	**Shoulder Periods**	**WESH Home**	**Previous Home***
Auto			48.9%	64.4%
Continuous			8.9%	6.7%
Auto	Continuous	Auto	6.7%	7.8%
Auto		Sporadic	4.4%	4.4%
Continuous		Auto	4.4%	2.2%
Auto	Continuous		3.3%	0.0%
Sporadic	Auto		3.3%	0.0%
Continuous	Auto		3.3%	0.0%
Auto	Sporadic		2.2%	3.3%
Auto	Sporadic	Auto	2.2%	2.2%
Sporadic		Auto	2.2%	2.2%
Continuous	Sporadic	Auto	2.2%	2.2%
Sporadic	Continuous	Auto	2.2%	1.1%
Auto	Continuous	Sporadic	1.1%	1.1%
Continuous		Sporadic	1.1%	1.1%
Sporadic	Continuous		1.1%	1.1%
Sporadic			1.1%	0.0%
Continuous	Auto	Sporadic	1.1%	0.0%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–18. Shoulder Period Sporadic Hours Assumptions

Before Installation of ECM Furnace		After Installation of ECM Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	**Sporadic Hours**	**Method**	**Sporadic Hours**	**Number of Days**	**Number of Hours Per Day**	
Auto	0	Sporadic	108	Don't Know	Don't Know	3 days/month x 3 months x 12 hours/day
Sporadic	8	Sporadic	8	2–3 days per month	1 hour per day	2.5 days/month x 3 months x 1 hour/day
Sporadic	16	Sporadic	16	1–2 days per month	3–4 hours per day	1.5 days/month x 3 months x 3.5 hours/day
Sporadic	27	Sporadic	27	Couple of days per month	Couple of hours per day	3 days/month x 3 months x 3 hours/day
Sporadic	61	Sporadic	61	4–5 days per month	3–6 hours per day	4.5 days/month x 3 months x 4.5 hours/day
Sporadic	180	Sporadic	180	2–3 days per month	24 hours per day	2.5 days/month x 3 months x 24 hours/day
Sporadic	216	Sporadic	216	8–10 days per month	8 hours per day	9 days/month x 3 months x 8 hours/day
Sporadic	300	Sporadic	300	10 days per month	10 hours per day	10 days/month x 3 months x 10 hours/day
Sporadic	580	Sporadic	580	Fan is running all of the time for 85% of the year	Fan is running all of the time for 85% of the year	(8800 hours x 85%) - 6900 hours
Sporadic	720	Sporadic	720	10 days per month	24 hours per day	10 days/month x 3 months x 24 hours/day

Table E–19. Changes in Furnace Fan Operation Method across All Seasons from Previous and WESH Home

Operation Method						Percent of Respondents (n=90)
Previous Home*			WESH Home			
Heating Season	Cooling Season	Shoulder Periods	Heating Season	Cooling Season	Shoulder Periods	
Auto			Auto			46.7%
Auto			Continuous			2.2%
Auto	Sporadic	Auto	Auto	Sporadic	Auto	2.2%
Continuous			Continuous			6.7%
Auto			Continuous		Auto	3.3%
Auto			Continuous	Auto		3.3%
Auto			Auto	Continuous		2.2%
Auto			Continuous	Auto	Sporadic	1.1%
Auto	Continuous	Auto	Auto			2.2%
Auto	Continuous	Auto	Auto	Continuous		1.1%
Auto	Continuous	Auto	Sporadic	Continuous	Auto	1.1%
Auto	Continuous	Sporadic	Auto	Continuous	Sporadic	1.1%
Auto	Sporadic		Sporadic			1.1%
Continuous		Auto	Auto	Continuous	Auto	1.1%
Continuous	Sporadic	Auto	Continuous	Sporadic	Auto	2.2%
Sporadic	Continuous		Sporadic	Continuous		1.1%
Auto	Continuous	Auto	Auto	Continuous	Auto	3.3%
Continuous		Auto	Continuous		Auto	1.1%
Auto		Sporadic	Auto		Sporadic	4.4%
Auto			Auto	Continuous	Auto	2.2%
Auto			Sporadic	Auto		3.3%
Sporadic		Auto	Sporadic		Auto	2.2%
Continuous		Sporadic	Continuous		Sporadic	1.1%
Sporadic	Continuous	Auto	Sporadic	Continuous	Auto	1.1%
Auto	Sporadic		Auto	Sporadic		2.2%

* For the 34 respondents who either owned a home with no FAF or did not own a home previous to WESH, the operation method in the "previous home" is assumed to be the same as that in the WESH home.

Table E–20. Homeowners Received Furnace Fan Operation Advice from Builder or HVAC Contractor

Received Furnace Fan Operation Advice	Percent of Respondents (n=90)
Yes	45.6%
No	53.3%
Don't Know	1.1%

Table E–21. Type of Advice Received from Builder or HVAC Contractor

Type of Advice	Percent of Respondents (n=41)
About the various settings that could be used *(Explain basic operation)*	2.4%
Basic operation such as how to set the thermostat to auto and to on *(Explain basic operation)*	7.3%
Basic orientation on operating the system *(Explain basic operation)*	2.4%
Builder didn't say anything but HVAC contractor said to run it continually to keep the heat more even throughout the house. Had problems keeping part of the home heated well at times and also had problems with the furnace being able to catch up after it *(Continuous operation: Even temperature)*	2.4%
Builder said that running the fan all of the time was not expensive *(Continuous operation: Not expensive)*	2.4%
Builder said to operate the fan 24/7/365 *(Continuous operation: No specific reason)*	2.4%
Contractor talked about the amount of electricity it would use *(Energy use)*	2.4%
Does not remember exactly what was said *(Not recall specifics)*	7.3%
Fan uses very little electricity, about the same as a 60 or 100 watt light bulb. Should leave it on all the time in the winter for sure, but could leave it on all year also *(Continuous operation: Little energy usage)*	2.4%
Have the option to run the fan all of the time *(How to operate)*	2.4%
How to operate the fan continually during the first year or so but don't know if said anything about how much energy the fan uses *(Continuous operation: First year)*	2.4%
How to turn the fan on and to turn the fan on if want to circulate the air *(How to turn fan on)*	2.4%
HVAC contractor/builder initially said to run the fan all the time and it would keep temperatures more even *(Continuous operation: Even temperature)*	2.4%
It would cost about $1 a month to run the fan continuously. Should run the fan continuously when first move in *(Continuous operation: Low cost)*	2.4%
Kind of remembers that the builder said to leave the fan on for the first year to remove construction dust. Said nothing about the energy efficiency of the motor *(Continuous operation: First year/Air filtration)*	2.4%
Leave the fan on 365/7/24 always, not just the first year *(Continuous operation: No specific reason)*	2.4%
Leave the fan on all year for the first year to remove new construction moisture from the house *(Continuous operation: First year/Moisture control)*	2.4%
Leave the fan on auto for the first year *(Continuous operation: No specific reason)*	2.4%

Type of Advice	Percent of Respondents (n=41)
Leave the fan on continuously and that it would hardly use any electricity *(Continuous operation: Low energy use)*	2.4%
Leave the fan on continuously and that it wouldn't take that much more energy to do this *(Continuous operation: Low energy use)*	2.4%
Leave the fan on continuously during the heating season *(Continuous operation: No specific reason)*	2.4%
Leave the fan on to remove moisture *(Continuous operation: Moisture control)*	2.4%
Leave the fan running all the time for the first year to remove moisture and that would consume more electricity in doing so *(Continuous operation: First year/Moisture control/Low energy use)*	2.4%
Operate continuously and that it would not use that much more electricity to do this *(Continuous operation: Low energy use)*	2.4%
Operate the fan continuously for the first year. Did not say what to do during the second year so are not sure what will do *(Continuous operation: First year)*	2.4%
Operation of the fan *(How to operate fan)*	2.4%
Realtor talked about the efficiency of the fan (doesn't remember what was said) and contractor gave a quick run through on basic operation *(Basic operation)*	2.4%
Received some information but never read it *(Not recall specifics)*	2.4%
Run continuously all year and that it wouldn't be using that much electricity by doing so *(Continuous operation: Low energy use)*	2.4%
Run the fan all the time *(Continuous operation: No specific reason)*	7.3%
Run the fan continuously during the cooling season will use less electricity in the long run because the CAC will not have run as much *(Continuous operation: Low energy use)*	2.4%
Run the fan continuously for the first 6 months to a year, but said it would use more energy *(Continuous operation: First year)*	2.4%
Run the fan continually during the first few months *(Continuous operation: First year)*	2.4%
Run the fan continuously for the first 6 months in order to remove dust and to help pull moisture out of the building materials *(Continuous operation: First year/Air filtration/Moisture control)*	2.4%
Run the fan continuously the first year *(Continuous operation: First year)*	2.4%

Table E–22. How Often Furnace Filter Is Changed

Frequency	Percent of Respondents (n=90)
Every 2 years	2.2%
Every 1–3 years (It is a very thick 4" filter)	1.1%
Every 1–2 years (Checks every 3 months)	1.1%
Every 1–2 years (Has an Aprilaire filter)	1.1%
Annually	18.9%
Annually (Checks monthly)	1.1%
Annually (Cleans every 6 months)	1.1%
Annually (Electrostatic filter)	1.1%

Frequency	Percent of Respondents (n=90)
Annually (Has a 4" filter)	1.1%
Plans to annually (Has been changing it more often during the first year because of the construction dust)	1.1%
Once or twice per year	1.1%
Every 8 months	1.1%
Twice per year	25.6%
Twice per year (Had to change it after the first six months because of the construction debris, but doesn't really know how often will be changing it in the future. Has an Aprilaire filter)	1.1%
Plans to twice per year (Has been changing it 3 times per year for the first year. Has a thick Aprilaire filter)	1.1%
2–3 times per year	2.2%
2–3 times per year (Checks every 3 months)	1.1%
3 times per year	4.4%
3–4 times per year	1.1%
4 times per year	12.2%
6 times per year	2.2%
Monthly	8.9%
Monthly (During the winter, but every 2 months in the summer)	1.1%
Cleans every 6 weeks (It is not a changeable filter)	1.1%
Cleans monthly (Has a cleanable filter that does not need to be changed)	1.1%
Cleans every 60–90 days (Electronic filter)	1.1%
Cleans once per quarter	1.1%
Don't Know	2.2%

Table E–23. Bought New Refrigerator for WESH Home

New Refrigerator	Percent of Respondents (n=90)
Bought New	92.2%
Brought from Previous Home	7.8%
Bought Used	0.0%

Table E–24. Bought New Clothes Dryer for WESH Home

New Clothes Dryer	Percent of Respondents (n=90)
Bought New	62.2%
Brought from Previous Home	35.6%
Bought Used	2.2%

Table E–25. Clothes Dryer Fuel Type

Clothes Dryer Fuel Type	Percent of Respondents			
	Overall (n=90)	Bought New (n=56)	Brought from Previous Home (n=32)	Bought Used (n=2)
Electric	77.8%	76.8%	78.1%	100.0%
Gas	22.2%	23.2%	21.9%	0.0%

Table E–26. Bought New Clothes Washer for WESH Home

New Clothes Washer	Percent of Respondents (n=90)
Bought New	63.3%
Brought from Previous Home	34.4%
Bought Used	2.2%

Table E–27. Bought New Dishwasher for WESH Home

New Dishwasher	Percent of Respondents (n=90)
Bought New	98.9%
Brought from Previous Home	0.0%
Bought Used	0.0%
No Dishwasher	1.1%

Table E–28. Builder Discussed Types of Appliances for WESH Home

Builder Discussed Types of Appliances	Percent of Respondents (n=90)
Yes	20.0%
No	76.7%
Don't Know	3.3%

Table E–29. Builder Encouraged Purchase of Energy Efficient Appliances for WESH Home

Builder Encouraged Energy Efficient Appliances	Percent of Respondents (n=18)
Yes	94.4%
No	0.0%
Don't Know	5.7%

Table E–30. Size of WESH Home

Size	Percent of Respondents (n=90)
900	1.1%
1,200	1.1%
1,300	2.2%
1,360	1.1%
1,400	2.2%
1,485	1.1%
1,500	8.9%
1,556	1.1%
1,580	1.1%
1,600	2.2%
1,680	1.1%
1,700	3.3%
1,730	1.1%
1,750	2.2%
1,800	7.8%
1,836	1.1%
1,850	1.1%
1,900	4.4%
2,000	6.7%
2,050	1.1%
2,100	3.3%
2,125	1.1%
2,150	2.2%
2,200	2.2%
2,300	4.4%
2,400	2.2%
2,480	1.1%
2,500	2.2%
2,562	1.1%
2,600	2.2%
2,700	4.4%
2,800	1.1%
2,850	1.1%
3,000	3.3%
3,100	3.3%
3,200	1.1%
3,350	1.1%
3,500	1.1%
3,600	2.2%

Size	Percent of Respondents (n=90)
4,000	1.1%
4,200	1.1%
5,000	2.2%
Don't Know	2.2%
Mean	2,218

Table E–31. Number of Levels

Number of Levels	Percent of Respondents (n=90)
One Story	46.7%
Two Story	42.2%
Bi-Level	2.2%
Tri-Level	5.6%
Three Story	3.3%

Table E–32. Number of Bedrooms

Number of Bedrooms	Percent of Respondents (n=90)
2	4.4%
3	61.1%
4	33.3%
5	1.1%
Mean	3.3

Table E–33. Number of People in Household–Total

Number of People	Percent of Respondents (n=90)
1	5.6%
2	45.6%
3	20.0%
4	21.1%
5	6.7%
7	1.1%
Mean	2.8

Table E–34. Number of People in Household–17 Years Old or Younger

Number of People	Percent of Respondents (n=90)
0	60.0%
1	16.7%
2	15.6%
3	6.7%
5	1.1%
Mean	0.7

Table E–35. Number of People in Household–Between 18–65 Years Old

Number of People	Percent of Respondents (n=90)
0	2.2%
1	7.8%
2	77.8%
3	10.0%
4	1.1%
5	1.1%
Mean	2.0

Table E–36. Number of People in Household–Over 65 Years Old

Number of People	Percent of Respondents (n=90)
0	96.7%
1	1.1%
2	2.2%
Mean	0.1

Table E–37. Highest Level of Education

Education Level	Percent of Respondents (n=90)
Some High School	0.0%
High School Graduate	8.9%
Some Technical School or College	15.6%
Technical School Graduate (Associates Degree)	12.2%
College Graduate (Bachelors Degree)	53.3%
Advanced Degree (Masters Degree or Higher)	10.0%

Table E–38. Income Level

Income Level	Percent of Respondents (n=90)
$10,000–$14,999	0.0%
$15,000–$19,999	0.0%
$20,000–$29,999	1.1%
$30,000–$39,999	1.1%
$40,000–$49,999	5.6%
$50,000–$74,999	24.4%
$75,000–$99,999	31.1%
$100,000 or More	25.6%
Refused	11.1%

Table E–39. Gender

Gender	Percent of Respondents (n=90)
Male	70.0%
Female	30.0%

APPENDIX F: NONPARTICIPANT FURNACE REPLACER INTERVIEW RESULTS– DETAILS

Appendix F provides detailed results from interviews with nonparticipants who have replaced their furnace in the last year that support the analysis in the report.

Table F–1. Furnace Fan Operation Method during Heating Season

Operation Method	Percent of Respondents (n=36)	
	After Installation of Furnace	Before Installation of Furnace
Auto	91.7%	94.4%
Continuous	5.6%	2.8%
Sporadic	2.8%	2.8%

Table F–2. Furnace Fan Operation Method during Heating Season before and after Installation of Furnace

Operation Method		Percent of Respondents (n=36)
Before Installation of Furnace	After Installation of Furnace	
Auto		91.7%
Auto	Continuous	2.8%
Continuous		2.8%
Auto	Sporadic	0.0%
Sporadic		2.8%
Sporadic	Continuous	0.0%
Continuous	Auto	0.0%

Table F–3. Reasons for Changing Operation Method during Heating Season after Installation of Furnace

Reasons
Changed from Auto to Continuous (n=1)
Because that's what the furnace guy said to do with this new furnace *(Contractor advice: Best way)*

Table F–4. Reasons for Using Continuous/Sporadic Operation Method during Heating Season BOTH before and after Installation of Furnace

Reasons
Continuous Before and After (n=1)
Have an air purifier on furnace *(Air filtration)*
Sporadic Before and After (n=1)
Turns the fan on to run all the time when sister comes over because she has allergies and it seems to help *(Air filtration)*

Table F–5. Heating Season Sporadic Hours Assumptions

Before Installation of Furnace		After Installation of Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Sporadic	112	Sporadic	112	4 days per month	6 hours per day	4 days/month x 6 months x 6 hours/day x 78% furnace cycling adjustment factor

Table F–6. Central Air Conditioner Ownership

Owned Central Air Conditioner	Percent of Respondents (n=36)	
	After Installation of Furnace	Before Installation of Furnace
Yes	80.6%	55.6%
No	19.4%	44.4%

Table F–7. Furnace Fan Operation Method during Cooling Season

Operation Method	Percent of Respondents (n=36)	
	After Installation of Furnace	Before Installation of Furnace
Auto	77.8%	83.3%
Continuous	13.9%	8.3%
Sporadic	8.3%	8.3%

Table F–8. Changes in Furnace Fan Operation Method during Cooling Season after Installation of Furnace

Operation Method		Percent of Respondents (n=36)
Before Installation of Furnace	After Installation of Furnace	
Auto		77.8%
Auto	Continuous	5.6%
Continuous		8.3%
Sporadic		8.3%
Sporadic	Continuous	0.0%
Auto	Sporadic	0.0%
Continuous	Auto	0.0%

Table F–9. Reasons for Changing Operation Method during Cooling Season after Installation of Furnace

Reasons
Changed from Auto to Continuous (n=2)
Because that's what the furnace guy said to do with this new furnace *(Contractor advice: Best way)*
To make sure circulating cool air as much as possible between the two floors of house *(Air circulation)*

Table F–10. Reasons for Using Continuous/Sporadic Operation Method during Cooling Season BOTH before and after Installation of Furnace

Reasons
Continuous Before and After (n=3)
Because it keeps the air moving *(Air circulation)*
Have an air purifier on furnace *(Air filtration)*
For more even cooling *(Even temperature)*
Sporadic Before and After (n=3)
To help circulate air when have the windows open *(Air circulation)*
Turns the fan on to help circulate the cool air without turning the air on *(Air circulation)*
On a rare occasion will turn the fan on to help bring the cool air up from the basement *(Air circulation)*

Table F–11. Cooling Season Sporadic Hours Assumptions

Before Installation of Furnace		After Installation of Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Sporadic	38	Sporadic	38	2–3 days per month	4–6 hours per day	2.5 days/month x 3 months x 5 hours/day
Sporadic	53	Sporadic	53	2–3 days per month	6–8 hours per day	2.5 days/month x 3 months x 7 hours/day
Sporadic	288	Sporadic	288	4 days per month	24 hours per day	4 days/month x 3 months x 24 hours/day

Table F–12. Furnace Fan Operation Method during Shoulder Periods

Operation Method	Percent of Respondents (n=36)	
	After Installation of Furnace	Before Installation of Furnace
Auto	88.9%	91.7%
Continuous	5.6%	2.8%
Sporadic	5.6%	5.6%

Table F–13. Changes in Furnace Fan Operation Method during Shoulder Periods after Installation of Furnace

Operation Method		Percent of Respondents (n=36)
Before Installation of Furnace	After Installation of Furnace	
Auto		88.9%
Auto	Continuous	2.8%
Continuous		2.8%
Sporadic		5.6%
Auto	Sporadic	0.0%
Sporadic	Continuous	0.0%

Table F–14. Reasons for Changing Operation Method during Shoulder Periods after Installation of Furnace

Reasons
Changed from Auto to Continuous (n=1)
Because that's what the furnace guy said to do with this new furnace *(Contractor advice: Best way)*

Table F–15. Reasons for Using Continuous/Sporadic Operation Method during Shoulder Periods BOTH before and after Installation of Furnace

Reasons
Continuous Before and After (n=1)
Have an air purifier on furnace *(Air filtration)*
Sporadic Before and After (n=2)
To help circulate air when have the windows open *(Air circulation)*
Turns the fan on to bring in cool air if it's warm in the house and cool outside *(Air circulation)*

Table F–16. Shoulder Period Sporadic Hours Assumptions

Before Installation of Furnace		After Installation of Furnace		Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
Method	Sporadic Hours	Method	Sporadic Hours	Number of Days	Number of Hours Per Day	
Sporadic	168	Sporadic	168	8 days per month	6–8 hours per day	8 days/month x 3 months x 7 hours/day
Sporadic	720	Sporadic	720	10 days per month	24 hours per day	10 days/month x 3 months x 24 hours/day

Table F–17. Furnace Fan Operation Method across All Seasons

Operation Method			Percent of Respondents (n=36)	
Heating Season	Cooling Season	Shoulder Periods	After Installation of Furnace	Before Installation of Furnace
Auto			77.8%	83.3%
Continuous			5.6%	2.8%
Auto	Sporadic	Auto	2.8%	2.8%
Auto	Continuous	Auto	5.6%	2.8%
Sporadic		Auto	2.8%	2.8%
Auto	Continuous	Sporadic	2.8%	2.8%
Auto	Sporadic		2.8%	2.8%

Table F–18. Changes in Furnace Fan Operation Method across All Seasons after Installation of Furnace

Operation Method						Percent of Respondents (n=36)
Before Installation of Furnace			After Installation of Furnace			
Heating Season	Cooling Season	Shoulder Periods	Heating Season	Cooling Season	Shoulder Periods	
Auto			Auto			77.8%
Auto			Continuous			2.8%
Auto	Sporadic	Auto	Auto	Sporadic	Auto	2.8%
Continuous			Continuous			2.8%
Auto			Auto	Continuous	Auto	2.8%
Auto	Continuous	Auto	Auto	Continuous	Auto	2.8%
Auto	Continuous	Sporadic	Auto	Continuous	Sporadic	2.8%
Auto	Sporadic		Auto	Sporadic		2.8%
Sporadic		Auto	Sporadic		Auto	2.8%

Table F–19. Homeowner Received Furnace Fan Operation Advice from HVAC Contractor or Salespeople

Received Furnace Fan Operation Advice	Percent of Respondents (n=36)
Yes	25.0%
No	50.0%
Don't Know	25.0%

Table F–20. Type of Advice Received from HVAC Contractor or Salespeople

Type of Advice	Percent of Respondents (n=9)
About the energy efficiency of it *(Energy efficiency)*	11.1%
Better off to run the fan all the time, but quit doing that in the winter once saw first bill *(Continuous operation: No specific reason)*	11.1%
Briefly went over information *(General information)*	11.1%
It's a 92% efficiency furnace *(Energy efficiency)*	11.1%
It's the most efficient model one can get *(Energy efficiency)*	11.1%
Run the fan all the time because it's a very efficient model and will cost little *(Continuous operation: Energy efficient/Cost little)*	11.1%
Run the fan all the time in the summer *(Continuous operation: No specific reason)*	11.1%
Said that it has a high efficiency DC motor fan and that it uses little energy *(Energy efficiency)*	11.1%
Talked about the efficiency level *(Energy efficiency)*	11.1%

Table F–21. Type of Furnace

How Furnace Is Vented	Percent of Respondents (n=36)
Up the Chimney	27.8%
Out Side of House (1 Large Plastic Pipe)	13.9%
Out Side of House (2 Large Plastic Pipe)	44.4%
Don't Know	13.9%

Table F–22. How Often Furnace Filter Is Changed

Frequency	Percent of Respondents (n=36)
Every couple of years (It's an Aprilaire)	2.8%
Annually	5.6%
Twice per year	13.9%
6 times per year	2.8%
4–6 times per year	8.3%
4 times per year	8.3%
Every few months	5.6%
Monthly	30.6%
Clean it every other week (Haven't had to change it yet)	2.8%
Cleaned monthly (It's washable)	2.8%
Washed monthly (It doesn't need replacing)	2.8%
Washed every 4–6 weeks	2.8%
Washed every other month (It doesn't need replacing)	2.8%
It's an electronic air cleaner that only needs to be run through the dishwasher on occasion	2.8%
Don't Know	5.6%

Table F–23. Own or Rent Residence

Own or Rent	Percent of Respondents (n=36)
Own	94.4%
Rent	2.8%
Refused	2.8%

Table F–24. Type of Residence

Type	Percent of Respondents (n=36)
Single Family Home	91.7%
Duplex or Triplex	8.3%

Table F–25. Size of Residence

Size	Percent of Respondents (n=36)
888	2.8%
950	2.8%
1,000	5.6%
1,100	2.8%
1,200	5.6%
1,250	2.8%
1,300	2.8%
1,400	5.6%
1,500	8.3%
1,700	5.6%
1,900	5.6%
2,000	8.3%
2,300	2.8%
2,400	2.8%
2,500	2.8%
2,600	2.8%
3,000	2.8%
Don't Know	25.0%
Refused	2.8%
Mean	1,661

Table F–26. Number of Levels

Number of Levels	Percent of Respondents (n=36)
One Story	38.9%
Two Story	58.3%
Refused	2.9%

Table F–27. Number of Bedrooms

Number of Bedrooms	Percent of Respondents (n=36)
2	16.7%
3	50.0%
4	22.2%
5	8.3%
Refused	2.8%
Mean	3.2

Table F–28. Number of Years in Home

Number of Years	Percent of Respondents (n=36)
1	2.8%
3	2.8%
4	8.3%
5	2.8%
6	5.6%
9	5.6%
10	16.7%
11	2.8%
13	5.6%
14	2.8%
15	5.6%
17	5.6%
18	2.8%
20	8.3%
22	2.8%
25	2.8%
33	2.8%
35	2.8%
37	2.8%
44	2.8%
Refused	5.6%
Mean	14.7

Table F–29. Year Home Built

Year	Percent of Respondents (n=36)
1880	2.8%
1885	2.8%
1890	2.8%
1900	8.3%
1904	5.6%
1928	2.8%
1930	5.6%
1935	5.6%
1943	2.8%
1945	2.8%
1948	2.8%
1950	2.8%
1955	2.8%
1959	2.8%
1960	2.8%
1965	2.8%
1967	5.6%
1968	2.8%
1969	2.8%
1970	2.8%
1975	2.8%
1976	2.8%
1979	2.8%
1989	2.8%
1990	2.8%
1993	2.8%
1994	2.8%
Don’t Know	5.6%
Refused	2.8%
Mean	1945

Table F–30. Number of People in Household–Total

Number of People	Percent of Respondents (n=36)
1	11.1%
2	36.1%
3	13.9%
4	16.7%
5	8.3%
6	2.8%
7	2.8%
Refused	8.3%
Mean	2.9

Table F–31. Number of People in Household–17 Years Old or Younger

Number of People	Percent of Respondents (n=36)
0	58.3%
1	13.9%
2	13.9%
4	5.6%
Refused	8.3%
Mean	0.7

Table F–32. Number of People in Household–Between 18–65 Years Old

Number of People	Percent of Respondents (n=36)
0	13.9%
1	11.1%
2	50.0%
3	11.1%
4	2.8%
5	2.8%
Refused	8.3%
Mean	1.9

Table F–33. Number of People in Household–Over 65 Years Old

Number of People	Percent of Respondents (n=36)
0	69.4%
1	8.3%
2	13.9%
Refused	8.3%
Mean	0.4

Table F–34. Highest Level of Education

Education Level	Percent of Respondents (n=36)
High School Graduate	16.7%
Some Technical School or College	30.6%
Technical School Graduate (Associates Degree)	16.7%
College Graduate (Bachelors Degree)	13.9%
Advanced Degree (Masters Degree or Higher)	16.7%
Refused	5.6%

Table F–35. Income Level

Income Level	Percent of Respondents (n=36)
$15,000–$19,999	2.8%
$20,000–$29,999	8.3%
$30,000–$39,999	5.6%
$40,000–$49,999	19.4%
$50,000–$74,999	22.2%
$75,000–$99,999	11.1%
$100,000 or More	2.8%
Refused	27.8%

Table F–37. Gender

Gender	Percent of Respondents (n=36)
Male	52.8%
Female	47.2%

APPENDIX G:NONPARTICIPANT NON-REPLACER INTERVIEW RESULTS–DETAILS

Appendix G provides detailed results from interviews with nonparticipants who have not replaced their furnace in the last year that support the analysis in the report.

Table G–1. Furnace Fan Operation Method during Heating Season

Operation Method	Percent of Respondents (n=100)
Auto	91.0%
Continuous	3.0%
Sporadic	6.0%

Table G–2. Reasons for Using Continuous/Sporadic Operation Method during Heating Season

Reasons
Continuous (n=3)
Because have an old house that is very inefficient and it helps to keep the air moving and the temperature more even throughout *(Air circulation/Even temperature)*
Has a special filter with a laser that kills germs and it doesn't work if the fan is not running. Has a child with asthma and it helps with that *(Air filtration)*
Has children with allergies, so run the fan to help keep the air moving. Also have an ultra-violet light on furnace to help with the allergies *(Air filtration)*
Sporadic (n=6)
Has a finished walk-out lower level. Runs the fan because it helps to circulate the air throughout the entire house *(Air circulation)*
Have a wood stove and when it gets warm turns on the furnace fan to help circulate the air *(Air circulation)*
If it gets really cold out, run it all the time to help keep the warm air circulating *(Air circulation)*
It depends on how warm or cold it is. If it's warmer out, run the fan to help circulate the air because the wood stove can really kick out some heat *(Air circulation)*
Run it on the colder days so the house temperature remains more even *(Even temperature)*
The fan runs all night long and is shut off during the day. Have a 10-hour burn efficiency wood stove that runs all winter long *(Air circulation)*

Table G–3. Heating Season Sporadic Hours Assumptions

Method	Sporadic Hours	Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
		Number of Days	Number of Hours Per Day	
Sporadic	94	Depends	2 hours per day	(4500 hours/24 hours/day) x 25% x 2 hours/day
Sporadic	234	5 days per month	10 hours per day	5 days/month x 6 months x 10 hours/day x 78% furnace cycling adjustment factor
Sporadic	750	80% of the days	5 hours per day	(4500 hours/24 hours/day) x 80% x 5 hours/day
Sporadic	1,685	15 days per month	24 hours per day	15 days/month x 6 months x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	2,246	20 days per month	24 hours per day	20 days/month x 6 months x 24 hours/day x 78% furnace cycling adjustment factor
Sporadic	2,438	Every day during the heating season	12–14 hours per day	(4500 hours/24 hours/day) x 13 hours/day

Table G–4. Central Air Conditioner Ownership

Owned Central Air Conditioner	Percent of Respondents (n=100)
Yes	90.0%
No	10.0%

Table G–5. Furnace Fan Operation Method during Cooling Season

Operation Method	Percent of Respondents (n=100)
Auto	85.0%
Continuous	2.0%
Sporadic	13.0%

Table G–6. Reasons for Using Continuous/Sporadic Operation Method during Cooling Season

Reasons
Continuous (n=2)
Because have an old house that is very inefficient and it helps to keep the air moving and the temperature more even throughout *(Air circulation/Even temperature)*
By running the furnace fan all the time and the ceiling fans all the time, are able to only use the AC on extremely hot days *(Air circulation)*
Sporadic (n=13)
Don't use the AC much, so turn the fan on during the warmer days to help move air around *(Air circulation)*
Has a finished walk-out lower level. Runs the fan because it helps to circulate the air throughout the entire house *(Air circulation)*
In the summer when it's really hot, run the fan to bring the cool air from the basement up *(Air circulation)*
It's on auto when it's very warm and using the AC. It's on when it's not really that warm and not running the AC *(Air circulation)*
Run the fan separate from the AC a lot because it really helps move air and cools the house down *(Air circulation)*
Run the fan to help keep the house cool and at a more even temperature *(Even temperature)*
Sometimes in the summer turn the fan on to help circulate the air *(Air circulation)*
Sometimes turn the fan on to help keep the cool air circulating when it's really warm outside *(Air circulation)*
Sometimes when it's not quite warm enough to run the AC *(Air circulation)*
There are some times when the kids are pretty healthy where will shut the fan off, but it really runs the majority of the time *(Air filtration)*
To bring the cool air from the basement up. Did this for the first time this past summer. Did it on only on the two 90 degree days this summer *(Air circulation)*
When it's high humidity combined with high heat *(Air circulation)*
When the basement might be humid and it's not warm enough to run the AC, but want to circulate air in the home *(Air circulation)*

Table G–7. Cooling Season Sporadic Hours Assumptions

Method	Sporadic Hours	Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
		Number of Days	Number of Hours Per Day	
Sporadic	4	2 days per summer	2 hours per day	2 days x 2 hours/day
Sporadic	41	1–2 days per month	6–12 hours per day	1.5 days/month x 3 months x 9 hours/day
Sporadic	60	2–3 days per summer	24 hours per day	2.5 days x 24 hours/day
Sporadic	75	5 days per month	4–6 hours per day	5 days/month x 3 months x 5 hours/day

Method	Sporadic Hours	Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
		Number of Days	Number of Hours Per Day	
Sporadic	79	4–5 days per month	6–8 hours per day	4.5 days/month x 3 months x 7 hours/day x 83% CAC cycling adjustment factor
Sporadic	82	2–4 days per month	10–12 hours per day	3 days/month x 3 months x 11 hours/day x 83% CAC cycling adjustment factor
Sporadic	180	5 days per month	Varies	5 days/month x 3 months x 12 hours/day
Sporadic	225	5 days per month	15 hours per day	5 days/month x 3 months x 15 hours/day
Sporadic	360	10 days per month	12 hours per day	10 days/month x 3 months x 12 hours/day
Sporadic	366	21 days per month	7 hours per day	21 days/month x 3 months x 7 hours/day x 83% CAC cycling adjustment factor
Sporadic	896	15 days per month	24 hours per day	15 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	1,195	20 days per month	24 hours per day	20 days/month x 3 months x 24 hours/day x 83% CAC cycling adjustment factor
Sporadic	1,394	70% of the time	24 hours per day	2400 hours x 70% x 83% CAC cycling adjustment factor

Table G–8. Furnace Fan Operation Method during Shoulder Periods

Operation Method	Percent of Respondents (n=100)
Auto	87.0%
Continuous	2.0%
Sporadic	11.0%

Table G–9. Reasons for Using Continuous/Sporadic Operation Method during Shoulder Periods

Reasons
Continuous (n=2)
Because have an old house that is very inefficient and it helps to keep the air moving and the temperature more even throughout *(Air circulation/Even temperature)*
Has children with allergies, so run the fan to help keep the air moving. Also have an ultra-violet light on furnace to help with the allergies *(Air filtration)*
Sporadic (n=11)
For just a short period of time here and there, to help move air *(Air circulation)*
Has a finished walk-out lower level. Runs the fan because it helps to circulate the air throughout the entire house *(Air circulation)*
If use the fireplace, then turn the fan on to help circulate the warm air *(Air circulation)*
It depends on the temperature outside. If it's nice outside and the windows are open, then the fan is in auto mode. If the windows are closed, then the fan is running all the time, along with the ceiling fans *(Air circulation)*
There are some times when the kids are pretty healthy where will shut the fan off, but it really runs the majority of the time *(Air filtration)*
To help circulate the air when don't have our windows open *(Air circulation)*
To help circulate the air when it seems a little stuffy in the house *(Air circulation)*
To help circulate the air when the windows are not open *(Air circulation)*
Try to get the moisture out of the house or cool the house off, it just depends on the situation *(Moisture control)*
When it's nice outside and want to help circulate the fresh air *(Air circulation)*
When the basement might be humid and it's not warm enough to run the AC, but want to circulate air in the home *(Air circulation)*

Table G–10. Shoulder Period Sporadic Hours Assumptions

Method	Sporadic Hours	Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
		Number of Days	Number of Hours Per Day	
Sporadic	15	2–3 days per month	Couple of hours per day	2.5 days/month x 3 months x 2 hours/day
Sporadic	45	5 days per month	3 hours per day	5 days/month x 3 months x 3 hours/day
Sporadic	60	3–5 days per month	4–6 hours per day	4 days/month x 3 months x 5 hours/day
Sporadic	99	Don't Know (It depends on the situation)	4–6 hours per day	(1,900 hours/24 hours/day) x 25% x 5 hours/day
Sporadic	105	5 days per month	6–8 hours per day	5 days/month x 3 months x 7 hours/day
Sporadic	249	70% of the days	4–5 hours per day	(1,900 hours/24 hours/day) x 70% x 4.5 hours/day

Method	Sporadic Hours	Extent to which Operated Sporadically		Calculation for Estimating Number of Sporadic Hours
		Number of Days	Number of Hours Per Day	
Sporadic	288	4 days per month	24 hours per day	4 days/month x 3 months x 24 hours/day
Sporadic	360	10 days per month	12 hours per day	10 days/month x 3 months x 12 hours/day
Sporadic	950	Don't Know (It depends on the situation)	Don't Know (It depends on the situation))	50% x 1900 hours
Sporadic	1,330	70% of the time	24 hours per day	1900 hours x 70%
Sporadic	1,440	20 days per month	24 hours per day	20 days/month x 3 months x 24 hours/day

Table G–11. Furnace Fan Operation Method across All Seasons

Operation Method			Percent of Respondents (n=100)
Heating Season	Cooling Season	Shoulder Periods	
Auto			76.0%
Auto	Sporadic	Auto	6.0%
Auto		Sporadic	4.0%
Sporadic	Auto		4.0%
Auto	Sporadic		4.0%
Continuous			1.0%
Sporadic			1.0%
Continuous	Sporadic		1.0%
Sporadic		Auto	1.0%
Continuous	Auto	Continuous	1.0%
Auto	Continuous	Sporadic	1.0%

Table G–12. Type of Furnace

How Furnace Is Vented	Percent of Respondents (n=100)
Up the Chimney	41.0%
Out Side of House (1 Large Plastic Pipe)	27.0%
Out Side of House (2 Large Plastic Pipe)	24.0%
Don't Know	8.0%

Table G–13. Age of Furnace

Age	Percent of Respondents (n=100)
1–2 Years	9.0%
3–5 Years	24.0%
6–10 Years	20.0%
More Than 10 Years	44.0%
Don't Know	3.0%

Table G–14. How Often Furnace Filter Is Changed

Frequency	Percent of Respondents (n=100)
Every 2 years	2.0%
Every 2 years (Cleaned on a regular basis)	1.0%
Every 2 years (Has a space guard filter)	1.0%
Every 2 years (It's a high efficiency filter)	1.0%
Annually	17.0%
Annually (Doesn't have to change it very often because doesn't use it very much. Mostly use wood stove in the winter and doesn't run the furnace)	1.0%
Twice per year	12.0%
2–3 times per year	1.0%
3–4 times per year	2.0%
3–4 times per year (Has an air purifying filter that's a whole unit and doesn't need replacing every month)	1.0%
4 times per year	9.0%
4 times per year (Uses the high-allergen filters)	1.0%
4–5 times per year	1.0%
4–6 times per year	2.0%
6 times per year	9.0%
6–12 times per year	4.0%
Monthly	18.0%
Monthly (Can also vacuum the filters so sometimes do that instead of replacing)	1.0%
Bi-Weekly	1.0%
Cleaned monthly (It's electronic filter that is not changed)	1.0%
Cleaned monthly (It has a hose with an electrostatic filter so it doesn't have to be replaced all the time, just cleaned)	1.0%
Cleaned twice per year (Doesn't have a filter that needs to be changed, it just needs to be cleaned)	1.0%
Cleaned twice per year (Don't replace it)	1.0%
Has an electrostatic air cleaner that is washed, not changed	1.0%
Sometimes just clean it because have a washable filter (Don't always replace it)	1.0%
There is no filter on the furnace	1.0%

Frequency	Percent of Respondents (n=100)
When it's needed	1.0%
Whenever think of it	1.0%
Don't Know	6.0%

Table G–15. Own or Rent Residence

Own or Rent	Percent of Respondents (n=100)
Own	99.0%
Rent	1.0%

Table G–16. Type of Residence

Type	Percent of Respondents (n=100)
Single Family Home	94.0%
Row or Townhouse	3.0%
Duplex or Triplex	3.0%

Table G–17. Size of Residence

Size	Percent of Respondents (n=100)
850	1.0%
920	1.0%
1,000	3.0%
1,066	1.0%
1,100	3.0%
1,200	5.0%
1,250	2.0%
1,300	3.0%
1,382	1.0%
1,400	6.0%
1,450	1.0%
1,500	8.0%
1,600	1.0%
1,700	3.0%
1,800	3.0%
1,900	3.0%
1,930	1.0%
2,000	8.0%

Size	Percent of Respondents (n=100)
2,050	1.0%
2,100	3.0%
2,200	4.0%
2,300	3.0%
2,400	4.0%
2,500	4.0%
2,600	2.0%
2,800	2.0%
2,900	1.0%
3,000	4.0%
3,200	1.0%
3,300	2.0%
3,400	1.0%
4,000	1.0%
4,800	1.0%
Don't Know	12.0%
Mean	1,953

Table G–18. Number of Levels

Number of Levels	Percent of Respondents (n=100)
One Story	55.0%
Two Story	36.0%
Bi-Level	8.0%
Tri-Level	1.0%

Table G–19. Number of Bedrooms

Number of Bedrooms	Percent of Respondents (n=100)
2	11.0%
3	66.0%
4	18.0%
5	2.0%
6	1.0%
Refused	2.0%
Mean	3.1

Table G–20. Number of Years in Home

Number of Years	Percent of Respondents (n=100)
1	3.0%
2	2.0%
3	5.0%
4	3.0%
5	8.0%
6	5.0%
7	4.0%
8	4.0%
9	2.0%
10	5.0%
11	2.0%
12	2.0%
13	5.0%
14	2.0%
15	4.0%
16	3.0%
17	2.0%
18	1.0%
19	1.0%
20	7.0%
24	1.0%
25	3.0%
26	1.0%
27	3.0%
29	2.0%
30	2.0%
32	1.0%
33	1.0%
34	2.0%
35	3.0%
36	1.0%
38	1.0%
40	1.0%
41	1.0%
45	1.0%
47	1.0%
50	2.0%
53	1.0%
Refused	2.0%
Mean	16.9

Table G–21. Year Home Built

Year	Percent of Respondents (n=100)
1870	1.0%
1875	1.0%
1878	1.0%
1896	1.0%
1900	1.0%
1909	1.0%
1910	2.0%
1919	1.0%
1926	1.0%
1929	2.0%
1930	1.0%
1936	1.0%
1939	1.0%
1940	1.0%
1945	1.0%
1947	2.0%
1948	1.0%
1950	2.0%
1951	1.0%
1952	1.0%
1953	1.0%
1954	1.0%
1955	1.0%
1956	2.0%
1957	1.0%
1959	1.0%
1960	1.0%
1961	1.0%
1964	3.0%
1965	3.0%
1968	1.0%
1969	2.0%
1970	1.0%
1972	1.0%
1973	2.0%
1974	1.0%
1975	2.0%
1976	1.0%
1978	1.0%

Year	Percent of Respondents (n=100)
1979	4.0%
1980	4.0%
1981	1.0%
1983	3.0%
1984	3.0%
1986	1.0%
1987	1.0%
1989	1.0%
1990	1.0%
1992	1.0%
1993	5.0%
1994	2.0%
1995	4.0%
1996	2.0%
1997	1.0%
1998	2.0%
1999	2.0%
2000	2.0%
2001	2.0%
2003	1.0%
Don't Know	4.0%
Refused	2.0%
Mean	1966

Table G–22. Number of People in Household–Total

Number of People	Percent of Respondents (n=100)
1	10.0%
2	47.0%
3	17.0%
4	15.0%
5	7.0%
7	1.0%
Refused	3.0%
Mean	2.7

Table G–23. Number of People in Household–17 Years Old or Younger

Number of People	Percent of Respondents (n=100)
0	65.0%
1	12.0%
2	13.0%
3	6.0%
5	1.0%
Refused	3.0%
Mean	0.6

Table G–24. Number of People in Household–Between 18–65 Years Old

Number of People	Percent of Respondents (n=100)
0	17.0%
1	10.0%
2	61.0%
3	6.0%
4	3.0%
Refused	3.0%
Mean	1.7

Table G–25. Number of People in Household–Over 65 Years Old

Number of People	Percent of Respondents (n=100)
0	77.0%
1	6.0%
2	14.0%
Refused	3.0%
Mean	0.4

Table G–26. Highest Level of Education

Education Level	Percent of Respondents (n=100)
Some High School	1.0%
High School Graduate	29.0%
Some Technical School or College	20.0%
Technical School Graduate (Associates Degree)	11.0%
College Graduate (Bachelors Degree)	27.0%
Advanced Degree (Masters Degree or Higher)	7.0%
Refused	5.0%

Table G–27. Income Level

Income Level	Percent of Respondents (n=100)
Less than $10,000	1.0%
$10,000–$14,999	2.0%
$15,000–$19,999	3.0%
$20,000–$29,999	10.0%
$30,000–$39,999	8.0%
$40,000–$49,999	5.0%
$50,000–$74,999	19.0%
$75,000–$99,999	15.0%
$100,000 or More	5.0%
Refused	32.0%

Table G–28. Gender

Gender	Percent of Respondents (n=100)
Male	48.0%
Female	52.0%

APPENDIX H: HPWES PARTICIPANT INTERVIEW GUIDE

Introduction

Hello, may I please speak to _____. My name is _____. I am a researcher calling on behalf of the State of Wisconsin's Focus on Energy Program about the new furnace that was installed <*insert installation period*> in which you received a $150 rebate. We would like to ask you a few questions about how you operate this new furnace. This is important because it will help make Wisconsin's Focus on Energy Program better.

Confirm: (1) installation of new furnace and (2) speaking with the best person in home about furnace operation.

Heating Season Fan Operation – New Furnace (HN)

We are studying how people operate their furnace fans. This is the fan in your furnace that blows air through your ducts and vents. Let's first talk about how you operate the fan on your new furnace during the heating season. This is the time of the year when temperatures are cold enough that you need to run your furnace to heat your home.

HN1. Which of the following two statements best describes how you operate the fan on your new furnace during the heating season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the heating season.

- ❑ The fan blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.

  HN2. Do you ever operate the fan on your new furnace during the heating season so that it blows air through your ducts and vents when your furnace is not running and delivering warm air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the heating season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the heating season.

If CONTINUOUS or SPORADIC operation:

HN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

HN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

HN5. On average, how many days per month do you do this during the heating season?

_____

HN6. Thinking about the typical day when you do this during the heating season, about how many hours do you do this on average?

_____

Heating Season Fan Operation – Old Furnace (HO)

HO1. Did you also operate the fan this way on your old furnace during the heating season?

- ❑ Yes

  Confirm response: "So you operated the fan on your old furnace so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

- ❑ No

  Use approach from HN1 to classify.

Ask HD1 if old furnace heating operation is not the same as new furnace; otherwise, go to CN1

Heating Season Fan Operation – Difference in New vs. Old (HD)

HD1. Just to confirm, you said that you operate the fan on your new furnace during the heating season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old furnace during the heating season. Is this correct?

- ❑ Yes

  HD2. Why did you make this change? [Probe for specific reasons]

  _____

- ❑ No

  Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home.
AUTO →	It blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your furnace is not running and delivering warm air to your home.

Central Air Conditioner Ownership (CA)

CA1. Does your home have central air conditioning?

- ❑ Yes

  CA2. Did your home have central air conditioning before your new furnace was installed?

  - ❑ Yes
  - ❑ No

- ❑ No

Ask CN1 if have central air conditioning; otherwise, go to NN1

Cooling Season Fan Operation – New Furnace (CN)

Now let's talk about your new system again. But this time, let's talk about how you operate the fan during the cooling season. These are the times of the year when temperatures are warm enough that you decide to run your central air conditioner to cool your home.

CN1. Which of the following two statements best describes how you operate the fan on your new system during the cooling season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the cooling season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the cooling season.

- ❑ The fan blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.

  CN2. Do you ever operate the fan on your new system during the cooling season so that it blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the cooling season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the cooling season.

If CONTINUOUS or SPORADIC operation:

CN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

CN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

CN5. On average, how many days per month do you do this during the cooling season?

_____

CN6. Thinking about the typical day when you do this during the cooling season, about how many hours do you do this on average?

_____

Ask CO1 if had central air conditioning before new furnace was installed; otherwise, go to SN1

Cooling Season Fan Operation – Old Furnace (CO)

CO1. Did you also operate the fan this way on your old system during the cooling season?

- ❑ Yes

  Confirm response: "So you operated the fan on your old system so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

- ❑ No

  Use approach from CN1 to classify.

Ask CD1 if old system cooling operation is not the same as new system; otherwise, go to SN1

Cooling Season Fan Operation – Difference in New vs. Old (CD)

CD1. Just to confirm, you said that you operate the fan on your new system during the cooling season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old system during the cooling season. Is this correct?

- ❑ Yes

  CD2. Why did you make this change? [Probe for specific reasons]

  _____

- ❑ No

  Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home.
AUTO →	It blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home.

Shoulder Fan Operation – New Furnace (SN)

Now, let's talk about your new system again. But this time, let's talk about how you operate the fan during the periods between the heating and cooling seasons. These are the times of the year, particularly spring and fall, when you are not running your furnace to heat your home and not running your central air conditioner to cool your home.

SN1. Which of the following three statements best describes how you operate the fan on your new system during the periods between the heating and cooling seasons?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the periods between the heating and cooling seasons.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the periods between the heating and cooling seasons.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the periods between the heating and cooling seasons.

If CONTINUOUS or SPORADIC operation:

SN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

SN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

SN4. On average, how many days per month do you do this during the periods between the heating and cooling seasons?

_____

SN5. Thinking about the typical day when you do this during the periods between the heating and cooling seasons, about how many hours do you do this on average?

_____

Ask SO1 if had central air conditioning before new furnace was installed; otherwise, go to NO1

Shoulder Fan Operation – Old Furnace (SO)

SO1. Did you also operate the fan this way on your old system during the periods between the heating and cooling seasons?

- ❑ Yes

  Confirm response: "So you operated the fan on your old system so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

- ❑ No

  Use approach from SN1 to classify.

Ask SD1 if old system shoulder operation is not the same as new system; otherwise, go to CP1

Shoulder Season Fan Operation – Difference in New vs. Old (SD)

SD1. Just to confirm, you said that you operate the fan on your new system during the periods between the heating and cooling seasons such that *<insert appropriate operation method description from below>*; which is different than how you operated the fan on your old system during the periods between the heating and cooling seasons. Is this correct?

- ❑ Yes

  SD2. Why did you make this change? [Probe for specific reasons]

  _____

- ❑ No

  Clarify with respondent

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day.
AUTO →	It never blows air through your ducts and vents.
SPORADIC →	It occasionally blows air through your ducts and vents, but not all of the time.

Non-Heating Season Fan Operation – New Furnace (NN)

Now, let's talk about how you operate the fan on your new furnace during the non-heating season. This is the time of the year when you are not running your furnace to heat your home.

NN1. Which of the following three statements best describes how you operate the fan on your new furnace during the non-heating season?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the non-heating season.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the non-heating season.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the non-heating season.

If CONTINUOUS or SPORADIC operation:

NN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

NN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

NN4. On average, how many days per month do you do this during the non-heating season?

_____

NN5. Thinking about the typical day when you do this during the non-heating season, about how many hours do you do this on average?

_____

Non-Heating Season Fan Operation – Old Furnace (NO)

NO1. Did you also operate the fan this way on your old furnace during the non-heating season?

❑ Yes

Confirm response: "So you operated the fan on your old furnace so that it <insert appropriate operation method description from below> ". If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

❑ No

Use approach from NN1 to classify.

Ask ND1 if old furnace non-heating operation is not the same as new furnace; otherwise, go to CP1

Non-Heating Season Fan Operation – Difference in New vs. Old (ND)

ND1. Just to confirm, you said that you operate the fan on your new furnace during the non-heating season such that *<insert appropriate operation method description from below>*; which is different than how you operated the fan on your old furnace during the non-heating season. Is this correct?

❑ Yes

ND2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day.
AUTO →	It never blows air through your ducts and vents.
SPORADIC →	It occasionally blows air through your ducts and vents, but not all of the time.

Contractor Promotion (CP)

CP1. Did the furnace salespeople or contractors that you dealt with tell you anything about the amount of electricity used by the fan motor of your new furnace or about how to operate the fan on your new furnace?

1 Yes → (Go to CP2)
2 No → (Go to AA1)
98 (Don't know) → (Go to AA1)

CP2. What did they tell you? [Probe for specifics]

_____

Action in Absence of Program (AA)

AA1. How likely would you have been to purchase the same furnace if the $150 rebate were not available? Would you have been . . .

1 Very likely
2 Somewhat likely
3 Not very likely
4 Not at all likely
98 (Don't know)
99 (Refused)

Furnace Filter Changing Behavior (FF)

FF1. About how often is the filter on your furnace changed? [Probe for frequency and times of the year]

_____

Demographics (DE)

Finally, I would like to ask you a few questions about your household. These questions are for classification purposes only. All of your answers are confidential.

DE1. Do you own or rent this residence?

1 Own/buying
2 Rent/lease
97 (Other) Please describe: _____
98 (Don't know) 99 (Refused)

DE2. Which of the following best describes your home? Is it a . . .

1 Single family home (house on separate lot, includes modular homes)
2 Row or townhouse (adjacent walls to another house)
3 Duplex or triplex
4 Unit in a multi-family structure with 4 or more attached units (example: fourplex, single family house converted to flats apartment house, high-rise condominium, garden apartments)
5 Mobile home or house trailer
97 (Other) Please describe: _____
98 (Don't know) 99 (Refused)

Demographics (DE) – Continued

DE3. What is the approximate square footage of your home? This includes finished space and does not include garages or unfinished basements.

_____ Square feet [Enter 98 for Don't Know and 99 for Refused]

DE4. Is your home a . . . [Read list, Record one number]

1	One story home (ranch)	4	Bi-level
2	Two story home	5	Tri-level
3	Three story home		
97	(Other)	Please describe: _____	
98	(Don't know)	99	(Refused)

DE5. How many bedrooms does your home have?

_____ Bedrooms [Enter 98 for Don't Know and 99 for Refused]]

DE6. How many years have you lived at your home?

_____ Years [If less than one year, record 0. Enter 998 for Don't Know and 999 for Refused]

DE7. In approximately what year was your home built?

_____ Year Built [Enter 9998 for Don't Know and 9999 for Refused]

DE8. Thinking of the people who live in your home full-time (including yourself) how many are:

a	_____	17 years old or younger
b	_____	Between the ages of 18 and 65
c	_____	Over 65 years old
d	_____	Total [Confirm total]

DE9. What is the highest level of education you have completed?

1	Some high school		
2	High school graduate		
3	Some technical school or college		
4	Technical school graduate (associates degree)		
5	College graduate (bachelors degree)		
6	Advanced degree (masters degree or higher)		
98	(Don't know)	99	(Refused)

DE10. Which of the following income categories best describes your total annual household income in 2002, before taxes? Please stop me when I get to the right category. Is it . . .

1	Less than $10,000	7	$50,000–$74,999
2	$10,000–$14,999	8	$75,000–$ 99,999
3	$15,000–$19,999	9	$100,000 or more
4	$20,000–$29,999	98	(Don't know)
5	$30,000–$39,999	99	(Refused)
6	$40,000–$49,999		

DE11. [RECORD GENDER] 1 Male 2 Female

Those are all the questions I have. Thank you for your help on this very important research study.

APPENDIX I: WESH HOMEOWNER (WITH AND WITHOUT ECM FURNACE) INTERVIEW GUIDE

Introduction

Hello, may I please speak to _____. My name is _____. I am a researcher calling on behalf of the State of Wisconsin's Focus on Energy Program about your new home. According to our records you participated in the Wisconsin ENERGY STAR Homes program. This program certified that your home met comfort, safety, durability, and energy efficiency standards and also may have provided rebates for energy efficient equipment and appliances. We would like to ask you a few questions about how you operate your furnace fan. This is important because it will help make Wisconsin's Focus on Energy Program better.

Confirm: (1) move-in date and (2) that speaking with the best person in home about furnace operation.

Central Air Conditioner Ownership (CA)

CA1. Before we start, does your new home have central air conditioning?

- ❑ Yes
- ❑ No

Previous Home (PH)

PH1. Also, did you own a home previous to this one or are you a first-time homeowner?

- ❑ Owned home previously

  PH2. Did your previous home have central air conditioning?

  - ❑ Yes → (Go to HN1)
  - ❑ No

- ❑ First-time homeowner

Heating Season Fan Operation – New Home (HN)

Okay, let's start. As I said, we are studying how people operate their furnace fans. This is the fan in your furnace that blows air through your ducts and vents. Let's first talk about how you operate the fan on the furnace in your new home during the heating season. This is the time of the year when temperatures are cold enough that you need to run your furnace to heat your home.

HN1. Which of the following two statements best describes how you operate the fan on the furnace in your new home during the heating season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the heating season.

- ❑ The fan blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.

  HN2. Do you ever operate the fan on the furnace in your new home during the heating season so that it blows air through your ducts and vents when your furnace is not running and delivering warm air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the heating season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the heating season.

If CONTINUOUS or SPORADIC operation:

HN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

HN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

HN5. On average, how many days per month do you do this during the heating season?

_____

HN6. Thinking about the typical day when you do this during the heating season, about how many hours do you do this on average?

_____

Ask HO1 if had previous home; otherwise, go to CN1

Heating Season Fan Operation – Previous Home (HO)

HO1. Did you also operate the fan this way on the furnace in your previous home during the heating season?

❑ Yes

Confirm response: "So you operated the fan on the furnace in your previous home so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

❑ No

Use approach from HN1 to classify.

Ask HD1 if old furnace heating operation is not the same as new furnace; otherwise, go to CN1

Heating Season Fan Operation – Difference in New vs. Previous (HD)

HD1. Just to confirm, you said that you operate the fan on the furnace in your new home during the heating season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on the furnace in your previous home during the heating season. Is this correct?

❑ Yes

HD2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home.
AUTO →	It blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your furnace is not running and delivering warm air to your home.

Ask CN1 if new home has central air conditioning; otherwise, go to NN1

Cooling Season Fan Operation – New Furnace (CN)

Now let's talk about the system in your new home again. But this time, let's talk about how you operate the fan during the cooling season. These are the times of the year when temperatures are warm enough that you decide to run your central air conditioner to cool your home.

CN1. Which of the following two statements best describes how you operate the fan on the system in your new home during the cooling season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the cooling season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the cooling season.

- ❑ The fan blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.

  CN2. Do you ever operate the fan on your new system during the cooling season so that it blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the cooling season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the cooling season.

If CONTINUOUS or SPORADIC operation:

CN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

CN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

CN5. On average, how many days per month do you do this during the cooling season?

_____

CN6. Thinking about the typical day when you do this during the cooling season, about how many hours do you do this on average?

_____

Ask CO1 if had previous home with central air conditioning; otherwise, go to SN1

Cooling Season Fan Operation – Old Furnace (CO)

CO1. Did you also operate the fan this way on the system in your old home during the cooling season?

❑ Yes

Confirm response: "So you operated the fan on the system in your previous home so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

❑ No

Use approach from CN1 to classify.

Ask CD1 if old system cooling operation is not the same as new system; otherwise, go to SN1

Cooling Season Fan Operation – Difference in New vs. Old (CD)

CD1. Just to confirm, you said that you operate the fan on the system in your new home during the cooling season such that *<insert appropriate operation method description from below>*; which is different than how you operated the fan on the system in your previous home during the cooling season. Is this correct?

❑ Yes

CD2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home.
AUTO →	It blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home.

Shoulder Fan Operation – New Furnace (SN)

Now, let's talk about the system in your new home again. But this time, let's talk about how you operate the fan during the periods between the heating and cooling seasons. These are the times of the year, particularly spring and fall, when you are not running your furnace to heat your home and not running your central air conditioner to cool your home.

SN1. Which of the following three statements best describes how you operate the fan on the system in your new home during the periods between the heating and cooling seasons?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the periods between the heating and cooling seasons.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the periods between the heating and cooling seasons.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the periods between the heating and cooling seasons.

If CONTINUOUS or SPORADIC operation:

SN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

SN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

SN4. On average, how many days per month do you do this during the periods between the heating and cooling seasons?

_____

SN5. Thinking about the typical day when you do this during the periods between the heating and cooling seasons, about how many hours do you do this on average?

_____

Ask SO1 if had previous home with central air conditioning; otherwise, go to NO1

Shoulder Fan Operation – Old Furnace (SO)

SO1. Did you also operate the fan this way on the system in your previous home during the periods between the heating and cooling seasons?

❑ Yes

Confirm response: "So you operated the fan on the system in your previous home so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

❑ No

Use approach from SN1 to classify.

Ask SD1 if old system shoulder operation is not the same as new system; otherwise, go to CP1

Shoulder Season Fan Operation – Difference in New vs. Old (SD)

SD1. Just to confirm, you said that you operate the fan on the system in your new home during the periods between the heating and cooling seasons such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on the system in your previous home during the periods between the heating and cooling seasons. Is this correct?

❑ Yes

SD2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent

Operation Method Descriptions

CONTINUOUS → It always blows air through your ducts and vents, 24 hours a day.

AUTO → It never blows air through your ducts and vents.

SPORADIC → It occasionally blows air through your ducts and vents, but not all of the time.

Non-Heating Season Fan Operation – New Furnace (NN)

Now, let's talk about how you operate the fan on the furnace in your new home during the non-heating season. This is the time of the year when you are not running your furnace to heat your home.

NN1. Which of the following three statements best describes how you operate the fan on the furnace in your new home during the non-heating season?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the non-heating season.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the non-heating season.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the non-heating season.

If CONTINUOUS or SPORADIC operation:

NN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

NN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

NN4. On average, how many days per month do you do this during the non-heating season?

_____

NN5. Thinking about the typical day when you do this during the non-heating season, about how many hours do you do this on average?

_____

Ask NO1 if had previous home; otherwise, go to CP1

Non-Heating Season Fan Operation – Old Furnace (NO)

NO1. Did you also operate the fan this way on the furnace in your previous home during the non-heating season?

❑ Yes

Confirm response: "So you operated the fan on the furnace in your previous home so that it <insert appropriate operation method description from below> ". If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

❑ No

Use approach from NN1 to classify.

Ask ND1 if old furnace non-heating operation is not the same as new furnace; otherwise, go to CP1

Non-Heating Season Fan Operation – Difference in New vs. Old (ND)

ND1. Just to confirm, you said that you operate the fan on your new furnace during the non-heating season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old furnace during the non-heating season. Is this correct?

❑ Yes

ND2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day.
AUTO →	It never blows air through your ducts and vents.
SPORADIC →	It occasionally blows air through your ducts and vents, but not all of the time.

Contractor Promotion (CP)

CP1. Did your home's builder or contractors tell you anything about the amount of electricity used by the fan motor of the furnace in your new home or about how to operate the fan on the furnace in your new home?

1 Yes → (Go to CP2)
2 No → (Go to FF1)
98 (Don't know) → (Go to FF1)

CP2. What did they tell you? [Probe for specifics]

_____

Furnace Filter Changing Behavior (FF)

FF1. About how often is the filter changed on the furnace in your new home? [Probe for frequency and times of the year]

_____

Appliances (AP)

Now, I'd like to ask a few questions about the types of appliances in your new home.

AP1. Did you buy a brand new refrigerator for your new home?

1 New
2 Refrigerator from previous home
3 Used
98 (Don't know)
99 (Refused)

AP2. Did you buy a brand new clothes dryer for your new home?

1 New → (Go to AP3)
2 Clothes dryer from previous home → (Go to AP3)
3 Used → (Go to AP3)
4 No clothes dryer → (Go to AP4)
98 (Don't know)
99 (Refused)

AP3. Is this an electric or gas clothes dryer?

1 Electric
2 Gas
98 (Don't know)
99 (Refused)

AP4. Did you buy a brand new clothes washer for your new home?

1 New
2 Clothes washer from previous home
3 Used
4 No clothes washer
98 (Don't know)
99 (Refused)

Appliances (AP) – Continued

AP5. Did you buy a brand new dishwasher for your new home?

1 New
2 Dishwasher from previous home
3 Used
4 No dishwasher
98 (Don't know)
99 (Refused)

AP6. Did your builder talk with you about the type of appliances to buy for your new home?

1 Yes → (Go to AP7)
2 No → (Go to DE3)
98 (Don't know) → (Go to DE3)
99 (Refused) → (Go to DE3)

AP7. Did your builder encourage you to buy energy efficient or ENERGY STAR appliances for your new home?

1 Yes
2 No
98 (Don't know)
99 (Refused)

Demographics (DE)

Finally, I would like to ask you a few questions about your household. These questions are for classification purposes only. All of your answers are confidential.

DE3. What is the approximate square footage of your home? This includes finished space and does not include garages or unfinished basements.

_____ Square feet [Enter 98 for Don't Know and 99 for Refused]

DE4. Is your home a . . . [Read list, Record one number]

1 One story home (ranch) 4 Bi-level
2 Two story home 5 Tri-level
3 Three story home
97 (Other) Please describe: _____
98 (Don't know) 99 (Refused)

DE5. How many bedrooms does your home have?

_____ Bedrooms [Enter 98 for Don't Know and 99 for Refused]]

DE8. Thinking of the people who live in your home full-time (including yourself) how many are:

a _____ 17 years old or younger
b _____ Between the ages of 18 and 65
c _____ Over 65 years old
d _____ Total [Confirm total]

Demographics (DE) – Continued

DE9. What is the highest level of education you have completed?

1	Some high school
2	High school graduate
3	Some technical school or college
4	Technical school graduate (associates degree)
5	College graduate (bachelors degree)
6	Advanced degree (masters degree or higher)
98	(Don't know)
99	(Refused)

DE10. Which of the following income categories best describes your total annual household income in 2002, before taxes? Please stop me when I get to the right category. Is it . . .

1	Less than $10,000	7	$50,000–$74,999
2	$10,000–$14,999	8	$75,000–$ 99,999
3	$15,000–$19,999	9	$100,000 or more
4	$20,000–$29,999	98	(Don't know)
5	$30,000–$39,999	99	(Refused)
6	$40,000–$49,999		

DE11. [RECORD GENDER] 1 Male 2 Female

Those are all the questions I have. Thank you for your help on this very important research study.

APPENDIX J: NONPARTICIPANT (REPLACERS AND NON-REPLACERS) INTERVIEW GUIDE

Introduction

Hello, may I please speak to _____. My name is _____. I am a researcher calling on behalf of the State of Wisconsin's Focus on Energy Program. This state-sponsored program offers Wisconsin residents information and rebates for making energy efficiency improvements. The reason for my call is that we are conducting a research study on how people operate their furnace fans. This study is very important to making Wisconsin's Focus on Energy Program better. Would you have a couple of minutes to talk about how you operate your furnace fan?

Confirm that speaking with the best person in home about furnace operation.

Please give respondents who are interested in learning more about Focus on Energy the information center number: (800)762-7077.

Demographics (DE) – Screening

DE2. Before we start, which of the following best describes your home? Is it a . . .

1 Single family home (house on separate lot, includes modular homes)
2 Row or townhouse (adjacent walls to another house)
3 Duplex or triplex
4 Unit in a multi-family structure with 4 or more attached units (example: fourplex, single family house converted to flats apartment house, high-rise condominium, garden apartments) → (Thank and terminate)
5 Mobile home or house trailer → (Thank and terminate)
97 (Other) Please describe: _____
98 (Don't know) → (Thank and terminate)
99 (Refused) → (Thank and terminate)

Forced Air Furnace (FA) – Screening

FA1. Also, do you heat your home with a forced air furnace? This is a heating system that delivers heat through ducts and vents in your home.

1 Yes
2 No → (Thank and terminate)
98 (Don't know) → (Clarify conversationally)
99 (Refused) → (Thank and terminate)

Insert 12 months for General NP sample and 18 months for NP Replacer sample

FA2. Finally, did you or someone else purchase a brand new furnace for your home during the last <*12 months/18 months*>?

1 Yes
2 No (*Thank and terminate for NP Replacer sample*)
98 (Don't know) → (Clarify conversationally)
99 (Refused) → (Thank and terminate)

Insert <TEXT> if replaced furnace (FA2)

Heating Season Fan Operation – New Furnace (HN)

Okay, let's start. As I said, we are studying how people operate their furnace fans. This is the fan in your furnace that blows air through your ducts and vents. Let's first talk about how you operate the fan on your <*NEW*> furnace during the heating season. This is the time of the year when temperatures are cold enough that you need to run your furnace to heat your home.

HN1. Which of the following two statements best describes how you operate the fan on your <*NEW*> furnace during the heating season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the heating season.

- ❑ The fan blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.

  HN2. Do you ever operate the fan on your <*NEW*> furnace during the heating season so that it blows air through your ducts and vents when your furnace is not running and delivering warm air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the heating season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering warm air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the heating season.

If CONTINUOUS or SPORADIC operation:

HN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

HN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

HN5. On average, how many days per month do you do this during the heating season?

_____

HN6. Thinking about the typical day when you do this during the heating season, about how many hours do you do this on average?

_____

Ask HO1 if replaced furnace (FA2); otherwise, go to CA1

Heating Season Fan Operation – Old Furnace (HO)

HO1. Did you also operate the fan this way on your old furnace during the heating season?

- ❑ Yes

  Confirm response: "So you operated the fan on your old furnace so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

- ❑ No

  Use approach from HN1 to classify.

Ask HD1 if old furnace heating operation is not the same as new furnace; otherwise, go to CN1

Heating Season Fan Operation – Difference in New vs. Old (HD)

HD1. Just to confirm, you said that you operate the fan on your new furnace during the heating season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old furnace during the heating season. Is this correct?

- ❑ Yes

  HD2. Why did you make this change? [Probe for specific reasons]

  _____

- ❑ No

  Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your furnace is running and delivering warm air to your home.
AUTO →	It blows air through your ducts and vents only when your furnace is running and delivering warm air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your furnace is not running and delivering warm air to your home.

Central Air Conditioner Ownership (CA)

CA1. Does your home have central air conditioning?

- ❑ Yes

  Ask CA2 if replaced furnace (FA2)

  CA2. Did your home have central air conditioning before your new furnace was installed?

  - ❑ Yes
  - ❑ No

- ❑ No

Ask CN1 if have central air conditioning; otherwise, go to NN1
Insert <TEXT> if replaced furnace (FA2)

Cooling Season Fan Operation – New Furnace (CN)

Now <*LET'S TALK ABOUT YOUR NEW SYSTEM AGAIN. BUT THIS TIME,*> let's talk about how you operate the fan during the cooling season. These are the times of the year when temperatures are warm enough that you decide to run your central air conditioner to cool your home.

CN1. Which of the following two statements best describes how you operate the fan on your <*NEW*> system during the cooling season?

- ❑ The fan always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the cooling season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the cooling season.

- ❑ The fan blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.

  CN2. Do you ever operate the fan on your <*NEW*> system during the cooling season so that it blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home?

  - ❑ Yes [SPORADIC]

    Confirm response: (1) "fan sometimes blows air through ducts and vents when furnace is not running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the cooling season.

  - ❑ No [AUTO]

    Confirm response: (1) "fan does not blow air through ducts and vents unless furnace is running and delivering cool air" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the cooling season.

If CONTINUOUS or SPORADIC operation:
CN3. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:
CN4. Please describe the types of situations when you do this? [Probe for specific situations]

_____

CN5. On average, how many days per month do you do this during the cooling season?

_____

CN6. Thinking about the typical day when you do this during the cooling season, about how many hours do you do this on average?

_____

Ask CO1 if replaced furnace (FA2)and if had central air conditioning before new furnace was installed; otherwise, go to SN1

Cooling Season Fan Operation – Old Furnace (CO)

CO1. Did you also operate the fan this way on your old system during the cooling season?

- ❑ Yes

  Confirm response: "So you operated the fan on your old system so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

- ❑ No

  Use approach from CN1 to classify.

Ask CD1 if old system cooling operation is not the same as new system; otherwise, go to SN1

Cooling Season Fan Operation – Difference in New vs. Old (CD)

CD1. Just to confirm, you said that you operate the fan on your new system during the cooling season such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old system during the cooling season. Is this correct?

- ❑ Yes

  CD2. Why did you make this change? [Probe for specific reasons]

  _____

- ❑ No

  Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day, regardless of whether or not your central air conditioner is running and delivering cool air to your home.
AUTO →	It blows air through your ducts and vents only when your central air conditioner is running and delivering cool air to your home.
SPORADIC →	It occasionally blows air through your ducts and vents when your central air conditioner is not running and delivering cool air to your home.

Insert <TEXT> if replaced furnace (FA2)

Shoulder Fan Operation – New Furnace (SN)

Now, *<LET'S TALK ABOUT YOUR NEW SYSTEM AGAIN. BUT THIS TIME,>* let's talk about how you operate the fan during the periods between the heating and cooling seasons. These are the times of the year, particularly spring and fall, when you are not running your furnace to heat your home and not running your central air conditioner to cool your home.

SN1. Which of the following three statements best describes how you operate the fan on your *<NEW>* system during the periods between the heating and cooling seasons?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the periods between the heating and cooling seasons.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the periods between the heating and cooling seasons.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the periods between the heating and cooling seasons" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the periods between the heating and cooling seasons.

If CONTINUOUS or SPORADIC operation:

SN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

SN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

SN4. On average, how many days per month do you do this during the periods between the heating and cooling seasons?

_____

SN5. Thinking about the typical day when you do this during the periods between the heating and cooling seasons, about how many hours do you do this on average?

_____

Ask SO1 if replaced furnace (FA2)and if had central air conditioning before new furnace was installed; otherwise, go to NO1

Shoulder Fan Operation – Old Furnace (SO)

SO1. Did you also operate the fan this way on your old system during the periods between the heating and cooling seasons?

❑ Yes

Confirm response: "So you operated the fan on your old system so that it <insert appropriate operation method description from below>." If operation method is SPORADIC for both old and new system, then probe for extent to which SPORADIC operation of the old system is the same or different from that of the new system.

❑ No

Use approach from SN1 to classify.

Ask SD1 if old system shoulder operation is not the same as new system; otherwise, go to CP1

Shoulder Season Fan Operation – Difference in New vs. Old (SD)

SD1. Just to confirm, you said that you operate the fan on your new system during the periods between the heating and cooling seasons such that <*insert appropriate operation method description from below*>; which is different than how you operated the fan on your old system during the periods between the heating and cooling seasons. Is this correct?

❑ Yes

SD2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day.
AUTO →	It never blows air through your ducts and vents.
SPORADIC →	It occasionally blows air through your ducts and vents, but not all of the time.

Insert <TEXT> if replaced furnace (FA2)

Non-Heating Season Fan Operation – New Furnace (NN)

Now, let's talk about how you operate the fan on your <*NEW*> furnace during the non-heating season. This is the time of the year when you are not running your furnace to heat your home.

NN1. Which of the following three statements best describes how you operate the fan on your <*NEW*> furnace during the non-heating season?

- ❑ The fan is always blowing air through your ducts and vents, 24 hours a day. [CONTINUOUS]

  Confirm response: (1) "fan constantly blows air through ducts and vents, every day for 24 hours a day during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to ON and never set to AUTO during the non-heating season.

- ❑ The fan is never blowing air through your ducts and vents. [AUTO]

  Confirm response: (1) "fan never blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is always set to AUTO and never set to ON during the non-heating season.

- ❑ The fan is occasionally blowing air through your ducts and vents, but not all of the time. [SPORADIC]

  Confirm response: (1) "fan sometimes blows air through ducts and vents during the non-heating season" and/or (2) talk about fan setting on thermostat to see if it is moved back and forth from AUTO to ON during the non-heating season.

If CONTINUOUS or SPORADIC operation:

NN2. Why do you operate the furnace fan this way? [Probe for specific reasons]

_____

If SPORADIC operation:

NN3. Please describe the types of situations when you do this? [Probe for specific situations]

_____

NN4. On average, how many days per month do you do this during the non-heating season?

_____

NN5. Thinking about the typical day when you do this during the non-heating season, about how many hours do you do this on average?

_____

Ask NO1 if replaced furnace (FA2); otherwise, go to FC1

Non-Heating Season Fan Operation – Old Furnace (NO)

NO1. Did you also operate the fan this way on your old furnace during the non-heating season?

❑ Yes

Confirm response: "So you operated the fan on your old furnace so that it <insert appropriate operation method description from below> ". If operation method is SPORADIC for both old and new furnace, then probe for extent to which SPORADIC operation of the old furnace is the same or different from that of the new furnace.

❑ No

Use approach from NN1 to classify.

Ask ND1 if old furnace non-heating operation is not the same as new furnace; otherwise, go to CP1

Non-Heating Season Fan Operation – Difference in New vs. Old (ND)

ND1. Just to confirm, you said that you operate the fan on your new furnace during the non-heating season such that *<insert appropriate operation method description from below>*; which is different than how you operated the fan on your old furnace during the non-heating season. Is this correct?

❑ Yes

ND2. Why did you make this change? [Probe for specific reasons]

_____

❑ No

Clarify with respondent.

Operation Method Descriptions

CONTINUOUS →	It always blows air through your ducts and vents, 24 hours a day.
AUTO →	It never blows air through your ducts and vents.
SPORADIC →	It occasionally blows air through your ducts and vents, but not all of the time.

Ask CP1 if replaced furnace (FA2); otherwise, go to FC1

Contractor Promotion (CP)

CP1. Did the furnace salespeople or contractors that you dealt with tell you anything about the amount of electricity used by the fan motor of your new furnace or about how to operate the fan on your new furnace?

1 Yes → (Go to CP2)
2 No → (Go to FC1)
98 (Don't know) → (Go to FC1)

CP2. What did they tell you? [Probe for specifics]

_____

Furnace Characteristics (FC)

Now, I'd like to ask about the type of furnace you have.

FC1. Some furnaces are vented up the chimney and others are vented out the side of the house. The furnaces vented out the side of the house have at least one white plastic pipe that goes out the side of the basement. Which of the following best describes your furnace's venting?

1 Furnace is vented up the chimney
2 Furnace has one large plastic pipe venting out the side of the house
3 Furnace has two large plastic pipes venting out the side of the house
98 (Don't know) 99 (Refused)

Ask FC2 if not replaced furnace (FA2); otherwise, go to FF1

FC2. Approximately how old is your furnace? Is your furnace . . .

1 Less than 1 year old
2 1 to 2 years old
3 3 to 5 years old
4 6 to 10 years old
5 More than 10 years old
98 (Don't know) 99 (Refused)

Furnace Filter Changing Behavior (FF)

FF1. About how often is the filter on your furnace changed? [Probe for frequency and times of the year]

_____

Demographics (DE)

Finally, I would like to ask you a few questions about your household. These questions are for classification purposes only. All of your answers are confidential.

DE1. Do you own or rent this residence?

1 Own/buying
2 Rent/lease
97 (Other) Please describe: _____
98 (Don't know)
99 (Refused)

Demographics (DE) – Continued

DE3. What is the approximate square footage of your home? This includes finished space and does not include garages or unfinished basements.

_____ Square feet [Enter 98 for Don't Know and 99 for Refused]

DE4. Is your home a . . . [Read list, Record one number]

1	One story home (ranch)	4	Bi-level
2	Two story home	5	Tri-level
3	Three story home		
97	(Other) Please describe: _____		
98	(Don't know)	99	(Refused)

DE5. How many bedrooms does your home have?

_____ Bedrooms [Enter 98 for Don't Know and 99 for Refused]]

DE6. How many years have you lived at your home?

_____ Years [If less than one year, record 0. Enter 998 for Don't Know and 999 for Refused]

DE7. In approximately what year was your home built?

_____ Year Built [Enter 9998 for Don't Know and 9999 for Refused]

DE8. Thinking of the people who live in your home full-time (including yourself) how many are:

a	_____	17 years old or younger
b	_____	Between the ages of 18 and 65
c	_____	Over 65 years old
d	_____	Total [Confirm total]

DE9. What is the highest level of education you have completed?

1	Some high school
2	High school graduate
3	Some technical school or college
4	Technical school graduate (associates degree)
5	College graduate (bachelors degree)
6	Advanced degree (masters degree or higher)
98	(Don't know) 99 (Refused)

DE10. Which of the following income categories best describes your total annual household income in 2002, before taxes? Please stop me when I get to the right category. Is it . . .

1	Less than $10,000	7	$50,000–$74,999
2	$10,000–$14,999	8	$75,000–$ 99,999
3	$15,000–$19,999	9	$100,000 or more
4	$20,000–$29,999	98	(Don't know)
5	$30,000–$39,999	99	(Refused)
6	$40,000–$49,999		

DE11. [RECORD GENDER] 1 Male 2 Female

Those are all the questions I have. Thank you for your help on this very important research study.