May 19, 2022

Ms. Lisa Felice
Michigan Public Service Commission
7109 W. Saginaw Hwy.
P. O. Box 30221
Lansing, MI 48909

Via E-Filing

RE: MPSC Case No. U-20836

Dear Ms. Felice:

The following is attached for paperless electronic filing:

Direct Testimony of Chris Neme and Exhibits MEC-74 to MEC-77 on behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and Citizens Utility Board of Michigan; and

Proof of Service

Sincerely,

Digitally signed by Tracy Jane Andrews
DN: cn=Tracy Jane Andrews, email=tjandrews@envlaw.com, c=US
Date: 2022.05.19 16:23:12 -04'00'

Tracy Jane Andrews
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xc: Parties to Case No. U-20836

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **DTE ELECTRIC COMPANY** for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority.	U-20836

DIRECT TESTIMONY OF CHRIS NEME

ON BEHALF OF

MICHIGAN ENVIRONMENTAL COUNCIL,
NATURAL RESOURCES DEFENSE COUNCIL, SIERRA CLUB,
AND
CITIZENS UTILITY BOARD OF MICHIGAN

May 19, 2022

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I. INTRODUCTIONS AND QUALIFICATIONS

Q. Please state your name, employer and business address.

A. My name is Chris Neme. I am a co-founder and Principal of Energy Futures Group, a consulting firm that provides specialized expertise on energy efficiency, demand response, renewable energy, strategic electrification and other clean energy markets, programs and policies. My business address is P.O. Box 587, Hinesburg, VT 05461.

Q. On whose behalf is this testimony being offered?

A. I am testifying on behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and the Citizens Utility Board of Michigan, collectively "MNSC."

Q. Please describe your educational background.

A. I received a Master of Public Policy degree from the University of Michigan (Ann Arbor) in 1986. That is a two-year, multi-disciplinary degree focused on applied economics, statistics and policy development. I also received a Bachelor's degree in Political Science from the University of Michigan (Ann Arbor) in 1985. My first year of graduate school counted towards both my Masters' and Bachelor's degrees.

Q. Please summarize your business and professional experience.

A. I have worked in the energy industry for more than twenty-five years for clients in more than 30 different states, half a dozen Canadian provinces and several European countries. My work has focused on utility system planning, with particular focus on markets, programs and policies regarding energy efficiency, demand response, and strategic electrification. That has included work on development and analysis of policies and pathways for decarbonizing the energy sector. Much of my work includes economic analysis, including benefit-cost analyses of various distributed energy resources and electrification measures. A copy of my curriculum vitae is attached as Exhibit MEC-74.

Q. Can you provide examples of projects on which you have worked since co-founding Energy Futures Group (EFG)?

A. I co-founded Energy Futures Group in 2010. Since then, I have played lead roles in a variety of energy efficiency consulting projects. Recent examples include:

- Representing NRDC in both informal consultations and contested regulatory proceedings in Michigan, Illinois and Ohio on energy efficiency and demand response program designs, cost-effectiveness analyses, evaluation, and shareholder incentive structures; distribution system planning and non-wires alternatives; electrification analysis, programs and policies; and integrated resource planning;
- Assisting the Sierra Club in providing technical input on gas utility decarbonization pathways and policies as part of the Massachusetts Future of Gas utility-stakeholder collaborative process and subsequent regulatory process;
- Co-leading a multi-stakeholder Vermont working group, co-authoring a white paper and providing legislative testimony and technical support on the policy concept of a Clean Heat Standard – a performance standard that would impose increasing annual obligations on Vermont Gas as well as the state's wholesale suppliers of fuel oil and propane to reduce greenhouse gas emissions;
- Serving as an appointed expert representative on both the Ontario Energy Board's Gas Integrated Resource Planning (IRP) Technical Working Group and its Evaluation and Audit Committee for gas demand-side management;

- Co-authoring the 2020 *National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources* (NSPM for DERs) and its 2017 predecessor *National Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources* (NSPM for EE), as well as providing technical support to numerous state regulators, utilities and other stakeholders in applying the guidance from these manuals;
- Leading a project for the Northeast Energy Efficiency Partnerships ("NEEP") to document lessons learned from utility and other efforts across the United States over the past 25 years to use geographically targeted efficiency programs (sometimes in concert with other distributed resources) to cost-effectively defer capital investment in transmission and/or distribution system infrastructure; and
- Drafting policy reports for the Regulatory Assistance Project on a variety of energy efficiency and related regulatory policy issues, such as whether 30% electric savings is achievable in ten years, the history of efforts across the United States to use geographically targeted efficiency programs to cost-effectively defer transmission and distribution system investments, and the history of bidding of efficiency resources into the PJM and New England capacity markets.

Q. Have you previously filed expert witness testimony in other proceedings before the Commission?

A. Yes. I filed testimony in the following Michigan Public Service Commission dockets:

- U-21090, regarding Consumers Energy's characterization and modeling of energy efficiency, demand response and conservation voltage regulation in its integrated resource plan;
- U-20881, regarding DTE's 2022-2023 gas waste reduction plan;

- U-20876, regarding DTE's 2022-2023 electric waste reduction plan;
- U-20697, regarding Consumers Energy's proposed shareholder incentive for investment conservation voltage regulation;
- U-20429, regarding DTE's 2020-2021 gas energy waste reduction plan;
- U-20373, regarding DTE's 2020-2021 electric energy waste reduction plan;
- U-20471, regarding DTE's assessment of energy efficiency resources in its Integrated Resource Plan;
- U-20164, regarding Consumers Energy's proposed new shareholder incentive mechanism for demand response programs;
- U-18419, regarding DTE's assessment of efficiency potential as part of its IRP put forward by the Company in support of a proposed new gas-fired power plant;
- U-18268, regarding DTE's proposed 2018-2019 gas energy efficiency programs (Energy Waste Reduction) plan;
- U-18262, regarding DTE's proposed 2018-2019 electric energy efficiency programs (Energy Waste Reduction) plan;
- U-18261, regarding Consumers Energy Company's proposed 2018-2021 energy efficiency programs (Energy Waste Reduction) plan;
- U-17771, regarding Consumers Energy Company's proposed amendment to its 2017 energy efficiency programs (Energy Waste Reduction) plan;
- U-17762, regarding DTE's proposed amendment to its 2017 energy efficiency programs (Energy Waste Reduction) plan;

- U-17429, regarding Consumers Energy's estimates of energy efficiency potential in its assessment of alternatives to its proposal to construct a new 700 MW gas-fired power plant (Thetford);
- U-17138, regarding Consumers Energy's proposed modifications to its 2013-2015 Energy Optimization plans;
- U-17049, regarding DTE's proposed modifications to its 2013-2015 Energy Optimization plan;
- U-16670, regarding Consumers Energy's biennial review and Amended Energy Optimization plan; and
- U-16671, regarding DTE's biennial review and Amended Energy Optimization plan.

Q. Have you been an expert witness on energy efficiency matters before other regulatory commissions?

A. Yes, I have filed expert witness testimony in nearly 50 dockets before similar regulatory bodies in twelve other states and provinces, including the neighboring jurisdictions of Ohio, Illinois and Ontario.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibits:

MEC-74:	Christopher Neme CV
MEC-75:	Cadmus, Michigan Baseline Housing Study (May 25, 2021)
MEC-76:	DTE Energy & Ipsos RDA, 2016 Residential Customer Applicant Saturation Survey
MEC-77:	Navigant Consulting, Inc., DTE Energy Residential Baseline Study: First Quarter 2013 (Sept. 2, 2013) (excerpt)

II. TESTIMONY OVERVIEW

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to propose that DTE develop an electric ratepayer funded residential pilot program for electrifying propane, fuel oil and kerosene-heated homes in its service territory.

Q. Please summarize the rationale for such a program.

A. Electrification of fossil fuel use in homes and businesses has been shown to be absolutely essential to meeting climate goals. It is also clear that electrification of propane, fuel oil and kerosene-heated homes is cost-effective today – lowering heating bills from Day 1. Moreover, because of the huge difference between DTE's proposed electric rates and the actual marginal cost of serving additional electric load, electrification can lower electric rates. In fact, depending on the specifics of the program design, it may be possible to fully fund a program to promote electrification – including substantial financial incentives to customers who electrify – while still reducing rates. Finally, given the urgency of the climate challenge, the significant market barriers to adoption of cold climate heat pumps, and the reality that it will likely take decades to fully transform the existing building stock, it is important that electrification initiatives begin as soon as possible. I address these points in greater detail in the following section (III) of my testimony.

Q: Please summarize your recommendation for the Michigan Public Service Commission.

A: I recommend that the Commission instruct DTE to develop a substantial residential electrification pilot, in conjunction with interested stakeholders, and bring the pilot program proposal back to the Commission for approval within a year of the Commission order in this proceeding. I provide greater detail on these recommendations in Section IV of my testimony.

III. RATIONALE FOR A RESIDENTIAL PROPANE ELECTRIFICATION PILOT

A. The Climate Imperative

Q. Why is concern about climate change a reason to support electrification of fossil fuel heated homes?

A: Over the past 10+ years, numerous studies have assessed options for achieving net-zero (or close to net-zero) GHG emission reductions by 2050 – i.e., to levels necessary to stabilize the global climate. A universal theme of those studies is that the use of natural gas, propane, fuel oil and other fossil fuels used to provide space heating, water heating and other energy end uses in buildings will need to be dramatically reduced, if not eliminated. Another universal theme is that many, if not the overwhelming majority of those buildings, will need to fuel-switch to electricity provided by a decarbonized grid (i.e., one in which electricity is produced by renewable energy and/or other carbon free fuel sources).

For example, a recent national study by Princeton University examined five different technological and economically plausible pathways for the U.S. to achieve net zero GHG emissions by 2050 and found that substantial levels of electrification of buildings was required in all scenarios.[1] Even a recent study funded by the Massachusetts gas utilities concluded building electrification was one of several "low regret" decarbonization strategies

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[1] Larson, Eric et al. (Princeton University), *Net-Zero America: Potential Pathways, Infrastructure and Impacts, Final Report Summary*, October 29, 2021,

(https://netzeroamerica.princeton.edu/img/Princeton%20NZA%20FINAL%20REPORT%20SUMMARY%20(29Oct2021).pdf).

across all of the scenarios analyzed, with annual gas throughput declined by at least 57% in all but one of the eight scenarios analyzed and by 73% in the "hybrid electrification" scenario found to be lowest cost.[2] And that is despite criticisms from a number of stakeholders, including the Massachusetts Attorney General's office, that the study was biased against electrification and in favor of biofuels.[3]

A recent DTE analysis also states that increased reliance on electric heat pumps "align(s) with long-term decarbonization goals in the state."[4]

Put simply, there is no debate about whether substantial levels of electrification will be necessary to meet climate goals. The debate is only about how widespread electrification will need to be and how quickly it must occur.

Q. What energy end uses are important to address in electrification of residential buildings?

A: In a climate like Michigan's, space heating is typically the single largest residential energy end use, accounting for nearly 60% of total site energy consumption.[5] Water heating is the

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[2] Energy and Environmental Economics, *The Role of Gas Distribution Companies in Achieving the Commonwealth's Climate Goals,* filed in Massachusetts D.P.U. Docket 20-80, March 18, 2022

(https://thefutureofgas.com/content/downloads/2022-03-21/3.18.22%20-%20Independent%20Consultant%20Report%20-%20Decarbonization%20Pathways.pdf).

[3] For example, see https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/14922666 and

https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/14922536.

[4] Guidehouse and DTE, *Residential Heat Pump Breakeven Analysis*, presentation to the Michigan EWR Collaborative, March 15, 2022, slide 7

(https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/EWR_Collaborative/2022/DTE-HP-Breakeven-Analysis.pdf?rev=36d0a18da7cd4b93833f76629655f42b&hash=D5A55F0F12D0C331AFDFECA41798909B#:~:text=Analysis%3A%20Natural%20Gas%20Price%20Breakeven&text=The%20graph%20on%20the%20right,is%20%2419%20%E2%80%93%2022%20per%20MCF.&text=(i.e.%2C%20greater%20than%20100%25%20increase).

[5] U.S. Energy Information Administration, 2015 Residential Energy Consumption Survey data for the East North Central region (which includes Michigan), Table CE3.3 (https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce3.3.pdf).

next most important, accounting for between 15% and 20% of total site energy consumption.[6] Space heating and water heating also account for more than 90% of propane and other fossil fuels energy used in homes.[7] That said, there can be merit to electrifying all end uses – even smaller ones like cooking – at the same time.

Q: Is building electrification one of the decarbonization strategies addressed in the recently published MI Healthy Climate Plan?

A: Yes. The plan notes at the outset that buildings (along with energy and transportation) are one of the three sectors "where the biggest, most rapid gains in GHG reductions can be made".[8] In the buildings section of the Plan's "Roadmap to 2030" it states:

> *"Decarbonizing buildings will require baseline investments in repairing Michigan's homes; stronger requirements, incentives, and financing options for energy efficiency and waste reduction; and evaluation and adoption of innovative home heating alternatives,* ***including electrification in immediately cost-effective use cases****."*[9] (emphasis added)

B. Propane and Oil Heating are Cost-Effective Places to Start

Q: Why focus the pilot on propane and oil-heated homes?

A. Propane and oil-heated homes are the portion of the existing building stock that uses fossil fuels for heating that would be most cost-effective to electrify. Indeed, DTE itself concluded

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[6] Ibid.

[7] U.S. Energy Information Administration, 2015 Residential Energy Consumption Survey data for the East North Central region (which includes Michigan), Table CE4.3 (https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce4.3.pdf).

[8] Michigan Department of Environment, Great Lakes and Energy, MI Healthy Climate Plan, April 2022 (https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Offices/OCE/MI-Healthy-Climate-Plan.pdf?rev=d13f4adc2b1d45909bd708cafccbfffa), p. 5.

[9] Ibid, p. 41.

in a recent analysis that centrally-ducted cold climate heat pumps have both lower annual operating costs and lower lifecycle costs than homes with oil or propane furnaces.[10]

Q. Could propane and oil-heated customers reduce their energy bills through electrification?

A. Yes. As Table 1 shows, a typical propane-heated home in Michigan is estimated to consume approximately 614 gallons of propane per year for space heating[11] with an average furnace efficiency of 86%.[12] All such fossil-fuel furnaces also have fans that consume electricity – estimated to average 427 kWh per year[13] – to blow warm air through ducts to the different rooms of the house. If that propane furnace were replaced by a new cold climate heat pump

[10] Guidehouse and DTE, *Residential Heat Pump Breakeven Analysis*, presentation to the Michigan EWR Collaborative, March 15, 2022, slide 7

(https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/EWR_Collaborative/2022/DTE-HP-Breakeven-Analysis.pdf?rev=36d0a18da7cd4b93833f76629655f42b&hash=D5A55F0F12D0C331AFDFECA41798909B#:~:text=Analysis%3A%20Natural%20Gas%20Price%20Breakeven&text=The%20graph%20on%20the%20right,is%20%2419%20%E2%80%93%2022%20per%20MCF.&text=(i.e.%2C%20greater%20than%20100%25%20increase). Note that though I have concerns with some of the assumptions and conclusions from this analysis, addressing those concerns would not change the conclusion that electrification of propane and oil-heated homes is very cost-effective.

[11] Annual propane consumption for space heating is based on the U.S. Energy Information Administration's 2015 Residential Energy Consumption Survey Table CE6.1 which estimated average propane space heating consumption of 53.8 MMBtu for the East North Central region

(https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce6.1.pdf). That value was increased 4.3% based on 2009 RECS data (Table CE4.8) that found Michigan propane heating consumption to be 4.3% higher than the East North Central region (https://www.eia.gov/consumption/residential/data/2009/index.php?view=consumption#end-use-by-fuel) and converted to gallons assuming 91,452 Btu's per propane gallon

(https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php).

[12] This is the average efficiency of fossil fuel-fired heating systems in lower peninsula per a recent study of the efficiency of Michigan's housing stock provided to me by Dave Walker, Michigan Public Service Commission Staff, 5/10/22 (Cadmus, *Michigan Baseline Housing Study*, presented to Consumers Energy and DTE Energy, May 25, 2021, Table 4, p. 12). Ex MEC-75.

[13] Based on U.S. Energy Information Administration's 2015 Residential Energy Consumption Survey Table CE5.3a which estimated average electricity consumption from air handlers for heating to be 409 kWh for the East North Central region (https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce5.3a.pdf). That value was increased 4.3% based on 2009 RECS data that found Michigan propane heating consumption to be 4.3% higher than the East North Central region (2009 RECS Table CE4.8).

with an average annual efficiency of 260%, a level that is consistent with recent testing of cold climate models in climates comparable to DTE's,[14] the annual heating bill would be cut by more than 40% with annual energy savings of more than $700.[15]

As Table 1 also shows, a typical propane water heater is estimated to consume approximately 270 gallons of propane per year[16] with an average efficiency of 63%.[17] If that propane water heater were replaced by a new heat pump water heater with an annual efficiency of 328%, which is typical if not at the low end of models currently being sold,[18] the annual water heating bill would be cut by about two-thirds with annual energy savings of over $450.[19]

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[14] The seasonal average efficiency of 13 cold climate heat pumps – including the effects of electric resistance back-up heat at very cold temperatures – was recently tested by the Northwest Energy Efficiency Alliance and Natural Resource Canada for eight different North American climate zones. After removing one outlier, the average seasonal coefficient of performance (COP) for the "cold-dry" climate zone, which includes most of Michigan, was 2.60 (Harley, Bruce, *EXP07:19 Load-Based and Climate-Specific Testing and Rating Procedures for Heat Pumps and Air Conditioners*, prepared for NEEA in partnership with BC Hydro, Natural Resources Canada, Northeast Energy Efficiency Partnerships and Pacific Gas and Electric, July 7, 2020, Table 6, p. 26 (https://neea.org/resources/exp0719-load-based-and-climate-specific-testing-and-rating-procedures-for-heat-pumps-and-air-conditioners). A recent Commonwealth Edison study found that single-head cold climate ductless mini-split heat pumps in Chicago-area, low-income multi-family buildings had a seasonal average COP of 2.63 (CMC Energy Services, Ductless Heat Pump Final Report, prepared for ComEd Energy Efficiency Program Emerging Technology, May 7, 2020, Table 31, p. 45, (https://ilsag.s3.amazonaws.com/ComEd-DHP-Final-Report-6-17-20-V5.pdf).

[15] Propane consumption converted to BTUs multiplied by propane heating system efficiency divided by 3412 Btu per kWh and divided by heat pump average heating system efficiency to estimate annual heating kWh with a heat pump (614 gallons * 91,452 Btu/gallon * 86% propane furnace efficiency / 3412 Btu/kWh / 260% heat pump efficiency = 5440 heat pump kWh). Note that the heat pump seasonal efficiency rating includes consumption by the fan used to blow air through the home's ducts.

[16] Annual propane consumption for water heating is a recent study of the efficiency of Michigan's housing stock which found an average annual consumption of 247 therms per year (Cadmus, *Michigan Baseline Housing Study*, presented to Consumers Energy and DTE Energy, May 25, 2021, Table 15, p. 18). Annual consumption in gas therms (100,000 Btu/therm) converted to gallons of propane (91,452 Btu/gallon).

[17] In its 2018 forecast for the U.S. Energy Information Administration, Navigant Consulting estimated that the typical Uniform Energy Factor rating of gas water heater sold in 2020 would be 0.63 (Navigant Consulting, *EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case*, presented to U.S. Energy Information Administration, April 2018 (https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf).

[18] Ibid. A review of models currently available and sold over the internet by Lowes and Home Depot suggests that typical efficiency ratings may be more in the 3.50 to 3.75 range.

[19] Propane consumption converted to BTUs multiplied by propane heating system efficiency divided by 3412 kWh per kWh and divided by heat pump average heating system efficiency to estimate annual heating kWh with a heat

Table 1: Propane Customer Energy Bill Savings from Electrification

	Cold Climate Heat Pump Replacing Propane Furnace	Heat Pump Water Heater Replacing Propane Water Heater	Total
Existing Propane System			
Propane Gallons	614	270	884
$ per Propane Gallon	$2.62	$2.62	$2.62
Propane Furance Fan kWh	427	-	-
$ per kWh	$0.180	$0.181	$0.180
Annual Propane System Energy Cost	$1,687	$709	$2,395
New Electric Heat Pump System			
Electric kWh with Heat Pump	5,440	1,390	6,830
$ per kWh	$0.180	$0.181	$0.180
Annual Cost after Electrification	$980	$251	$1,232
Annual Cost Savings			
Annual Cost Savings from Electrification ($)	**$707**	**$457**	**$1,164**
Annual Cost Savings from Electrification (%)	**42%**	**65%**	**49%**

Q: Heat pumps provide both heating and cooling. Does your analysis include the effects on cooling costs?

A: No. The impact of electrification on cooling energy use will be a function of two factors: (1) how many program participants have (A) central air conditioning, (B) window air conditioning, and (C) no air conditioning; and (2) the difference between the cooling efficiency of cold climate heat pumps and the cooling efficiency of typical central or window air conditioners.

Q: What fraction of DTE customers have central air conditioning, window air conditioning and no air conditioning?

A: DTE's most recent customer data suggest that 79% of its customers have central air conditioning and 28% have window air conditioning.[20] No data are available on the fraction

pump (270 gallons * 91,452 Btu/gallon * 63% propane water heater efficiency / 3412 Btu/kWh / 328% heat pump water heater efficiency = 1390 heat pump water heater kWh).

[20] DTE, Residential Customer Appliance Survey, 12/19/2019, provided in response to MNSCDE-7.1.

of customer with no air conditioning, but the fact that the sum of central and window air conditioning usage exceeds 100% suggests that very few customers have no air conditioning.[21]

Q: How does the cooling efficiency of cold climate heat pumps compare to the cooling efficiency of central air conditioners?

A: Cold climate heat pumps are much more efficient in cooling mode than the average central air conditioner. The average seasonal energy efficiency ratio (SEER) of central air conditioners currently in homes in Michigan's lower peninsula is 11.3.[22] In contrast, of the 396 centrally-ducted cold climate heat pumps with heating capacities of between 35,000 and 40,000 Btus of heating capacity at 5° F (a common size range), none had a SEER (cooling efficiency) rating of less than 15, only 14 – or about 3.5% - had a SEER rating lower than 17, and nearly half had a SEER rating of 20 or higher.[23] A SEER rating of 20 would reduce the amount of electricity used for cooling by 44% relative to the current average SEER of 11.3.[24]

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[21] Note that even among customers with annual incomes below $60,000, approximately two-thirds have central air conditioning and 35% have one or more window air conditioners. Ex MEC-76 (Ipsos RDA, 2016 Residential Customer Appliance Saturation Survey, filed by DTE as a discovery response to NRDCDE-1.5 in U-20373).

[22] Cadmus, *Michigan Baseline Housing Study*, presented to Consumers Energy and DTE Energy, May 25, 2021, Table 5, p. 13). See Ex MEC-75.

[23] https://ashp.neep.org/#!/product_list/

[24] Note that cold climate heat pumps are also much more efficient than brand new central air conditioners. The minimum efficiency for new models is SEER 13. DTE currently provides rebates through its EWR programs for models with SEER ratings of 15 or higher, with the vast majority of such rebates going to units with efficiency ratings between 15 and 17 (based on DTE's forecast participation rates by EWR measure provided an Excel file attached to its response to NRDCNHTECDE-1.6ai in Case U-20876).

The average efficiency of window air conditioners in Michigan – an Energy Efficiency Ratio (EER) of 10.5 in the lower peninsula[25] – is even lower than the average efficiency of central air conditioners. Thus, cold climate heat pumps can provide cooling roughly twice as efficiently as window air conditioners. However, that savings will be offset by the fact that a centrally-ducted cold climate heat pump will provide cooling to more of the house (more conditioned space) than one or two window air conditioners would. If a new centrally-ducted heat pump cooled twice as much of the house as was previously cooled with window air conditioners, but did so twice as efficiently, total cooling energy use might be roughly the same as before electrification.

Q: What is the net effect of all of these factors likely to be on cooling energy use by customers who participate in an electrification program?

A: If participation was roughly proportional to the existing DTE customer mix, the impacts of electrifying fossil fuel heating with cold climate heat pumps would likely be a significant reduction in cooling energy consumption in the average electrified home. Very large cooling savings from the vast majority of participants that would otherwise have had much less efficient central air conditioners, combined with potentially very small to no impacts on most of the rest of customers who would have otherwise use window air conditioners, would swamp the effects of increased cooling energy use by a relatively small number of customers who would have had no cooling absent electrification. In other words, I would expect that adding cooling effects to the analysis would improve the average customer economics of electrification. However, this is a hypothesis that could be tested in a pilot program.

[25] Cadmus, *Michigan Baseline Housing Study*, presented to Consumers Energy and DTE Energy, May 25, 2021, Table 6, p. 13). Ex MEC-75.

Q: What is the basis for the propane and electricity costs that you used in your analysis?

A: For propane, I used the average weekly retail Michigan propane price for the past winter (November 2021 through March 2022) from the U.S. Energy Information Administration.[26] I then escalated that price by 1.5 years of inflation (assumed to be 2.9% per year)[27] to produce a price in 2023 dollars that would be comparable to 2023 electric rates proposed in this proceeding by DTE.

For the variable cost of electricity – i.e., the added cost to the customer per kWh of space heating or water heating load to be added through electrification – I used the variable retail rates per kWh proposed by DTE its new Residential Time of Service Rate TOU – D1.11.[28] Because the variable rates for power supply are different depending on the season, day of the week and time of day, I had to estimate how much of the annual space heating and water heating kWh usage would be in each of the following four costing periods: Summer on peak, Summer off peak, Winter on peak, and Winter off peak. That was done using hourly end use load shapes for the ECAR region (which includes Michigan) from the Electric Power Research Institute (EPRI).[29]

Q: Are the customer economics of electrifying fuel oil and kerosene-heated homes also attractive?

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[26] https://www.eia.gov/dnav/pet/PET_PRI_WFR_DCUS_SMI_W.htm.

[27] Consistent with DTE estimates provided in the Direct Testimony of Robert A. Bellini, p. 11, lines 2-3.

[28] See column "e" in DTE Exhibit A-16, Schedule F-3 p. 11 of 57.

[29] https://loadshape.epri.com/enduse

A: Yes. Michigan fuel oil prices this past winter were only about 11% lower per million Btu's of energy than its propane prices.[30] Thus, electrification would significantly lower energy bills for fuel oil customers as well as propane customers.

Q: Is it possible that the customer economics of electrifying propane or oil heating will change in future years?

A: One can never be certain about how energy prices will change in the future. However, the U.S. Energy Information Administration's most recent forecast of energy prices for the region that includes Michigan (East North Central) suggests that propane prices are expected to increase faster than inflation while electricity prices are expected to decline slightly in inflation adjusted terms.[31] Fuel oil prices are expected to drop a little in the next year or two and then also increase faster than inflation, though not as quickly as propane prices. These forecast trends are depicted graphically in Figure 1. Thus, the lifecycle cost savings of electrifying propane-heated homes today (or next year) will be greater than the annual energy savings estimates in Table 1 suggest. The lifecycle cost savings of electrifying oil heated homes will also likely be greater than an analysis based on just current year prices suggests.

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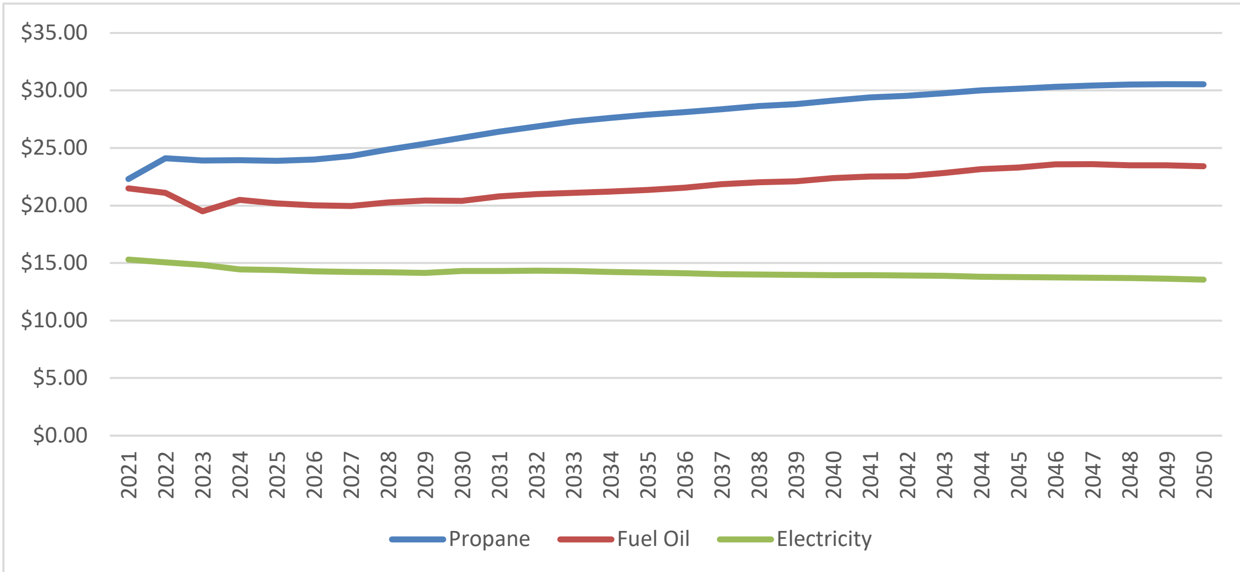
[30] Based on experience, I would expect oil furnaces to be less efficient, on average, than propane furnaces. That would offset, at least in part, the modest price advantage fuel oil may have over propane today.

[31] U.S. EIA Annual Energy Outlook 2022

(https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2022&region=1-3&cases=ref2022&start=2020&end=2040&f=A&linechart=~ref2022-d011222a.3-3-AEO2022.1-0~ref2022-d011222a.6-3-AEO2022.1-0~ref2022-d011222a.6-3-AEO2022.1-3~~ref2022-d011222a.3-3-AEO2022.1-3&map=ref2022-d011222a.4-3-AEO2022.1-3&ctype=linechart&chartindexed=0&sid=~&sourcekey=0)

Figure 1: Forecast Changes in Midwest Electricity, Propane and Fuel Oil Prices (2021 $ per MMBtu of Heat Output)[32]



Q. How much propane or oil heating is there in DTE's electric service territory?

A. DTE has a little more than 2 million residential electric customers. Approximately 3% of those customers – or on the order of 60,000 – heat primarily with a fuel other than electricity or natural gas.[33] It appears that approximately half of those – or ~30,000 – are likely to be propane-heated; the rest heat with fuel oil or kerosene.[34] Importantly, customers that heat primarily with propane or fuel oil are disproportionately low-income. In fact, the fraction of

[32] Note that EIA forecasts prices per MMBtu of energy input. To account for the significant differences between the end use efficiency of cold climate heat pumps (260%) relative to existing propane (86%) and oil heating systems (80%), I've converted the EIA data to costs per unit of heat output. The propane and oil lines on the graph would get a little better if one assumed the use of the most efficient propane and oil heating systems (e.g., 95% for propane and a little lower for oil). However, electric heat provided by efficient cold climate heat pumps would still be much less expensive. Also, the use of the most efficient cold climate heat pumps (rather than the 260% average I have used) would lower the electric price per unit of heat output.

[33] DTE, Residential Customer Appliance Survey, 12/19/2019, provided in response to MNSCDE-7.1.

[34] Ex MEC-77 (Navigant Consulting, DTE Energy Residential Baseline Study: First Quarter 2013, Table 49 on p. 45, provided by DTE in response to NRDC 1.7 in U-18262).

customers heating with such fuels is roughly three times as large among customers with annual incomes below $20,000 as for customers with annual incomes greater than $60,000.[35]

C. A Ratepayer Electrification Program Could Lower Electric Rates

Q: What effect would ratepayer funding of programs to promote electrification have on electric rates?

A: The answer depends on how electric rates are designed or structured, what electric rate electrifying customers are on, and – most importantly – the cost of the electrification program, including the degree to which installation of cold climate heat pumps and other electrification measures is subsidized. However, my analysis suggests that a robust program could result in lowering of rates. That is because the cost of the electrification program could be more than offset by the increase in net revenue (the difference between electric rates and the actual cost of serving added load) over the life of the electrification measures.

Q: What is the magnitude by which rates could be reduced?

A: The answer depends primarily on the design and therefore the cost of the electrification program. As shown in Table 2, even a program that includes a significant emphasis on electrifying low-income homes and paid for the entire cost of electrification of those homes could result in an increase in net revenue in excess of $3 million per 1000 electrified homes over the life of the heat pumps – or ~$10 million for 3000 electrified homes.

[35] Ex MEC-76 (Ipsos RDA, 2016 Residential Customer Appliance Saturation Survey, filed by DTE as a discovery response to NRDCDE-1.5 in U-20373).

Table 2: Net Revenue from Hypothetical Electrification Program

	Cold Climate Heat Pump	Water Heater
Increase in Net Revenue		
Marginal Electric Rate ($/kWh)	$0.1802	$0.1808
Marginal Cost of Serving Load ($/kWh)	$0.0321	$0.0321
Marginal Net Revenue ($kWh)	$0.1481	$0.1487
Added Annual kWh	5440	1390
Added Net Revenue - 1st Year	$806	$207
Measure Life	16	13
Added Net Revenue - NPV Over Measure Life	**$10,450**	**$2,258**
Average Program Cost per Participant		
Fully Installed Measure Cost	$10,000	$2,524
Low Income Rebate as % of Measure Cost	100%	100%
Non-Low Income Rebate as % of Measure Cost	40%	40%
Low Income Participation %	33%	33%
Weighted Average Program Rebate	$5,980	$1,509
Program delivery adder	25%	25%
Average Total Program Cost per Participant	**$7,475**	**$1,887**
Net Change in Revenue		
Per Participant	**$2,975**	**$372**
Per 1000 Participants	$2,975,137	$371,860
Total per 1000 Participants Taking Both Measures	**$3,346,997**	

Q: Please describe how you estimated net revenue – the difference between what DTE would charge customers for added consumption through its electric rates and what it would cost to actually serve the added load?

A: As previously described, my estimate of the added revenue DTE would receive from serving newly electrified load – the 18.02 cents/kWh for space heating and 18.08 cents/kWh for water heating – is based on the variable costs per kWh proposed by DTE its new Residential Time of Service Rate TOU – D1.11[36] and hourly end use load shapes for the ECAR region from the Electric Power Research Institute (EPRI).[37]

[36] See column "e" in DTE Exhibit A-16, Schedule F-3 p. 11 of 57.

[37] https://loadshape.epri.com/enduse

My estimate of the average marginal cost of serving added load – i.e., 3.21 cents/kWh for 2023 – is based on the value of avoided energy used in DTE's assessment of the cost-effectiveness of its EWR programs.[38] Note that my estimates of EWR avoided energy costs are annual averages for the mix of efficiency measures and programs that are part of DTE's EWR plan. More accurate estimates could be developed using hourly avoided costs. However, I do not have access to DTE's 8760 hourly avoided energy costs. That said, I would not expect use of hourly values to materially affect the conclusion that there is a very large difference between marginal revenue per kWh of added electrified load and the marginal cost of serving that added load. For example, I estimated the value of avoided energy costs using that average annual value for EWR programs that have load profiles I would expect to be very different from the portfolio average (e.g., the Residential HVAC program, which I would expect to disproportionately produce savings in the summer) and found the NPV of avoided energy costs was within 5-8% of the values computed by DTE in its cost-effectiveness analyses of the same programs using time differentiated avoided energy costs. I computed the net present value of added net revenue over the life of the cold climate heat pumps and heat pump water heaters based on estimates of the average useful life for such equipment that were developed for the U.S. Energy Information Administration's energy forecasting by Navigant Consulting[39] using DTE's proposed after-tax weighted average cost

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[38] I had to impute DTE's estimated average avoided cost per kWh from (1) the net present value of "avoided electric production" provided in cost-effectiveness screening results for its EWR program portfolio as a whole, as well as several individual programs, provided in response to NRDCNHTECDE-1.6c in U-20876; and (2) DTE's estimated annual savings and its estimated average measure life from its response to NRDCNHTECDE-1.8a in the same docket.

[39] Navigant Consultant, EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, presented to U.S. Energy Information Administration, April 2018

(https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf).

of capital (5.56%)[40] as a nominal discount rate and DTE's estimated inflation rate of 2.9%[41] to convert the nominal discount rate into a real discount rate.

Q: Did your estimate of net revenue impacts account for the effect of electrification on peak demands?

A: No. I did not account for the effect on peak demands. However, as discussed above, I expect an electrification program to reduce cooling energy consumption and therefore reduce – or at least not materially increase – peak demands. It should also be noted that my analysis of net revenue from electrification does not account for the value of additional marginal energy cost savings resulting from cooling energy efficiency improvements that cold climate heat pumps will provide throughout the summer. Thus, my estimates of net revenue are likely to be understated.

Q: Why would you expect electrification to lower – or at least not materially increase peak demands?

A: DTE is summer peaking[42] and those peak demands tend to be driven by cooling loads. As discussed earlier in my testimony, cold climate heat pumps tend to be much more efficient in cooling mode than the central air conditioners that they would most commonly replace. As also previously discussed, their extremely high efficiency may offset the effect of cooling larger portions of homes that would otherwise have relied on window air conditioners. While there may be some homes who would have had no air conditioning without the installation of a cold climate heat pump, they are likely to be limited in number and the impacts of their

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[40] Exhibit A-14, Schedule D1.

[41] Bellini Direct, p. 11, lines 2-3.

[42] DTE forecasts that its summer peak demands will be between 40% and 50% higher than its winter peak demands over the next decade (DTE response to MNSCDE-7.4).

added cooling load are likely to be way more than offset by cooling efficiency gains in the much larger number of homes that previously had central air conditioning. While there may be some increase in summer peak demands from electrification of water heating, those increases will be very modest both because heat pump water heaters are extremely efficient and because they also lower cooling loads in a home.

Q: How did you develop the estimate of program costs shown in Table 2?

A: There are two components to the estimate: (1) the cost of new electric equipment; and (2) the assumed program design features, including rebate levels.

To estimate the cost of a centrally-ducted cold climate heat pump, I started with the estimated installed cost for high efficiency (SEER 19, HSPF 9.0) air source heat pumps developed by Navigant Consulting for the U.S. Energy Information Administration (about $7400 in inflation adjusted terms for 2023)[43] and then adjusted the value up by about one-third based on my understanding of the technology and manufacturer pricing. My assumed cost for a heat pump water heater is based entirely on the same Navigant study, adjusted for inflation.[44] While the estimated program costs in the table are hypothetical, I believe that they are at least reasonable ballpark estimates of the costs of a program.[45]

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[43] Navigant Consultant, EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, presented to U.S. Energy Information Administration, April 2018

(https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf). Navigant's estimated installed cost is $6100 in 2017 dollars. Inflation between April 2017 and April 2022 was 18.2%. I added another 2.9% to reflect inflation between 2022 and 2023.

[44] Navigant Consultant, EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, presented to U.S. Energy Information Administration, April 2018

(https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf).

[45] In a recent analysis of the relative customer economics of different heating fuels that DTE conducted with Guidehouse, the Company appeared to assume that a cold climate centrally-ducted heat pump would cost about $12,500 (Guidehouse and DTE, *Residential Heat Pump Breakeven Analysis*, presentation to the Michigan EWR Collaborative, March 15,

With respect to program design, I assumed that there would be a rebate of 40% for non-low-income customers and 100% for low-income customers – and that 33% of participants would be low-income. I also assumed those rebates would be applicable to the full installed cost of a new cold climate heat pump and/or heat pump water heater. I further assumed that there would be additional program costs for marketing, contractor outreach, inspections, administration and evaluation and that such costs would be equal to about 25% of the total rebate costs.

My program design assumptions may be conservative because they implicitly assume that the measure costs are the full installed costs of a new cold climate heat pump and a new heat pump water heater. It could be possible to lower those measure costs if the program were to focus on customers who are in the process of replacing a central air conditioner or propane furnace – and therefore cover only the *incremental cost* between such standard new pieces of equipment and the more expensive cold climate heat pump. The same could be done for water heaters – e.g., focusing on *incremental cost* of a heat pump water heater relative to the cost of a standard propane one.

2022, https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/EWR_Collaborative/2022/DTE-HP-Breakeven-Analysis.pdf?rev=36d0a18da7cd4b93833f76629655f42b&hash=D5A55F0F12D0C331AFDFECA41798909B#:~:text=Analysis%3A%20Natural%20Gas%20Price%20Breakeven&text=The%20graph%20on%20the%20right,is%20%2419%20%E2%80%93%2022%20per%20MCF.&text=(i.e.%2C%20greater%20than%20100%25%20increase)). That assumption appears to have been based on a several analyses of costs in the Northeast. However, even in the Northeast the number of centrally-ducted cold climate heat pumps sold each year is extremely low. Thus, the high prices are highly likely to be a function very few contractors competing to provide product to meet extremely low demand. The history of federal product efficiency standards makes clear that when premium products sold in very small numbers become more commonplace, competition increases and costs are typically lower than forecast (see, for example, Nadel, Steve and Andrew deLaski, Appliance Standards: Comparing Predicted and Observed Prices, ACEEE report E13D, July 2013

(https://appliancestandards.org/sites/default/files/Appliance_Standards_Comparing_Predicted_Expected_Prices.pdf) That said, even if the assumed cost of a centrally-ducted cold climate heat pump shown in the analysis in Table 2 is increased to $12,500 – and the electrification program is still conservatively assumed to address the full cost of the heat pump rather than just the incremental cost over a new furnace and/or new central air conditioners – the net present value of added revenue from added electricity sales still exceeds the average program cost per participant.

D. The Process of Electrification of Buildings Needs to Start ASAP

Q. Why is it important that DTE begin to invest in electrification of fossil fuel-heated customers now?

A. The pace of change in the building stock that is necessary to meet 2050 climate change goals, let alone achieve substantial emission reductions by 2030 is unprecedented. Indeed, a recent analysis funded by the Massachusetts gas utilities found that the number of electric heat pumps installed in that state of about 2.8 million households would have to grow from about 0.3 million today to about 1.0 million in 2030 and 1.7 million in 2035 in the lowest cost scenario analyzed for meeting that state's climate goals (the numbers were not appreciably different in most other scenarios).[46]

However, experience with energy efficiency programs suggests that it is very difficult to quickly change our existing building stock. Indeed, even the most aggressive programs in North America and Europe have failed to comprehensively weatherize more than 2% of the residential housing stock per year.[47]

The situation may be even more challenging for electrification than for insulating and sealing buildings – at least in the near-term – because of a number of major market barriers to customer investments in electrification. To begin with, customer awareness of the latest advances in heat pump technology is extremely low. In fact, most HVAC contractors are

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[46] Energy and Environmental Economics, *The Role of Gas Distribution Companies in Achieving the Commonwealth's Climate Goals,* filed in Massachusetts D.P.U. Docket 20-80, March 18, 2022

(https://thefutureofgas.com/content/downloads/2022-03-21/3.18.22%20-%20Independent%20Consultant%20Report%20-%20Decarbonization%20Pathways.pdf), p. 98.

[47] See Neme, Chris et al., Residential Efficiency Retrofits: A Roadmap for the Future, published by the Regulatory Assistance Project, May 2011 (https://www.raponline.org/knowledge-center/residential-efficiency-retrofits-a-roadmap-for-the-future/). I am unaware of any evidence that this report's conclusions about the pace of residential retrofits have changed since it was published a decade ago.

unaware of the ability of new generations of heat pumps to function efficiently in very cold temperatures – cold climate models can produce their nameplate heating capacity at a temperature of 5° F. Most current opinions of heat pumps are shaped by outdated experiences from decades ago when heat pumps could not produce any heat – and had to rely on very inefficient electric resistance back-up heating – when temperatures dropped below 30° F (or worse). As a result, cold climate heat pumps are not widely stocked or promoted. That, in turn, means that they are much more expensive than they would be if sold in greater volumes. The state's electric utilities have recognized these barriers and plan to begin an initiative this year, funded through their energy waste reduction (EWR) program budgets, to begin educating customers and contractors about the current generation of cold climate heat pumps.[48] However, that education will only go so far without parallel efforts to begin to drive demand for the products.

Q: Won't the utilities EWR programs drive demand?

A: No, or at least not nearly enough to put Michigan on the path necessary to achieve its climate goals. There are three related reasons for that. First, the Commission has made clear in EWR proceedings that while it will support promotion of heat pumps as an electric efficiency measure, it will not support EWR funding of electrification of existing fossil heating equipment.[49] That significantly limits the reach of EWR heat pump promotions to the modest number of residential housing units with inefficient electric resistance heating. Second, most of electric resistance heating, particularly in DTE's service territory, is in multi-family buildings. Thus, heat pump applications in single family homes will be addressed in an

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[48] Case No. U-20876, Testimony of Jeffrey C. LeBrun, 2 TR 96, lines 1-3.

[49] Commission Order in Case U-20372, p. 2.

extremely limited way – if at all – through EWR programs. Third, the type of heat pump most applicable to displacing electric resistance heating – ductless mini-splits – is different from the centrally-ducted heat pumps that would be most applicable to electrifying the vast majority of fossil fuel heated homes in the state.[50] Thus, while the utilities' EWR programs can play a supporting role in driving the market for cold climate heat pumps, other non-EWR efforts will be essential to moving the market.

Q: What did the MI Healthy Climate Plan say about the urgency of starting efforts to promote electrification?

A: As stated in the MI Healthy Climate Plan, "sustained, aggressive action across Michigan's economy is necessary" to reach Michigan's goals of achieving carbon neutrality by 2050 and a 52% reduction in GHG emissions by 2030.[51] The Plan further states that its intent is "to spur changes that are imperative – that must happen, **and happen now** to meet our goals."[52] (emphasis added) It further states that "Michigan should use every tool and chase every dollar available…to help meet our climate goals."[53] The report also noted that 1.5 million Michigan households could save money by "using modern heat pump space heaters and heat pump water heaters instead of their current appliances, which use electric resistance, fuel oil, or propane;" that half of those households are low to moderate income; and that the state "should establish incentive programs for electric appliances and heat pumps for use-cases

[50] The technology that allows for efficient operation in cold climates is the same and the outdoor component of centrally-ducted heat pumps will be very similar if not identical to outdoor component of ductless mini-splits. However, the indoor mechanism for transferring and distributing heat (and cooling) is very different.

[51] MI Healthy Climate Plan, p. 27.

[52] Ibid.

[53] Ibid.

that will save customers money today, with an emphasis on energy burden relief for low-income residents."

IV. RECOMMENDATIONS

Q: What are you recommending for this proceeding?

A: My recommendations are as follows:

1. DTE should be instructed to develop a pilot program to electrify propane, oil and kerosene heated homes.
2. DTE should be required to work with MNSC, Commission Staff and other interested stakeholders in the development of pilot program design.
3. DTE should be required to bring the pilot program design, goals and budget to the PSC for approval within 12 months. The proposal could be part of a future rate case (if the Company were to make a new rate case proposal within the next year) or a stand-alone proposal.
4. While the details of the program design would be developed by DTE with input from interested parties, the Company's proposal should be consistent with the following design principles:
   a. The pilot should address, at a minimum, both space heating and water heating. These are the two biggest energy end uses in most homes. Other fossil fuel end uses, such as cooking, could also be addressed.
   b. The pilot should have a goal of electrifying at least 3,000 homes over three years. The principal purpose of this pilot would be to test how to drive significant demand for cold climate heat pumps and identify and address the market delivery challenges what will arise when there is such demand.[54] That can only be reasonably assessed with a pilot of this scale. Note that though 3,000 is a substantial number of homes, it is still only about 5% of the homes in DTE's service territory that use unregulated fossil fuels for space heating.
   c. There should be a commitment to ensuring that at least 33% of the electrified homes are low-income. It is important that electrification challenges for low-income customers be identified through the pilot. It is also critical, from an

[54] The Company as well as other utilities in the state have been testing the performance of cold climate heat pumps through their EWR programs. While this pilot could provide additional insights into their performance, we suggest that be a secondary objective.

equity perspective, that low-income customers not be left behind as electrification proceeds as they are the customers who would most benefit from the lowering of heating costs and who are least able to afford the upfront investments needed to achieve such lowering of heating costs.

d. There should be a commitment to pay 100% of the cost of electrification measures for the low-income participants. Decades of experience in both Michigan and other states makes clear that this will be necessary to ensure any significant low-income participation.

e. The program should simultaneously emphasize the importance and value of building envelope efficiency improvements – and support participant investments in such improvements as they are being electrified. This may be accomplished, in part, by referring customers to DTE's existing EWR program offerings. However, DTE should also consider whether it is necessary to supplement EWR offerings to ensure significant follow through on insulation and air sealing opportunities.[55]

Q: Does that conclude your testimony?

A: Yes, it does.

[55] This may be particularly important for non-low-income electrification participants because current EWR incentives for insulation and air sealing for non-low-income homes are pretty modest and may not be adequate to ensure that most electrifying customers optimize their home's efficiency. In contrast, EWR offerings for low-income customers tend are intended to cover the full cost of efficiency upgrades.

Chris Neme
Principal

ENERGY FUTURES GROUP

Professional Summary

Chris specializes in analysis of markets for energy efficiency, demand response, renewable energy and strategic electrification measures, as well as the design and evaluation of programs and policies to promote them. During his 25+ years in the industry, he has worked for energy regulators, utilities, government agencies and advocacy organizations in 30+ states, 7 Canadian provinces and several European countries. He has filed expert witness testimony in 60+ cases before regulatory commissions in 13 different jurisdictions; he has also testified before several state legislatures. Chris has authored numerous reports and papers on clean energy policies and programs, including the National Standard Practice Manual for Benefit Cost Analysis of Distributed Energy Resources (2020), the predecessor NSPM for energy efficiency (2017), and several reports on electric non-wires and gas non-pipe alternatives.

Experience

2010-present: Principal, Energy Futures Group, Hinesburg, VT

1999-2010: Director of Planning & Evaluation, Vermont Energy Investment Corp., Burlington, VT

1993-1999: Senior Analyst, Vermont Energy Investment Corp., Burlington, VT

1992-1993: Energy Consultant, Lawrence Berkeley National Laboratory, Gaborone, Botswana

1986-1991: Senior Policy Analyst, Center for Clean Air Policy, Washington, DC

Education

M.P.P., University of Michigan, 1986

B.A.., Political Science, University of Michigan, 1985

Selected Projects

- Natural Resources Defense Council (Illinois, Michigan and Ohio). Critically review efficiency, demand response, electrification, distribution system investment and integrated resource plans filed by IL, MI and OH utilities. Draft/defend regulatory testimony on critiques. Represent NRDC in regular stakeholder-utility engagement processes. Represent NRDC in collaborative development of non-wires solution pilots. Support development of Illinois clean energy legislation. (2010 to present)
- E4TheFuture. Co-authored National Standard Practice Manual Benefit Cost-Analysis of Distributed Energy Resources (2020) and NSPM for efficiency (2017). Present the NSPM to audiences across the U.S. and Canada; helping several to assess how to use it to refine current practices. (2016-present)
- Connecticut Energy Efficiency Board. Part of team providing on-going review and input on utility efficiency program planning and related policy issues. Lead role in providing input on New England Avoided Energy Supply Cost study and cost-effectiveness screening policy issues. (2019-present)

- Ontario Energy Board. Appointed to serve on provincial gas DSM Evaluation Advisory Committee, providing input on multi-year evaluation plans, scopes of work for evaluation studies and independent evaluator assessments of utilities' annual gas savings claims. Also serve on gas IRP committee, providing input on non-pipe alternatives, including cost-effectiveness analyses and selection of pilot projects. Previously also appointed to advisory committees on gas and electric efficiency potential studies and advisory committee on carbon price forecast studies. (2015-present)
- Green Energy Coalition (Ontario). Represent coalition of environmental groups in regulatory proceedings, utility negotiations and stakeholder meetings on DSM policies, utility proposed DSM Plans, integrated resource planning and rules governing non-pipe alternatives. (1993 to present)
- Energy Action Network (Vermont). Co-authored a white paper on the concept of a "Clean Heat Standard" – a kind of renewable portfolio standard that would impose increasing obligations on Vermont Gas and wholesale suppliers of fuel oil and propane to reduce greenhouse gas emissions from burning of fossil fuels in homes and businesses, consistent with the state's Global Warming Solutions Act requirements (e.g., 40% reduction by 2030). Co-leading related voluntary working group of interested parties providing input on the design of the policy. Testified before Vermont House Energy and Technology Committee on Clean Heat Standard legislation. (2020-present)
- Sierra Club (Massachusetts). Supporting Sierra Club's participation in a year-long process in which the Massachusetts' gas utilities are engaging with stakeholders to discuss and consider the future of the gas industry in the context of decarbonization policy goals. Reviewing technical study of options for decarbonizing the gas industry that is being presented to the group. (2021-present).
- Environmental Law and Policy Center. Filed expert witness testimony supporting AEP Ohio's initial proposal to run a portfolio of efficiency programs and in opposition to a proposed rate case settlement agreement to eliminate such programs. (2021)
- Sierra Club (Maryland). Provided strategic support on testimony on cost-effectiveness and other rules governing expansion of gas infrastructure to connect additional customers. (2021)
- New Jersey Board of Public Utilities. Served on management team responsible for statewide delivery of New Jersey Clean Energy Programs. Led strategic planning; support regulatory filings, cost-effectiveness analysis & evaluation work. (2015 to 2020). Served on management team for start-up of residential and renewables programs for predecessor project. (2006-2010)
- Regulatory Assistance Project - U.S. Provided guidance on efficiency policy and programs. Lead author on strategic reports on program options for decarbonizing Vermont buildings, achieving 30% electricity savings in 10 years, using efficiency to defer T&D system investments, & bidding efficiency into capacity markets. (2010 to 2020)
- Energy Efficiency Alberta. Assisted EEA in providing input to Alberta Utilities Commission on the role efficiency resources can play in reducing electric system costs. (2019 to 2020)
- Consumers Association of Canada (Manitoba) and Winnipeg Harvest. Critically reviewed and filed regulatory testimony on Efficiency Manitoba's first three-year plan (2020-2023), with particular emphasis on the extent to which the plan supported advanced heat pump technology as both an electric efficiency measure and a key to future building electrification. (2019-2020).

- Citizens Action Coalition of Indiana. Critically reviewed how energy efficiency resources were modeled in utility IRPs, as well as the design of energy efficiency program portfolios. (2018 to 2020)
- Efficiency Vermont. Provided technical support in review of avoided cost assumptions, as well as related policies on cost-effectiveness analyses of efficiency resources (2019).
- Earth Justice and Southern Alliance for Clean Energy. Helped critically review Florida utilities' efficiency potential studies and proposed 2020-2024 energy efficiency savings targets. (2019)
- New Hampshire Office of the Consumer Advocate. Drafted expert witness testimony on the merits of utilities adding a pilot non-wires solution project to their efficiency program plans. (2018)
- Regulatory Assistance Project - Europe. Provide on-going support on efficiency policies and programs in the United Kingdom, Germany, and other countries. Reviewed draft European Union policies on Energy Savings Obligations, EM&V protocols, and related issues. Drafted policy brief on efficiency feed-in-tariffs and roadmap for residential retrofits. (2009 to 2018)
- Green Mountain Power (Vermont). Supported development and implementation of GMP's first compliance plan for Vermont RPS Tier 3 requirement to reduce customers' direct consumption of fossil fuels, with significant emphasis on strategic electrification strategies. Also developed 10-year forecast of sales that could result from three different levels of policy/program promotion of residential electric space heating, electric water heating and electric vehicles. (2016 to 2018)
- Alberta Energy Efficiency Alliance. Drafted white paper how treatment of "efficiency as a resource" could be institutionalized in Alberta. The paper followed several presentations to government agencies and others on behalf of the Pembina Institute. (2017 to 2018)
- Southern Environmental Law Center. Assessed reasonableness of Duke Energy's historic efficiency program savings claims, as well as the design of their efficiency program portfolios for 2019. Filed expert witness testimony on findings in North Carolina dockets (2018).
- Toronto Atmospheric Fund. Helped draft an assessment of efficiency potential from retrofitting of cold climate heat pumps into electrically heated multi-family buildings (2017).
- Northeast Energy Efficiency Partnerships. Helped manage Regional EM&V forum project estimating savings for emerging technologies, including field study of cold climate heat pumps. Led assessment of best practices on use of efficiency to defer T&D investment. (2009 to 2015)
- Ontario Power Authority. Managed jurisdictional scans on leveraging building efficiency labeling/disclosure requirements and non-energy benefits in cost-effectiveness screening. Supported staff workshop on the role efficiency can play in deferring T&D investments. Presented on efficiency trends for Advisory Council on Energy Efficiency. (2012-2015)
- Vermont Public Interest Research Group. Conducted comparative analysis of the economic and environmental impacts of fuel-switching from oil/propane heating to either natural gas or efficient, cold climate electric heat pumps. Filed regulatory testimony on findings. (2014-2015)
- New Hampshire Electric Co-op. Led assessment of the co-op's environmental and social responsibility programs' promotion of whole building efficiency retrofits, cold climate heat pumps and renewable energy systems. Presented recommendations to the co-op Board. (2014)

- National Association of Regulatory Utility Commissioners (NARUC). Assessed alternatives to 1st year savings goals to eliminate disincentives to invest in longer-lived savings. (2013)
- California Investor-Owned Utility. Senior advisor on EFG project to analyze 10 leading U.S. utility portfolios to determine if there are differences in the cost of saved energy related to utility spending in specific non-incentive categories, including administration, marketing, and EM&V. (2013)
- DC Department of the Environment (Washington DC). Part of VEIC team administering the DC Sustainable Energy Utility (SEU). Helped characterize the DC efficiency market and supporting the design of efficiency programs that the SEU will be implementing. (2011 to 2012)
- Ohio Sierra Club. Filed and defended expert witness testimony on the implications of not fully bidding all efficiency resources into the PJM capacity market. (2012)
- Regulatory Assistance Project – Global. Assisted RAP in framing several global research reports. Co-authored the first report – an extensive "best practices guide" on government policies for achieving energy efficiency objectives, drawing on experience with a variety of policy mechanism employed around the world. (2011)
- Tennessee Valley Authority. Assisted CSG team providing input to TVA on the redesign of its residential efficiency program portfolio to meet aggressive new five-year savings goals. (2010)
- New York State Energy Research and Development Authority (NYSERDA). Led residential & renewables portions of several statewide efficiency potential studies. (2001 to 2010)
- Ohio Public Utilities Commission. Senior Advisor to a project to develop a web-based Technical Reference Manual (TRM). The TRM includes deemed savings assumptions, deemed calculated savings algorithms and custom savings protocols. It was designed to serve as the basis for all electric and gas efficiency program savings claims in the state. (2009 to 2010)
- Vermont Electric Power Company. Led residential portion of efficiency potential study to assess alternatives to new transmission line. Testified before Public Service Board. (2001-2003)
- Efficiency Vermont. Served on Sr. Management team. Supported initial project start-up. Oversaw residential planning, input to regulators on evaluation, input to regional EM&V forum, development of M&V plan and other aspects of bidding efficiency into New England's Forward Capacity Market (FCM), and development and updating of nation's first TRM. (2000 to 2010)
- Long Island Power Authority Clean Energy Plan. Led team that designed the four major residential programs (three efficiency, one PV) incorporated into the plan in 1999. Oversaw extensive technical support to the implementation of those programs. This involved assistance with the development of goals and budgets, development of savings algorithms, cost-effectiveness screening, and on-going program design refinements. (1998 to 2009)

Selected Publications and Reports

- *Tip of the Spear: How Efficiency Programs Supporting Cold Climate Heat Pumps in Low Income Multi-Family Buildings Could Help Lay the Foundation for Building Decarbonization in Michigan and Illinois*, forthcoming in 2022 ACEEE Summer Study on Energy Efficiency in Buildings (with Laura Goldberg, Valeria Rincon and Samantha Williams)
- *The Clean Heat Standard*, Vermont Energy Action Network (EAN) White Paper, December 2021 (with Richard Cowart)
- *National Standard Practice Manual for Benefit Cost Analysis of Distributed Energy Resources*, August 2020, (with Tim Woolf and others)
- *Reducing CO_2 Emissions from Vermont Buildings: Potential and Cost-Effectiveness of Select Program Options*, Regulatory Assistance Project, February 13, 2019 (with Richard Faesy)
- *Pumping Energy Savings: Recommendations for Accelerating Heat Pump Adoption in Ontario's Electrically Heated Multi-Residential Buildings*, Toronto Atmospheric Fund, July 2018 (with Devon Calder, Brian Purcell and Judy Simon)
- *National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources*, Edition 1, Spring 2017 (with Tim Woolf, Marty Kushler, Steven Schiller and Tom Eckman)
- *The Next Quantum Leap in Efficiency: 30% Electricity Savings in 10 Years*, Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings, Volume 9, pp. 1-14 (with Jim Grevatt, Rich Sedano and Dave Farnsworth)
- *The Next Quantum Leap in Efficiency: 30% Electricity Savings in Ten Years*, published by the Regulatory Assistance Project, February 2016 (with Jim Grevatt)
- *Energy Efficiency as a T&D Resource: Lessons from Recent U.S. Efforts to Use Geographically Targeted Efficiency Programs to Defer T&D Investments*, published by Northeast Energy Efficiency Partnerships, January 9, 2015 (with Jim Grevatt)
- *Unleashing Energy Efficiency: The Best Way to Comply with EPA's Clean Power Plan*, Public Utilities Fortnightly, October 2014, pp. 30-38 (with Tim Woolf, Erin Malone and Robin LeBaron)
- *The Resource Value Framework: Reforming Energy Efficiency Cost-Effectiveness Screening*, published by the National Efficiency Screening Project, August 2014 (with Tim Woolf et al.)
- *U.S. Experience with Participation of Energy Efficiency in Electric Capacity Markets*, Regulatory Assistance Project, August 2014 (with Richard Cowart)
- *The Positive Effects of Energy Efficiency on the German Electricity Sector*, IEPEC 2014 Conference, September 2014 (with Friedrich Seefeldt et al.)
- *Final Report: Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges*, prepared for the Michigan Public Service Commission, September 13, 2013 (with Optimal Energy)
- *Energy Efficiency Feed-in-Tariffs: Key Policy and Design Considerations*, Proceedings of ECEEE 2013 Summer Study, pp 305-315 (with Richard Cowart)

- *Can Competition Accelerate Energy Savings? Options and Challenges for Efficiency Feed-in-Tariffs*, published in Energy & Environment, Volume 24, No. 1-2, February 2013 (with Richard Cowart)
- *An Energy Efficiency Feed-in-Tariff: Key Policy and Design Considerations*, published by the Regulatory Assistance Project, March/April 2012 (with Richard Cowart)
- *U.S. Experience with Efficiency as a Transmission and Distribution System Resource*, published by the Regulatory Assistance Project, February 2012 (with Rich Sedano)
- *Achieving Energy Efficiency: A Global Best Practices Guide on Government Policies*, published by the Regulatory Assistance Project, February 2012 (with Nancy Wasserman)
- *Residential Efficiency Retrofits: A Roadmap for the Future*, published by the Regulatory Assistance Project, May 2011 (with Meg Gottstein and Blair Hamilton)
- *Is it Time to Ditch the TRC?* Proceedings of ACEEE 2010 Summer Study on Energy Efficiency in Buildings, Volume 5 (with Marty Kushler)
- *Energy Efficiency as a Resource in the ISO New England Forward Capacity Market*, in Energy Efficiency, published on line 06 June 2010 (with Cheryl Jenkins and Shawn Enterline)
- *A Comparison of Energy Efficiency Programmes for Existing Homes in Eleven Countries*, prepared for the British Department of Energy and Climate Change, 19 February, 2010 (with Blair Hamilton et al.)
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- *Playing with the Big Boys: Energy Efficiency as a Resource in the ISO New England Forward Capacity Market*, Proceedings of ACEEE 2008 Summer Study Conference on Energy Efficiency in Buildings, Volume 5 (with Cheryl Jenkins and Blair Hamilton)
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- *Shareholder Incentives for Gas DSM: Experience with One Canadian Utility*, Proceedings of ACEEE 2004 Summer Study on Energy Efficiency in Buildings, Volume 5 (with Kai Millyard)
- *Cost Effective Contributions to New York's Greenhouse Gas Emission Reduction Targets from Enegy Efficiency and Renewable Energy Resources*, ACEEE 2004 Summer Study Proceedings, Volume 8 (with David Hill et al.)
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- *Coal and Emerging Energy and Environmental Policy*, in Natural Resources and Environment, 1991 (with Don Crane)
- *Acid Rain: The Problem*, in EPA Journal, January/February 1991 (with Ned Helme)
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Michigan Baseline Housing Study

May 25, 2021

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Acknowledgements

This report is a deliverable submitted to Consumers Energy and DTE Energy as part of a multiyear, independent calibration research study to analyze the baseline energy conditions in Michigan homes. The results of this study will be used to improve the energy efficiency programs across the state of Michigan and update the Michigan Energy Measures Database. Cadmus led this research with the support of multiple entities, including Apex Analytics and Guidehouse. The Cadmus team would like to acknowledge their invaluable contributions and support to complete this work. Additionally, Cadmus would like the acknowledge and thank, BuildingMetrics, ClearResult, Morgan Marketing Partners and the EWR Collaborative members for providing valuable feedback throughout the development of the project and supporting the objectives of this study.

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Executive Summary

Consumers Energy and DTE Energy contracted with an independent evaluation team led by Cadmus to assess the characteristics of the Michigan residential building stock and the impacts of this study on various home parameters in the *Michigan Energy Measures Database* (MEMD). The baseline housing study is a broad study of the lower peninsula of Michigan that characterizes the building stock within two climate zones (5 and 6)[1] and two housing types: single family homes[2] and multifamily buildings. This report presents findings based on data collected from 195 completed site visits. The Cadmus team weighted the results to ensure that building observations were weighted proportionally to the segments of the population represented in the sample. In-home observation and data collection began in July of 2019 and ran through the fall of 2020. The study was temporarily halted in March through August of 2020 due to the COVID-19 pandemic.

The primary objective of the study is to characterize the existing residential building stock within Consumers Energy and DTE Energy service territory, which makes up approximately 98%[3] of the state's population of households, from a representative sample of homes. The Cadmus team designed the study to account for regional differences, such as climate, housing type, homeownership, and household income levels. The characterization includes the principle characteristics of homes (e.g., square footage, insulation levels, and heating systems), their occupants (e.g., household size and income levels), and the end-use equipment (e.g., lighting and appliances) that together define residential energy usage. This study was in part developed to support the Michigan Public Service Commissions (MPSC) maintenance of the state's energy efficiency database (known as the Michigan Energy Measures Database or MEMD).

This document is organized to outline the needs of key stakeholders in the MEMD update process:

- *Summary of Key Findings, Conclusions, and Recommendations,* outlines key findings and recommendations for stakeholders.
- *Study Overview,* outlines the background and objectives of this study.

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[1] International Code Council (ICC) defined climate zones used in building construction standards. The upper peninsula of Michigan was not included in this study as there are no customers served by these utilities. Upper peninsula homes are being studied in a separate study funded by the Michigan Public Service Commission (MPSC).

[2] Single-family homes include site-built and modular homes on a permanent foundation. Manufactured homes were excluded from this study during the scoping process. DTE Energy finalized a pilot study in June of 2019 of 83 manufactured homes. The 2018/19 Manufactured Homes Pilot, DTE Energy

[3] Combined Consumers Energy and DTE Energy serve approximately 3,793,405 addresses in Michigan, according to the American Community Survey 5-year estimates from 2016 Michigan has approximately 3,860,394 occupied housing units.

Executive Summary

- Detailed Findings: Mechanical Systems*,* outlines study findings related to mechanical equipment found in Michigan homes.
- *Detailed Findings: Building Construction and Envelope,* outlines study findings related to construction characteristics, size of dwellings, and insulation.
- *Detailed Recommendations: Key Datapoint Updates* outlines significant differences to the MEMD, warranting updates. In this section the team provides recommended values to be incorporated into the MEMD.
- Study Overview,
- *Summary of Methodologies*, outlines the methods and processes the team used to identify participants in the study, visit their homes and gather data relevant to the objectives of the study. This section also covers how data was managed, reviewed and processed.
- Four Appendices are included at the end of this document outlining;
  - The survey used to recruit customers**;** *Appendix A. Customer Recruitment Survey*
  - The certification letter customers received upon recruitment*; Appendix B.* Certification Letter
  - Details of the types of data collected onsite through the teams tablet-based tool*; Appendix C. Datapoints Collected*
  - Details the methodology used to process field collected data related to home insulation levels; Appendix D*. Thermal Transmittance Calculations*

Summary of Key Findings, Conclusions, and Recommendations

This section presents the Cadmus team's key research findings, conclusions, and recommendations associated with our research objectives. The detailed findings chapters of this report provide further explanation and the context for our conclusions and recommendations. These recommendations are tailored for natural gas and electric service providers in Michigan, members of Energy Waste Reduction (EWR) Collaborative, MEMD Technical Subcommittee, the Technical Subcommittee Chair and the MEMD Developers (Morgan Marketing Partners, MMP). Findings outlined in *Detailed Recommendations: Key Datapoint Updates,* provide further details on the specific parameters and values we are recommending to be updated. These updates reference the weather sensitive documentation[4] provided each year with the MEMD.

[4] Michigan Statewide Energy Savings Database Weather Sensitive Retrofit Measures for Residential and Commercial Buildings, BuildingMetrics Incorporated, Updated October 15, 2020

Executive Summary

To assist various stakeholders in prioritizing the actions needed to address these recommendations, the Cadmus team organized each recommendation by topic and prioritized them based on the following definitions.

- ***High Priority:*** The study revealed compelling and conclusive data that is likely to have an impact on MEMD modeling and energy savings calculated for weather sensitive measures
- ***Medium Priority:*** The team estimates that implementing this recommendation would improve the quality and results of the MEMD but is based on compelling evidence and observations outside the formal experimental design of this study.
- ***Low Priority:*** Considerations for future improvement of the MEMD and weather-sensitive measures development process.

CONCLUSION 1: In general, the year a home was constructed (i.e., its vintage) had the strongest correlation with that home's efficiency and levels of insulation; additionally, the vintage bins defined in the MEMD could be better aligned with the efficiency levels of Michigan Lower Peninsula homes.

The team explored homeownership type (homeowners versus renters) and household income (greater than or less than $40,000/year) as variables correlating to overall home efficiency and envelope insulation levels, but found that – in aggregate – the year in which sampled homes were constructed had the greatest impact on their insulation levels. There were certain areas where household income and homeownership type correlated with building characteristics, specifically for heating and cooling system efficiencies; however, these results were localized and not consistent across home types or climate zones.

The current vintages used in the MEMD are not explicitly defined in MEMD documentation and have room for subjective interpretation making direct comparisons difficult. However, the commonly accepted years of construction consisting of old, existing, and new are pre-1978, 1980 to 2005 and post-2005. The team found prevailing codes and standards, and trends in the sample population indicated differences in the population starting in 1979, with additional trends between 1980 and 1997 and after 1998. The current energy code[5] went into effect in 2015 with specific requirements that relate to newly built homes. From the housing data and reviewing the state codes over time, adding an additional vintage and redefining the existing vintages would better characterize single-family and multifamily homes.

RECOMMENDATIONS

High Priority: The MEMD developers should update the definitions of home vintage in the MEMD to align with specific years of construction and the prevailing codes and typical home characteristics corresponding to homes built during that time period. To account for changes to codes and standards, a new construction vintage bin should be established. These new vintage bins should include homes built before 1979, between 1979 and 2015, and beyond 2016. The building characteristics of vintages through 2015 represent homes included in this study while homes built after 2016 represent a newly constructed home, built to code. Specific recommended parameters and the data used to define these vintages are outlined in *Detailed Recommendations: Key Datapoint Updates; Home Vintages*.

Medium Priority: Based on the study findings that home vintage was predictive of home efficiency, the MEMD Developers and the MEMD Technical Subcommittee should review the MEMD vintages annually to assess the need for additional tiers due to code and standard changes. Changes requiring periodic updates include federal standard changes to update HVAC efficiencies and state building code changes requiring updates to the building envelope characteristics. New codes and

[5] Michigan Energy Code adopted October 9, 2015, based on the International Energy Conservation Code 2015 edition,

standards adopted in Michigan should initiate a discussion if the characteristics of newly constructed homes should be set at code or another standard based on quantitative research.

CONCLUSION 2: Michigan homes are exceptionally variable, which limits the ability for deemed measures to accurately represent savings for all types of home energy usage characteristics associated with efficiency upgrades.

The current MEMD measures are developed assuming an average home with insulation upgraded to a higher standard. This method implicitly assumes all homeowners are equally likely to upgrade the insulation in their home. Our findings indicate homes are similar based on their vintage but not identical. Accounting for the variability in the population of homes would both increase the precision of the energy savings estimates and allow the users of the MEMD to target homes that would benefit the most from insulation upgrades. This variability can be accounted for by including measure baseline characteristics that represent more types of homes.

While homes of similar vintages may have been built to similar standards, some homeowners make changes and upgrades to their homes over time. Homes may also deteriorate or undergo additions or major renovations significantly affecting their energy consumption characteristics and the corresponding energy savings available from further upgrading the home. Of the dwellings visited in the study, 66% of basements and crawlspaces, 15% of above grade walls[6], and 2% of attics were un-insulated. Even relatively new homes would benefit from insulation measures where the existing insulation had failed (e.g., fell down, improperly secured to the insulating surface), degraded (e.g., settled and compressed attic and wall insulation, rotted from moisture, missing areas of insulation), or been damaged (e.g., physical damage, environmental damage).

RECOMMENDATIONS

High Priority: The MEMD Developers should update the baseline and measure characteristics for single-family and multifamily envelope insulation measures to better represent baseline home characteristics. A new construction baseline should also be included in the MEMD to allow builders to apply prescriptive upgrades to newly constructed homes. Detailed recommendations for changes to insulation measures are provided in *Detailed Recommendations: Key Datapoint Updates Insulation Measure Characteristics*. The measures upgrades are based on observed home characteristics and common upgrades.

High Priority: Natural gas and electric service providers should document baseline insulation levels in homes receiving insulation upgrades that are relevant to the upgrade (e.g., existing wall insulation levels prior to the measure upgrade). This data should be gathered as a standard part of

[6]Above grade walls are referring to wood framed and masonry exterior walls of the dwelling.

the application process and would be used to determine energy and demand savings associated with insulation upgrades. Collecting this data along with the aforementioned MEMD updates would allow utilities to capture unrealized savings and identify measure opportunities.

CONCLUSION 3: Individual room cooling systems are used in a significant number of both single-family and multifamily dwellings, but these conditions are not represented in MEMD savings calculations.

The MEMD currently assumes that central cooling systems are the only type of cooling used in single-family homes, while this study that found approximately 20% of single-family dwellings visited used room or window air conditioners (primarily window air conditioners) as their only source for mechanical cooling. Many homes had multiple room cooling systems, averaging more than two systems that serve approximately 2/3 of the dwelling area. The MEMD excludes all cooling energy savings in homes with room cooling systems when insulation is added. Adding room cooling as an HVAC option would allow those customers to be targeted with weather dependent measures that save cooling energy such as insulation measures, air sealing and high efficiency heat pumps. .

Additionally, the MEMD assumes package terminal air conditioners and heat pumps are the primary room cooling options for multifamily homes. Cadmus found other room cooling systems include window air conditioners (22% of homes) to be more common in the population than package terminal system (2% of homes). Package terminal air conditioners operate in very similar way to as other room cooling systems and could be combined into one category.

RECOMMENDATIONS

High Priority: The MEMD Developers should include window and room cooling options among the HVAC types used in developing weather sensitive measure savings. We outline our proposed HVAC system types and proposed efficiency updates in *Detailed Recommendations: Key Datapoint Updates, HVAC Systems*. These updates add two new categories for single-family HVAC systems, including adding room cooling for homes with either electric or gas heating. Multifamily package terminal systems should be updated to include room cooling or package terminal cooling.

High Priority: Natural gas and electric service providers should document the presence of room cooling systems used in homes receiving weather sensitive measures. This data should be gathered as a standard part of the application process and would be used to determine energy and demand savings associated with these types of cooling systems. Collecting this data along with the aforementioned MEMD updates would allow utilities to capture unrealized savings and identify measure opportunities.

CONCLUSION 4: The home characteristics used for weather sensitive measures are outdated; updating the dwelling characteristics in the MEMD will ensure energy saving estimates more accurately represent homes in the Michigan Lower Peninsula.

The standard dwelling features used by the MEMD have a significant impact on calculated energy savings for all weather sensitive measures. The current home characteristics used in weather sensitive measures were derived from a 2004 study of housing characteristics in California and are different to homes visited in this study.

Across all vintages, ceilings and attics were found to have similar or more insulation than the current MEMD assumptions. The MEMD assumed R-11 ceiling insulation in older homes where we found homes averaged R-19 insulation. We found windows to be more efficient than the assumptions in the MEMD, which assumed all windows in older homes were single paned. Conversely, walls were found to have less insulation than assumed: the current MEMD assumes between R-7 and R-11 in existing walls depending on vintage, while the team founds between R-5 and R-10 were the average values.

While more data will be available in the summer of 2021 when the findings from the furnace metering portion of this study will be analyzed, Cadmus used customer reported temperature setpoints (based on interviews) and the data collected during field visits to estimate thermostat settings among the study population. The team found significant differences between how customers operated their thermostats and the assumptions in the MEMD. The MEMD assumes that single-family customers set their thermostat to 70ºF with a setback to 60ºF[7] to heat their homes. Customers' reported thermostats settings and schedules indicate a similar setpoint of 69ºF but a very moderate setback to 67ºF is more common. When cooling their homes, customers also indicated a 72ºF cooling setpoint with a setback to 74ºF, this contrasts to the 75ºF setpoint with an 80ºF setback assumed by the current MEMD.

Updating these characteristics to align with the findings of the baseline housing study would increase the accuracy of energy savings estimates in the weather sensitive MEMD based on conditions in Michigan homes.

RECOMMENDATIONS

High Priority: The MEMD Developers should update the insulation levels used in single-family and multifamily homes. The specific values we recommend be updated are outlined in the findings *Detailed Recommendations: Key Datapoint Updates; Home Insulation*.

Medium Priority: The MEMD Developers should update the thermostat settings used in single-family and multifamily homes. The specific values we recommend be updated are outlined in the findings Detailed Recommendations: Key Datapoint Updates; Thermostat Setpoints. While further

[7] Setback length of time is unspecified in the current MEMD.

refinement of these data is expected based on the results of the furnace metering study, the recommended estimates would better align the current MEMD with customer behavior.

Study Overview

The Michigan residential housing baseline study was conducted over two phases. Phase I, conducted in 2017, was used to assess if a larger statewide study was warranted and test study methods, such as recruitment, data collection, and customers receptiveness to site visits. As part of Phase I, the Cadmus team reviewed existing program documentation including program tracking data and audit reports to assess the alignment of MEMD vintage parameters with actual participant home data. In nearly all the cases, the Cadmus team found that participant data did not align well with the MEMD. That conclusion triggered Phase II of the study.

For Phase II, the Cadmus team collected primary field data from Michigan homes in Consumers Energy and DTE Energy service territories to support updated input parameters for measure savings estimates in the Michigan Energy Measures Database (MEMD).[8] During the Phase II scoping process, stakeholders agreed that the study should reflect a broader focus on various baseline parameters, rather than just home vintage, and helped establish the following research objectives.

This report addresses several research objectives:

Characterize envelope and equipment efficiency levels in Michigan homes while controlling for key parameters of interest including home vintage, household income and home ownership; as well as provide representative results across the two climate zones of the lower peninsula and major dwelling types including single-family and multifamily homes.

Compare study findings to the existing vintage schema used in the MEMD and propose updates or alternative scenarios as appropriate.

Identify gaps in data collection necessary to verify and calculate energy savings within the recommended revisions to the MEMD schema and to inform future MEMD updates and program planning. Recommend data that should be captured by EWR implementation teams.

8 The original statement of work proposed a study of the upper peninsula of Michigan. This study was not approved; however, an upper peninsula study was commissioned by the MPSC to be conducted by CLEAResult. The team has coordinated with the CLEAResult team discussing reporting results and data formatting. The results of the upper peninsula study are expected to be published soon.

Detailed Findings: Mechanical Systems

The Cadmus team visually assessed mechanical systems during the site visits. Mechanical systems included space heating and cooling and water heating equipment. We classified the type of each major piece of equipment and gathered available nameplate information. In some cases, the nameplate information had faded or was otherwise unreadable, resulting in missing equipment details. In these cases, we estimated the missing details based on the equipment age or based on related systems.[9] The team gathered the energy efficiency of mechanical equipment from the equipment nameplate or from manufacturer data, or we estimated this detail based on vintage.

Heating Types

We classified each heating system as primary or secondary, where primary systems were built into the structure and controlled by a thermostat and secondary systems were typically used by the homeowner in the same space as a primary system.

Ducted furnaces were the most common heating system across home types and climate zones. Table 1 shows the percentage of heating systems found by system type.

Table 1. Heating Types (excluding heat pumps) by Home Type and Climate Zone

Climate Zone	Heating System Type	Single-Family		Multifamily	
		n	Percentage of Systems	n	Percentage of Systems
Climate Zone 5	Ducted Furnace	47	60.26%	41	53.25%
	Space Heater	12	15.38%	14	18.18%
	Electric Baseboard	6	7.69%	5	6.49%
	Fireplace	5	6.41%	7	9.09%
	Other	2	2.56%	0	0.00%
	Boiler (Water)	3	3.85%	0	0.00%
	Wood Stove	1	1.28%	0	0.00%
	Common Boiler	0	0.00%	7	9.09%
	Wall Furnace	0	0.00%	3	3.90%
	Boiler (Steam)	2	2.56%	0	0.00%
	Furnace - Gravity	0	0.00%	0	0.00%
	Combi Boiler	0	0.00%	0	0.00%
Climate Zone 6	Ducted Furnace	37	42.53%	28	37.33%
	Space Heater	11	12.64%	10	13.33%
	Electric Baseboard	10	11.49%	20	26.67%
	Fireplace	11	12.64%	6	8.00%
	Other	7	8.05%	1	1.33%
	Boiler (Water)	2	2.30%	4	5.33%
	Wood Stove	6	6.90%	1	1.33%
	Common Boiler	0	0.00%	3	4.00%

9 To estimate the capacity of cooling systems with missing nameplate information, the Cadmus team used the rated capacity of the coil on the indoor component of the split cooling system.

Climate Zone	Heating System Type	Single-Family		Multifamily	
		n	Percentage of Systems	n	Percentage of Systems
	Wall Furnace	2	2.30%	1	1.33%
	Boiler (Steam)	0	0.00%	0	0.00%
	Furnace - Gravity	1	1.15%	0	0.00%
	Combi Boiler	0	0.00%	1	1.33%

Note: The Cadmus team weighted these values based on the sample strata.

Among primary heating systems, ducted furnaces and electric baseboard heating systems were the most common. Homes with electric baseboard heating were likely to have multiple heating systems, averaging more than two baseboard heating systems per dwelling. Portable space heating and fireplaces were common sources of secondary heating. Table 2 shows the percentage of primary and secondary systems by heating system type.

Table 2. Heating Types (excluding heat pumps) for Primary and Secondary Heating

Heating System Type	Primary		Secondary	
	n	Percentage of Systems	n	Percentage of Systems
Ducted Furnace	149	74.4%	4	5.2%
Portable Space Heater	9	3.7%	38	54.5%
Boiler (Water)	32	8.6%	9	7.1%
Fireplace	3	1.7%	26	27.1%
Other	5	2.7%	5	2.7%
Wood Stove	9	3.9%	0	0.0%
Electric Baseboard	4	1.7%	4	1.7%
Boiler (Steam)	4	0.9%	2	1.7%
Furnace - Gravity	2	2.3%	0	0.0%
Wall Furnace	1	0.2%	0	0.0%
Combination Boiler	1	0.0%	0	0.0%

Note: The Cadmus team weighted these values based on the sample strata.

Heat pumps were uncommon, with only three homes using geothermal heat pumps, two homes using ductless mini-split heat pumps, and one home using a package terminal heat pump. These heat pumps were relatively new, with the oldest system manufactured in 2006. Table 3 shows the observed installations of heat pump systems in single-family and multifamily homes in climate zone 5 and climate zone 6.

Table 3. Heat Pump Types Installed

Climate Zone	Single-Family	Multifamily
Southern – Climate Zone 5	1 geothermal heat pump	2 ductless mini-split heat pumps 1 geothermal heat pump 1 package terminal heat pump
Northern – Climate Zone 6	1 geothermal heat pump	none

Heating Efficiency

Single-family homes more commonly had higher-efficiency fuel-fired heating systems than multifamily homes. Standard efficiency non-condensing (low efficiency) heating systems are still very common in multifamily homes, which have lower efficiency. There was no significant difference in heating efficiency between climate zone 5 and climate zone 6, as shown in Table 4.

The Cadmus team also analyzed heating efficiency by home vintage, household income, and homeownership type, and system type, but did not find any consistent correlations.

Table 4. Percentage Efficiency of Fuel-Fired Heating Systems

Climate Zone	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	**86.2%**	1.6	52	**82.0%**	1.5	36
Northern – Climate Zone 6	**88.8%**	2.0	35	**80.1%**	4.4	34
Lower Peninsula Average/Total	**86.4%**	**1.5**	**87**	**81.9%**	**1.4**	**70**

Note: The Cadmus team weighted these values based on the sample strata. Bolded values are significantly different.

Central Cooling Systems

Standard efficiency cooling systems[10] are common across the Lower Peninsula, with 95% of the central cooling systems we inspected at or below the current federal standard of 13 Seasonal Energy Efficiency Ratio (SEER). The Cadmus team found no significant difference in central cooling efficiency by climate zone or by home type (single-family versus multifamily). The team also analyzed central cooling efficiency by home vintage, household income, and homeownership type, but did not find any consistent correlations.

Table 5 shows the Seasonal Energy Efficiency Ratio (SEER) of central air conditioners for single-family and multifamily homes in climate zone 5 and climate zone 6.

[10] The federal standard efficiency for central cooling systems has increased over time from 10 SEER to 13 SEER in 2006.

Table 5. Efficiency (SEER) of Central Air Conditioners

Climate Zone	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	11.3	0.6	36	10.9	0.6	31
Northern – Climate Zone 6	11.4	0.7	23	10.4	0.6	21
Lower Peninsula Average/Total	**11.3**	**0.6**	**59**	**10.9**	**0.5**	**52**

Note: The Cadmus team weighted these SEER values based on the sample strata.

Room Cooling Systems

A significant number of dwellings in the Lower Peninsula use room cooling systems, which consisted of window air conditioners (22%), package terminal air conditioners (2%), and portable air conditioners (1%) across all climate zones. Of the multifamily homes we visited, 30% in climate zone 5 and 28% in climate zone 6 used room cooling as their only cooling source, compared to 20% of single-family homes in climate zone 5 and climate zone 6.

Room cooling system efficiency was consistent across strata. Multifamily homes in climate zone 6 show slightly lower efficiency, but this result was not statistically significant.

Table 6 shows the Energy Efficiency Ratio (EER) of room cooling systems for single-family and multifamily homes in climate zone 5 and climate zone 6.

Table 6. Efficiency of Room Cooling Systems

Climate Zone	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	10.5	0.3	26	10.4	0.6	19
Northern – Climate Zone 6	10.4	0.3	15	9.4	0.9	12
Lower Peninsula Average/Total	**10.5**	**0.2**	**41**	**10.4**	**0.6**	**31**

Note: The Cadmus team weighted these EER values based on sample strata.

Distribution Systems

Distribution systems consisted of central forced air, hydronic (hot water), and steam systems. Most distribution systems were in the conditioned space of both the single-family and multifamily homes. Table 7 shows the percentage of distribution systems located in unconditioned spaces at single-family and multifamily homes.

Table 7. Percentage of Distribution Systems in Unconditioned Space

Distribution System Type	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Central Forced Air	26.2%	8.9%	85	29.2%	10.0%	70
Hydronic	11.7%	11.9%	5	0.0%	0.0%	7
Steam	36.5%	22.1%	2	0.0%	0%	1

Note: The Cadmus team weighted these values based on sample strata. Percentages will not sum to 100%.

Less than half the square-footage area for distribution systems located in unconditioned spaces was insulated. The uninsulated areas led to thermal losses through the walls of the duct system. Central forced air distribution systems were generally less insulated in multifamily homes compared to single-family homes. Table 8 shows the percentage of insulated area for distribution systems in unconditioned spaces.

Table 8. Percentage of Distribution Systems Insulated in Unconditioned Space

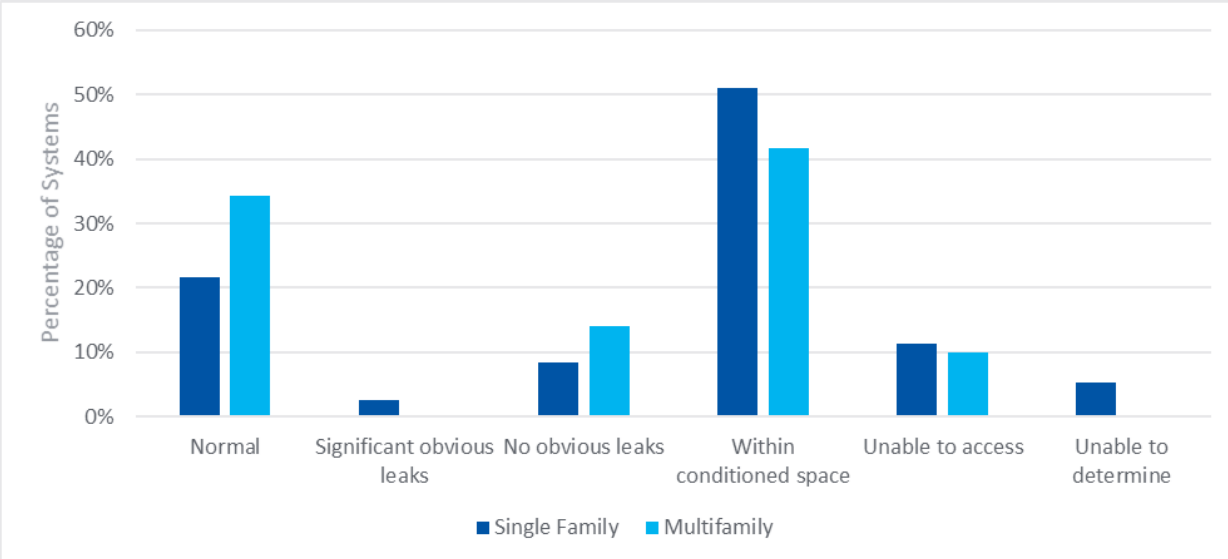
Distribution System Type	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Central Forced Air	40.0%	11.1%	85	17.7%	9.4%	70
Hydronic	4.6%	10.9%	5	N/A*	N/A*	7
Steam	45.0%	284.1%	2	N/A*	N/A*	1

Note: The Cadmus team weighted these values based on sample strata. Percentages will not sum to 100%
*Distribution systems entirely within the conditioned space of the dwelling do not have applicable insulation on the distribution system since the losses are recovered by the home.

The Cadmus team qualitatively assessed the air leakage in central forced air duct systems. The relative construction of duct systems and the presence of duct sealing materials are described below.

The team ignored duct leakage in conditioned spaces for our assessment since this leakage does not result in heat losses by the duct system. Figure 1 shows the percentage of duct systems in each qualitative assessment category. *Normal* duct leakage characterizes duct systems with typical build quality where mechanical joints are connected but small gaps exist from the connections. Duct systems with *no obvious leaks* were characterized by tight fitting connections and no gap observed in the duct work. Duct systems with significant obvious leaks were characterized as damaged or had poorly fitting joints resulting in significant airflow.

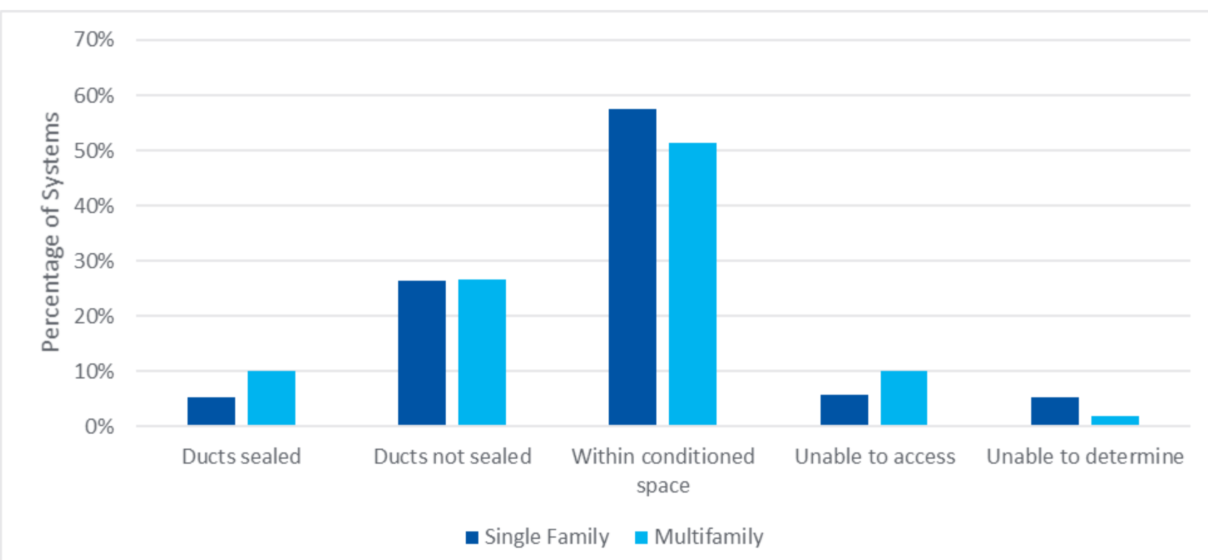
Figure 1. Qualitative Leakage of Central Forced Air Distribution



Note: The Cadmus team weighted these values based on sample strata. Distribution systems entirely within the conditioned space of the dwelling were assumed to not have detrimental impacts from duct leakage.

Air ducts typically have many mechanical joints where relatively small gaps can results in significant air leakage. Few distribution systems were sealed to prevent leakage from the joints. Figure 2 shows the percentage of distribution systems in unconditioned spaces that had been sealed.

Figure 2. Percentage of Distribution Systems in Unconditioned Spaces with Sealing Materials



Note: The Cadmus team weighted these values based on sample strata. Distribution systems entirely within the conditioned space of the dwelling were assumed to not have detrimental impacts from duct leakage.

Heating and Cooling Capacities

The team calculated heating and cooling capacities installed in homes as a function of the area of the dwelling served by the system. Multifamily homes with central cooling had significantly more cooling capacity installed than single family homes. Multifamily dwellings with both electric and fuel heating had significantly more heating capacity installed. While the reason for this difference is not known multifamily dwellings were significantly smaller than single family dwellings.

Dwellings in Climate Zone 5 had significantly more central cooling capacity installed and surprisingly more heating capacity installed. Due to the warmer climate in climate zone 5 dwellings were expected to have less heating capacity.

Table 9 through Table 12 show the installed capacity of cooling and heating systems installed in dwellings per square foot of conditioned area served for single family and multi-family homes by climate zone and system type.

Table 9. Cooling BTU/hr Capacity Per Square Foot of Conditioned Area for Single-Family and Multifamily Dwellings

	Single Family			Multifamily		
Cooling System Type	Mean	EB	n	Mean	EB	n
Central AC	**13.6**	1.5	57	**23.1**	2.7	52
Window AC	27.6	5.8	37	20.6	5.5	25
PTAC	69.4	-	1	25.2	16.5	2
Other	-	-	-	32.0	-	1

Note: Values are weighted and in the units BTU/hr/sq-ft. Bold values indicate significant differences.

Table 10. Cooling BTU/hr Capacity Per Square Foot of Conditioned Area for Climate Zone 5 and Climate Zone 6

	Climate Zone 5			Climate Zone 6		
Cooling System Type	Mean	EB	n	Mean	EB	n
Central AC	**15.9**	1.4	65	**13.3**	1.2	44
Window AC	27.2	5.2	40	16.3	6.1	22
PTAC	25.2	16.5	2	69.4	-	1
Other	-	-	-	32.0	-	1

Note: Values are weighted and in the units BTU/hr/sq-ft. Bold values indicate significant differences.

Table 11.Heating BTU/hr Capacity Per Square Foot of Conditioned Area for Single-Family and Multifamily Dwellings

	Single Family			Multifamily		
Heating Fuel Type	Mean	EB	n	Mean	EB	n

Electric	**19.9**	0.4	11	**58.8**	32.6	17
Fuel	**44.1**	4.2	83	**66.8**	7.5	73

Note: Values are weighted and in the units BTU/hr/sq-ft. Bold values indicate significant differences.

Table 12. Heating BTU/hr Capacity Per Square Foot of Conditioned Area for Climate Zone 5 and Climate Zone 6

Heating Fuel Type	Zone 5			Zone 6		
	Mean	EB	n	Mean	EB	n
Electric	29.0	8.0	15	25.9	6.3	13
Fuel	**49.4**	4.0	90	**40.0**	3.7	66

Note: Values are weighted and in the units BTU/hr/sq-ft. Bold values indicate significant differences.

Domestic Hot Water

Most water heating systems at the sites we visited were storage tank water heaters. Water heating systems that served multiple dwellings were relatively common, representing 28% (n=29) of the multifamily units visited. Table 13 shows the quantities of each water heating system type in the sample population, and whether each system served a single dwelling or multiple dwellings.

Table 13.Water Heating Systems by Type

	Served One Dwelling	Served Multiple Dwellings
Storage tank water heater	142	19
Boiler with tank	13	2
Instantaneous	9	0
Heat pump water heater	1	0
Combination boiler	1	0
Unable to access	1	10
Total	**167**	**31**

Note: The values in this table are unweighted.

Tank sizes for water heaters ranged from 30 gallons to 80 gallons, with a mean of less than 44 gallons across all strata. Table 14 shows the average water heater tank size in gallons for single-family and multifamily homes by climate zone.

Table 14. Storage Water Heater Size in Nominal Gallons

Climate Zone	Single-Family	Multifamily
Southern – Climate Zone 5	43.5	41.5
Northern – Climate Zone 6	42.1	39.2

Note: The values in this table are unweighted.

The energy-efficiency values for water heating systems are typically expressed as the efficiency factor or the uniform efficiency factor. Historically, these efficiency values were not displayed on water heating system nameplates and documentation for older water heaters was rarely available. However, Energy Guide labeling has been required on new water heaters since 1979. These labels typically express the energy usage of a water heater in therms per year, kilowatt-hours per year, or dollars per year.

Energy Guide label data was not significantly different across home vintage, climate zone, or home type. Electric water heaters consume approximately 4,800 kWh per year and natural gas water heaters consume approximately 250 therms per year. Table 15 details the available Energy Guide label data by the type of unit shown on the label for single-family versus multifamily homes.

Table 15. Water Heater Energy Guide Label Consumption by Home Type

Energy Guide Label Type	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Dollars per year	269.3	28.4	26	287.0	27.7	15
Kilowatt-hours per year	4,834.5	84.7	12	4,819.8	70.3	10
Therms per year	247.1	7.5	35	250.4	5.9	41

Detailed Findings: Building Construction and Envelope

The Cadmus team extensively measured each home in the sample to determine square footage and construction characteristics. We summarized the construction characteristics as the effective insulating qualities of the dwelling including insulation, the construction materials, and environmental factors. These effective insulating qualities are the thermal transmittance of each area, represented as U-factors. Lower U-factors represent a more efficient area, with a theoretical minimum U-factor of 0.0 representing a perfectly insulated area. Details on the calculations we used to determine dwelling U-factors are shown in *Appendix D*.

Dwelling Size

The conditioned floor area of a home is important for estimating the energy usage of that home. The conditioned floor area of a home must meet several characteristics:

- It is served by the home heating system
- It maintains a temperature close to the home thermostat setpoint
- It is within the thermal boundary of the home

Basements are often difficult to classify as being conditioned or unconditioned, as they may meet one or two but not all three of these characteristics. The Cadmus team used professional judgement to classify spaces that did not meet all the requirements of a conditioned space.

The size of conditioned areas in multifamily homes are significantly smaller than those in single-family homes. There were not significant differences in the size of conditioned areas between the Lower Peninsula climate zones. Table 16 details the conditioned floor area of the dwellings by home type.

Table 16. Conditioned Floor Area in Square Feet

Climate Zone	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	2,392.9	248.5	52	1,136.8	167.9	53
Northern – Climate Zone 6	2,406.0	233.4	41	1,065.1	121.4	49
Lower Peninsula Average/Total	**2,394.3**	**221.7**	**93**	**1,133.2**	**158.3**	**102**

Note: The Cadmus team weighted the conditioned floor areas shown in the table.

The Cadmus team also measured the square footage of unconditioned floor areas at each home. We considered unconditioned areas as those that did not meet the definition of conditioned floor area (outlined above) but are protected from outside weather conditions. This typically included basements, storage areas, and open attic areas. Table 17 details the unconditioned floor area of the dwellings by home type and climate zone.

Table 17. Unconditioned Floor Area in Square Feet

Climate Zone	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	350.5	101.5	52	143.2	72.9	53
Northern – Climate Zone 6	415.1	116.4	41	125.1	54.8	49
Lower Peninsula Average/Total	**357.4**	**90.8**	**93**	**142.3**	**51.7**	**102**

Note: The Cadmus team weighted the unconditioned floor areas shown in the table.

Number of Floors

Single-family homes averaged 1.6 floors, while multifamily homes averaged slightly lower, at 1.3 floors. Multifamily dwellings within a larger building averaged slightly more floors per home, at 2.2. Table 18 shows details of the number of above-grade floors by home type and climate zone.

Table 18. Number of Above-Grade Floors

Climate Zone	Single-Family Homes			Multifamily Homes			Multifamily Buildings		
	Mean	Error Bound	n	Mean	Error Bound	n	Mean	Error Bound	n
Southern – Climate Zone 5	1.6	0.1	52	1.3	0.1	53	2.2	0.2	51
Northern – Climate Zone 6	1.5	0.1	41	1.3	0.1	49	1.9	0.2	48
Lower Peninsula Average/Total	**1.6**	**0.1**	**93**	**1.3**	**0.1**	**102**	**2.2**	**0.2**	**99**

Note: The Cadmus team weighted the number of floors shown in this table.

Construction U-factors

The Cadmus team analyzed home construction U-factors for various areas of the homes by home type, controlling for climate zone. Enclosed ceiling areas had the only U-factor that was significantly different between single-family and multifamily homes. Enclosed ceiling areas in multifamily homes were often flat roofs that were 12- to 18-inches thick and had significant room for insulation, while enclosed areas in single-family homes typically consisted of vaulted ceilings 6- to 12-inches thick. Table 19 shows effective U-factors by home area and home type.

Table 19. Effective U-factors of Single-Family and Multifamily Homes

Home Area	Single-Family			Multifamily		
	Mean	Error Bound	n	Mean	Error Bound	n
Open attics	0.044	0.004	117	0.047	0.006	72
Enclosed ceilings	**0.057**	0.005	47	**0.038**	0.007	19
Doors	0.676	0.039	249	0.716	0.055	132
Framed floors	0.202	0.020	75	0.216	0.020	56
Foundation walls	0.273	0.016	234	0.284	0.022	82
Rim band joists	0.087	0.003	220	0.094	0.006	131
Skylights	0.380	0.000	62	0.385	0.006	78
Above-grade walls	0.101	0.008	295	0.116	0.013	171
Windows	0.463	0.012	1211	0.493	0.018	522

Note: The Cadmus team weighted each area shown in the table. Bold values indicate significant differences.

U-factors also had a few significant differences by climate zone. Homes in climate zone 6 had slightly higher skylight U-factors and lower wall U-factors than homes in climate zone 5. No other U-factor characteristics had significant differences. Table 20 shows effective U-factors by home area and climate zone.

Table 20. Effective U-factors of Northern and Southern Climate Zone Homes

Home Area	Southern – Climate Zone 5			Northern – Climate Zone 6		
	Mean	Error Bound	n	Mean	Error Bound	n
Open Attics	0.044	0.004	90	0.050	0.005	99
Enclosed ceiling	0.053	0.005	38	0.046	0.005	28
Doors	0.680	0.035	193	0.738	0.035	188
Framed floors	0.205	0.017	68	0.211	0.016	63
Foundation wall	0.276	0.015	171	0.277	0.024	145
Rim band joists	0.088	0.003	189	0.097	0.007	162
Skylights	**0.380**	0.000	71	**0.394**	0.002	69
Above-grade walls	**0.109**	0.008	258	**0.066**	0.004	208
Window	0.471	0.011	956	0.462	0.012	777

Note: The Cadmus team weighted each area shown in the table. Bold values indicate significant differences.

The year of a home's construction significantly impacted the observed U-factors. Homes built in 1998 or later had significantly lower U-factors in attics, enclosed ceilings, foundation walls, above-grade walls, and windows than homes built prior to 1979. Homes built in 1998 or later also had significantly lower U-factors in attics, foundation walls, and windows than homes built between 1979 and 1997.

Homes built prior to 1979 had the highest U-factors among all analyzed areas except attic insulation and skylights, indicating that these homes are the least insulated. Homes built after 1998 had the lowest U-factors for every area except doors, floors, and skylights. However, there were no significant differences in U-factors for doors and framed floors across all vintages. Table 21 shows effective U-factors by home area and vintage.

Table 21. Effective U-factors by Home Area and Vintage

Home Area	Pre-1979			1979-1997			1998-2019		
	Mean	Error Bound	n	Mean	Error Bound	n	Mean	Error Bound	n
Open attics	**0.047**	0.002	101	**0.055**	0.007	38	**0.034**	0.002	44
Enclosed ceilings	**0.055**	0.004	34	0.046	0.006	15	**0.043**	0.005	16
Doors	0.715	0.026	192	0.658	0.045	80	0.705	0.039	101
Framed floors	0.211	0.011	70	0.200	0.022	26	0.227	0.007	33
Foundation walls	**0.320**	0.016	167	**0.248**	0.013	70	**0.206**	0.010	77
Rim band joists	**0.094**	0.003	187	0.093	0.007	74	**0.085**	0.005	85
Skylights	**0.396**	0.006	72	**0.419**	0.012	33	**0.420**	0.016	32
Above-grade walls	**0.113**	0.007	215	**0.077**	0.007	97	**0.076**	0.005	146
Windows	**0.516**	0.010	912	**0.428**	0.012	324	**0.399**	0.006	469

Note: The values in this table are unweighted. Bold values indicate significant differences.

Detailed Recommendations: Key Datapoint Updates

The MEMD Overview and Maintenance Process Manual outlines the standard update process to submit new measures, update existing measures and calibrate energy savings. However, the manual focuses on non-weather sensitive measures when the entire scope of the measure update can be outlined in a single whitepaper update. Weather sensitive measures require coordination with multiple parties to propose and execute updates. Further refining the steps in the process and parties involved would be helpful for all EWR Collaborative members.

The MEMD uses sets of DOE-2.2[11] energy models to develop energy-savings estimates for weather-dependent measures. These energy models characterize a home based on vintage, HVAC system types, and location. Using the field data collected (presented in previous sections of this report), the Cadmus team created several recommendations for updating the MEMD energy models and measure calculations used to develop energy savings. This chapter outlines our recommended updates by home characteristic.

Measures are modeled using a baseline and efficient energy model. The energy savings for a measure is the decrease in energy usage from the baseline to the efficient models. For each measure, the baseline and efficient conditions of the measure are varied while keeping all other characteristics of the home constant. The home characteristics kept constant are general characteristics of the home that represent a large population of homes, while the measure baselines are specific to the measure. For example when a high efficiency air conditioner is modeled, the baseline for the measure is the federal standard efficiency. However when windows are upgraded in a home with central air conditioning, the efficiency of the air conditioner is best represented as the general efficiency of central air conditioners.

Home Vintages

The MEMD defines home vintage based on the year energy codes were introduced and adopted and on code updates over time, which characterize a home's energy efficiency. The current MEMD vintages are as defined as;

1. **Old**, poorly insulated building constructed prior to the introduction of building codes. This vintage is referred to as the "old" vintage
2. **Existing**, average insulated building conforming to 1980 and 1990s era building codes. This vintage is referred to as the "average" vintage.
3. **New,** Recent construction conforming to the Michigan State Uniform Energy Code. This vintage is referred to as the "new" vintage.

For this Phase II study, the Cadmus team recommends further refining the MEMD vintage bins into specific age ranges and updating the new construction vintage that can evolve to account for future changes to building codes and equipment standards. Table 22 shows an outline of three vintage bin

[11] DOE-2.2 is an hourly energy simulation engine developed by the U.S. Department of Energy that supports calculations of building energy usage.

ranges and their corresponding home characteristics we recommend adopting into the MEMD. Due to construction schedules, it typically takes between one and two years for the new homes market to fully align with new building codes. The team selected these vintages based on energy code changes in Michigan, the housing population we observed, and trends in the data we collected.

Table 22. Recommended Vintages and Home Characteristics for MEMD Updates

Vintage Range	Code Considerations	Housing Population	Data Trends
Pre 1979	Prior to 1977, there was no adopted building code in Michigan.	Approximately half the homes in the study were built before 1979.	In the late 1970s the insulation levels of the least-efficient homes started to increase.
1979-2015	In 1977, the state adopted its first energy code, changing how buildings are constructed in the state. In early 1996, Michigan SB719 repealed the adoption of the newer 1993 Michigan Energy Code, delaying energy code advancements.	Approximately one-half of homes in the study were built between 1979 and 2015.	The trend of increasing efficiency levels of the least-efficient homes began to level off through the late 90's, however the most efficient homes still show increasing energy efficiency. Homes built into the 2000's and after show moderate increases in overall insulation
New Construction (2016-Current)	In February 2016 the current code (International Energy Conservation Code 2015) went into effect. As new building codes are adopted in Michigan, this vintage bin should be updated to reflect the current standard.	Over time, the efficiency of new construction will shift as new codes are adopted.	Field data indicates that newer homes are much more efficient and should be accounted for accordingly.

Weather Locations

The MEMD uses seven weather locations in Michigan, which are appropriate and broad enough to reasonably cover the state. The team did not find significant differences in construction characteristics between homes built in climate zone 5 and those built in climate zone 6; however, the mechanical systems in each zone do have significant differences. Additionally, the newest code, International Energy Conservation Code 2015, requires more stringent insulation levels in climate zone 6. The MEMD should preserve the current weather locations with distinct home characteristics.

HVAC Systems

Room cooling systems, including window air conditioners, were common in both single-family and multifamily homes. We recommend that the MEMD add window air conditioning as an available HVAC type for energy simulations.

Electric furnaces (n=2) were significantly less common than electric baseboard heating (n=12). We recommend that the MEMD replace the current electric furnace option with electric baseboard heating and rename the option to encompass all electric resistance heating systems as these systems operate at similar efficiencies.

Additionally we did not find significant differences in installed efficiencies between natural gas fueled heating systems. To simplify the data collecting and reduce the number of prototypes we recommend modeling a natural gas furnace as the primary heating type for centrally heated natural gas homes.

Table 23 details our recommended updates to heating and cooling types for single-family and low-rise multifamily homes. The MEMD should use these recommended characteristics in both climate zone 5 and climate zone 6 for all measures except HVAC replacements, which use measure-specific baseline values.

Table 23. Recommended MEMD General HVAC Characteristics for Single-Family and Multifamily Low Rise Homes

Home Type	HVAC Type	Heating Efficiency	Cooling Efficiency
Single-Family	Central split-system AC with natural gas heating	**86% AFUE**	**11.3 SEER** (NC=13 SEER)
	Central split-system heat pump	8.2 HSPF	**11.3 SEER** (NC=14 SEER)
	Central split-system dual-fuel heat pump	**86% AFUE** and 8.2 HSPF	**11.3 SEER** (NC=14 SEER)
	Electric resistance heating with room cooling	100% efficient	**10.5 EER (NC=10.9 CEER)**
	Electric resistance heating only	100% efficient	N/A
	Natural gas heating only	**86% AFUE**	N/A
	Natural gas heating with room cooling	**86% AFUE**	**10.5 EER** (**NC=10.9 CEER**)
Multifamily (low rise)	Central split-system AC with natural gas heat	**82% AFUE**	**10.9 SEER** (NC=13 SEER)
	Central split-system AC with electric resistance heat	100% efficient	**10.9 SEER** (NC=13 SEER)
	Split-system heat pump	8.2 HSPF	**11.3 SEER** (NC=14 SEER)
	Packaged terminal heat pump	7.4 HSPF	7.1 EER (**NC=10.9 CEER**)
	Packaged terminal air conditioner or room air conditioner with electric resistance heating	100% efficient	**10.5 EER (NC=10.9 CEER)**
	Electric baseboard only	100% efficient	N/A
	Natural gas heating only	**82% AFUE**	N/A
	Natural gas heating with room cooling	**82% AFUE**	**10.5 EER (NC=10.9 CEER)**

Notes: AC stands for air conditioner and NC stands for new construction. Where the efficiency of the existing systems was less efficient than current federal standards, the MEMD should use federal standard efficiency levels for new construction scenarios. Most existing room cooling systems were rated in EER while the newest federal standard rates those system in CEER based on a newer test procedure. Bolded values indicate a difference from current MEMD values. SEER may be converted to EER using the follow equation, EER=(-0.02*SEER^2)+(1.12*SEER). [From: Wassmer, M. (2003), "A Component Based Model for Residential Air Conditioner and Heat Pump Energy Calculations," Master's Thesis, University of Colorado at Boulder]

Thermostat Setpoints

The current thermostat setting used by the MEMD assume a 70F setpoint for heating with a setback temperature to 60F in single-family and 67F in multifamily homes and a 75F cooling setpoint with a setback to 80F in single-family and 78F in multifamily homes. Typically, few customers reported using heating and cooling setback with 23% of single family homes 12% of multifamily homes reporting they typically schedule their thermostat. Of thermostat setting viewed in the field an average heating setback of 2.6F and a cooling setback of 1.6F was observed.

Due to the ongoing metering study, full indoor temperature data was not available for the Cadmus team to calibrate thermostat setpoints. In the interim, we recommend that the MEMD use thermostat setpoints from customer interviews and thermostat settings observed in the field. The setpoints and setback temperatures we observed were significantly less stringent than those currently used in the MEMD.

Table 24 details our recommended general setpoints and corresponding times for those setpoints. These setpoints are derived from observed thermostat setting at the time of the site visit and a limited sample of thermostat loggers. The MEMD should use these recommended setpoints as standard for all measures except thermostat setback measures until they can be further refined based on additional collected meter data.

Table 24. Recommended MEMD General Thermostat Setpoints for Residential Homes

Setpoint Type	Setpoint	Time Frame
Heating setpoints	69°F	5 p.m. to 10 p.m.
	67°F	10 p.m. to 6 a.m.
	68°F	6 a.m. to 5 p.m.
Cooling setpoints	72°F	4 a.m. to 12 p.m.
	74°F	12 p.m. to 4 a.m.

Home Insulation

Cadmus observed several significant differences between home insulation characteristics and current MEMD assumptions. Attic and ceiling insulation values in older homes were significantly higher than MEMD assumptions, while wall insulation values were noticeably lower than current MEMD assumptions. Table 25 details our recommended nominal insulation values[12] by home area and climate zone. These parameters are informational used in for single-family and low rise multifamily (less than 4 floors) energy simulations. The MEMD should use these general values for all measures except insulation measures, which use measure-specific values. The team provides measure specific baseline recommendations below in *Insulation Measure Characteristics.*

[12]Nominal insulation values represent a home intentional insulation amount that excludes the insulating values of structural and decorative components of the home.

Table 25. Recommended MEMD General Insulation Characteristics by Climate Zone (R-Values)

Characteristic	Southern – Climate Zone 5			Northern – Climate Zone 6		
	Pre-1979	1979-2015	2016 - Current	Pre-1979	1979-2015	2016 - Current
Window U-factor	0.52	0.41	0.32	0.52	0.41	0.32
Skylight U-factor	0.40	0.42	0.55	0.40	0.42	0.55
Attic R-value	19	31	38	19	31	49
Enclosed ceiling R-value	17	23	38	17	23	49
Wood-framed wall R-value	5	10	20	5	10	20
Mass wall R-value	5	11	13	5	11	19
Floor R-value	1	1	30	1	1	30
Basement wall R-value	Unins.	5	10	Unins.	5	15
Slab R-value	Unins.	5, 2 foot	10, 2 foot	Unins.	5, 2 foot	10, 4 foot
Crawlspace wall R-value	3	10	15	3	10	15

Nominal insulation values can be interpreted in various ways due to the nature of building construction. Construction assumptions are an important consideration in developing an updated MEMD energy model. Table 26 details the construction characteristics that are assumed in MEMD nominal U-factors and R-values.

Table 26. Construction Characteristics Assumed with Nominal U-Factors and R-Values

Characteristic	Construction Assumptions
Window U-factor	Assuming window types detailed in *Appendix D*
Skylight U-factor	Assuming skylight types detailed in *Appendix D*
Ceiling with attic R-value	Assuming a 3/12 pitch roof with hip and valley construction and 2x4 chord rafters (insulation over 2.25-inches deep does not fully insulate out to the roof eve with 5/8-inch wallboard on the ceiling)
Enclosed ceiling R-value	Assuming a 6-inch thick rafter with cavity insulation fully filling the enclosed space, with 1/2-inch plywood sheathing, asphalt shingles, and 5/8-inch wallboard
Wood-framed wall R-value	Assuming a 2x4 wood-framed wall with cavity insulation of the nominal value with 1/2-inch sheathing, 1/2-inch wallboard, 1/2-inch wood siding, and cavity insulation of the nominal value
Mass wall R-value	Assuming a 6-inch thick masonry wall with a 2x4 furred interior wall and cavity insulation of the nominal value
Floor R-value	Assuming 2x8 floor joists with hardwood flooring, 1/2-inch plywood subfloor, and cavity insulation that fully contacts the floor surface
Basement wall R-value	Assuming a 6-inch thick, furred masonry foundation wall with 1/2-inch wallboard and an uninsulated interior wall with bare concrete
Slab R-value	Assuming continuous vertical slab edge insulation on the home exterior down to the specified depth
Crawlspace wall R-value	Assuming a 6-inch thick, furred masonry foundation wall with 1/2-inch wallboard and an uninsulated interior wall with bare concrete

Table 27 details the equivalent U-factors we used to develop the nominal R-values presented above. The U-factor represents the effective efficiency of a component and were calculated from field data. Additional details on these calculations can be found in *Appendix D*. Cadmus recommends the MEMD developers utilize the equivalent u-factors in modeling general home characteristics as these values represent the total insulating characteristics of homes including structural and decorative components of a home.

Table 27. Recommended MEMD General Equivalent U-Factors by Climate Zone

Characteristic	Southern – Climate Zone 5			Northern – Climate Zone 6		
	Pre-1979	1979-2015	2016 - Current	Pre-1979	1979-2015	2016 - Current
Window U-factor	0.52	0.41	0.32	0.52	0.41	0.32
Skylight U-factor	0.40	0.42	0.55	0.40	0.42	0.55
Attic U-factor	0.051	0.044	0.030	0.051	0.044	0.026
Enclosed ceiling U-factor	0.055	0.044	0.030	0.055	0.044	0.026
Wood-framed wall U-factor	0.113	0.076	0.057	0.113	0.076	0.057
Mass wall U-factor	0.113	0.076	0.082	0.113	0.076	0.060
Floor U-factor	0.211	0.215	0.033	0.211	0.215	0.033
Basement wall U-factor	0.320	0.226	0.059	0.320	0.226	0.050
Crawlspace wall U-factor	0.320	0.226	0.055	0.320	0.226	0.055

Insulation Measure Characteristics

The current MEMD assumes typical baseline characteristics for insulation measures to determine energy and demand savings for weather-sensitive measures. However, this method assumes that an average cross section of the population upgrades their home insulation. Yet customers who have the lowest amounts of insulation have the most to gain from insulation upgrades. These customers are more likely to seek insulation upgrades due to their homes' performance.

Homes typically either had or did not have wall cavity insulation installed. Wall insulation has a significant impact on energy usage, where as little as R-5 insulation can more than double the effectiveness[13] of the wall assembly and make a significant impact on energy usage and calculated energy savings. We observed similarly large variations in insulation amounts in other areas including floors, foundations, and ceilings. The team recommends several updates to the MEMD insulation measures' baseline and efficient characteristics.

Table 28 through Table 31 show the teams recommended measure scenarios including the description of the baseline and efficient conditions relevant to the scenario. Scenario are included for unknown insulation where the existing condition is not known. Measures where the baseline case should reflect current Michigan energy code are only applicable to new construction. Also, the energy code varies by climate zone for certain measures. These scenarios are applicable to both single-family and low rise multifamily.

[13] An uninsulated wall has an effective R-value of approximately R-4 and adding R-5 to the wall cavity increases the effective insulation level to nearly R-9. This assumes infiltration has a negatable impact on insulation efficacy.

Table 28. Wall Insulation Recommended Measure Scenarios

Measure	Baseline Case	Efficient Case	Applicable Vintages and Climate Zones
Insulate existing wall of unknown condition with R-10	Existing R-5 wall	Add continuous insulation of R-10 or better to the interior or exterior of the wall	Pre 1979 Vintage / CZ5&CZ6
	Existing R-10 wall	Add continuous insulation of R-10 or better to the interior or exterior of the wall	1979-2015 Vintage/ CZ5&CZ6
Insulate existing uninsulated 2X4 wall cavity	Existing uninsulated 2X4 wall	Filled wall cavity with insulating materials of at least R2 per inch	All Existing Vintages / CZ5&CZ6
Insulate existing uninsulated 2X4 Wall with R10 continuous insulation		Add continuous insulation of R-10 or better to the interior or exterior of the wall	
Insulate existing masonry wall with R10 insulation	Existing masonry wall without interior or exterior insulation		
Insulate standard 2X4 Wall with an additional R5 of continuous insulation	Existing 2X4 wall with standard R-11 cavity insulation	Add continuous insulation of R-5 or better to the interior or exterior of the wall	
Insulate standard 2X4 Wall with R10 continuous insulation		Add continuous insulation of R-10 or better to the interior or exterior of the wall	
Insulate new 2X6 Wall with R5 continuous insulation	Code R-20 Insulation	Add continuous insulation of R-5 or better to the interior or exterior of the wall	New Construction / CZ5&CZ6
Insulate new 2X6 Wall with R10 continuous insulation		Add continuous insulation of R-10 or better to the interior or exterior of the wall	

Note: These scenarios assume the same construction characteristics outlined in Table 27

Table 29. Ceiling Insulation Recommended Measure Scenarios

Measure	Baseline Case	Efficient Case	Applicable Vintages and Climate Zones
Insulate unknown ceiling or attic to R-30	R-19 attic insulation	Insulate to R-30	Pre 1979 Vintage / CZ5&CZ6
Insulate unknown ceiling or attic to R-38		Insulate to R-38	
Insulate unknown ceiling or attic to R-49		Insulate to R-49	
Insulate unknown ceiling or attic to R-60		Insulate to R-60	
Insulate unknown ceiling or attic to R-38	R-31 attic insulation	Insulate to R-38	1979-2015 Vintage / CZ5&CZ6
Insulate unknown ceiling or attic to R-49		Insulate to R-49	
Insulate unknown ceiling or attic to R-60		Insulate to R-60	
Insulate uninsulated ceiling or attic to R-30	Existing uninsulated roof or ceiling	Insulate to R-30	All Existing / CZ5&CZ6
Insulate uninsulated ceiling or attic to R-38		Insulate to R-38	
Insulate uninsulated ceiling or attic to R-49		Insulate to R-49	
Insulate uninsulated ceiling or attic to R-60		Insulate to R-60	
Insulate R-11 ceiling or attic to R-30	Existing R-11 insulation	Insulate to R-30	
Insulate R-11 ceiling or attic to R-38		Insulate to R-38	
Insulate R-11 ceiling or attic to R-49		Insulate to R-49	
Insulate R-11 ceiling or attic to R-60		Insulate to R-60	
Insulate R-19 ceiling or attic to R-30	Existing R-19 insulation	Insulate to R-30	
Insulate R-19 ceiling or attic to R-38		Insulate to R-38	
Insulate R-19 ceiling or attic to R-49		Insulate to R-49	
Insulate R-19 ceiling or attic to R-60		Insulate to R-60	
Insulate new ceiling or attic to R-49	Code R-38 insulation	Insulate to R-49	New Construction / CZ5
Insulate new ceiling or attic to R-60	Code R-49 insulation	Insulate to R-60	New Construction / CZ6

Note: These scenarios assume the same construction characteristics outlined in Table 27

Table 30. Floor Insulation Recommended Measure Scenarios

Measure	Baseline Case	Efficient Case	Applicable Vintages and Climate Zones
Insulate unknown floor to R-30	Existing R-1 floor	Insulate to R-30	All Existing / CZ5&CZ6
Insulate unknown floor to R-38	Existing R-1 floor	Insulate to R-38	
Insulate uninsulated floor to R-30	Existing uninsulated floor	Insulate to R-30	
Insulate R-11 floor to R-30	Existing R-11 floor		
Insulate R-19 floor to R-30	Existing R-19 floor		
Insulate new R-30 floor to R-38	Code R-30 floor	Insulate to R-38	New Construction / CZ5&CZ6

Note: These scenarios assume the same construction characteristics outlined in Table 27

Table 31. Foundation Insulation Recommended Measure Scenarios

Measure	Baseline Case	Efficient Case	Home Types
Insulate unknown basement wall to R-10	Existing uninsulated basement wall	Insulate to R-10	Pre 1979 Vintage / CZ5&CZ6
	Existing R-5 basement wall		1979-2015 Vintage / CZ5&CZ6
Insulate unknown crawlspace wall to R-10	Existing uninsulated crawlspace wall		Pre 1979 Vintage / CZ5&CZ6
Insulate uninsulated foundation walls to R-10	Existing uninsulated crawlspace		All Existing / CZ5&CZ6
Insulate unknown basement wall to R-20	Existing uninsulated basement wall	Insulate to R-20	Pre 1979 Vintage / CZ5&CZ6
	Existing R-5 basement wall		1979-2015 Vintage / CZ5&CZ6
Insulate unknown crawlspace wall to R-20	Existing uninsulated crawlspace wall		Pre 1979 Vintage / CZ5&CZ6
	Existing R-10 crawlspace wall		1979-2015 Vintage / CZ5&CZ6
Insulate uninsulated foundation walls to R-20	Existing uninsulated crawlspace		All Existing / CZ5&CZ6
Insulate new R-10 basement walls to R-15	New Code R-10 basement walls	Insulate to R-15	New Construction / CZ5
Insulate new R-15 crawlspace walls to R-20	New Code R-15 crawlspace walls	Insulate to R-20	
Insulate new R-15 foundation walls to R-20	New Code R-15 foundation walls		New Construction / CZ6

Note: These scenarios assume the same construction characteristics outlined in Table 27

Summary of Methodologies

The Cadmus team focused research activities for Phase II of the Michigan baseline housing study on conducting sampling, recruiting customers, performing site visits, assessing data quality, and processing data, and weighting the results of our research. This chapter outlines our methodology for each task.

Sampling

Customers of Consumers Energy and DTE Energy represent most households in Michigan, with 89% of Michigan counties (including 68 of 69 counties in the Lower Peninsula) being served by these two utilities. As a result, this joint study provides broad results covering home characteristics across the Lower Peninsula of Michigan.

The team initially requested all residential customer account details from DTE Energy and Consumers Energy to support the sample design process. We then merged these databases using the customer service address and removed duplicate addresses, leaving 3,793,405 residential addresses in the sample population. This population represented most households in the Lower Peninsula of Michigan.[14]

Drawing from the Consumers Energy and DTE Energy residential accounts lists, the Cadmus team pulled representative samples stratified by climate zone 5 and climate zone 6,[15] targeting 102 sites from each climate zone for a total of 204 sites. The Cadmus team further stratified these 204 sites by home type and targeted a total of 92 single-family homes and 112 multifamily homes for inclusion in the study.[16] We divided this Phase II study into a pilot phase (±20 sites) and a main phase (±184 sites).

The Cadmus team also employed target quotas for several parameters during site visit recruiting. We tracked homeownership type and low-income qualification to provide nested quotas, and used

[14] Per the 2016 American Community Survey five-year estimates, there were 3,735,953 occupied housing units in the Lower Peninsula of Michigan (https://www.census.gov/programs-surveys/acs).

[15] This Phase II study was restricted to the Lower Peninsula. The Michigan Upper Peninsula represents roughly 3% of Michigan's housing units, and Consumers Energy and DTE Energy do not have territory in the Upper Peninsula. To capture research findings covering the entire state, the Michigan Public Service Commission contracted with a separate firm to conduct a supplemental study in the Upper Peninsula. Climate zone 7 only occurs in the Upper Peninsula at the far west and east portions of the land mass and represents roughly 2% of Michigan housing units.

[16] Other dwelling types represent roughly 5% of Michigan housing units and were excluded from the stratification scheme. For this study, single-family homes include both detached and attached homes and multifamily homes include all low-rise apartment-style dwellings with two or more units.

applicable MEMD weather stations to identify non-nested quotas.[17] We anticipated that recruitment would naturally align with the known distributions of the parameters, so we set criteria during customer recruitment to restrict the overrepresentation of one customer group. If a customer taking the survey represented a strata where enough recruits had already been recruited, the customer was informed their study group was full. The team planned the overall study to achieve ±10% precision at the 90% confidence level for assuming a coefficient of variation (CV) of 0.90 for multifamily homes and 0.80 for single-family homes. We targeted ±20% precision at the 90% confidence level for inference at the strata level. Table 32 presents the sample design for the pilot and main phases of the study, including nested quota targets.

Table 32. Pilot and Main Phase Sample Targets

Climate Zone	Home Type	Homeownership Status	Income <$40,000 Per Year	Target Number	Completed Visits	Percentage of Target
Climate Zone 5	Single-Family	Owned	Yes	15	14	93%
			No	23	30	130%
		Rented	Yes	3	4	133%
			No	5	3	60%
	Multifamily	Owned	Yes	2	7	350%
			No	3	9	300%
		Rented	Yes	20	21	105%
			No	31	16	52%
Climate Zone 6	Single-Family	Owned	Yes	15	17	113%
			No	23	19	83%
		Rented	Yes	3	3	100%
			No	5	2	40%
	Multifamily	Owned	Yes	2	4	200%
			No	3	9	300%
		Rented	Yes	20	22	110%
			No	31	14	45%
Total				**204**	**195**	**96%**

Note: An additional two customers were visited who were not included in the analysis due to incomplete data and conflicts with the customers schedule to revisit the home. One customer did not identify their household income and was not included in the sub-strata analysis.

17 Samples and quotas were informed by the 2016 American Community Survey five-year census data for Michigan. We rounded targets up and set a minimum of two, in conformance with industry best practices. Weather station quotas are not nested since we anticipated that study data would need to be normalized by actual and historical weather measurements, where nesting would add minimal value for the increased precision.

Customer Recruitment

At the start of the COVID-19 pandemic in March 2020, the team cancelled 13 appointments with customers. When we resumed site visits in July 2020, we were only able to reschedule four of those original 13 appointments. Recruitment and scheduling during the summer of 2020 was more problematic than it had been in previous periods, with the customer response rate dropping from 4.4% before 2020 to 3.4% in 2020. Also, fewer customers qualified for the study, dropping from 39% before 2020 to 27% in 2020. The team conducted site visits at 55 customer homes in July through September 2020.

COVID-19 IMPACT

In February 2020 the Cadmus team was on track to complete the study, but the lockdown forced us to halt the data collection. We resumed site visits in August with stringent health and safety protocols in place to collect additional data.

The Cadmus team used a combination of direct mailing, email, and outbound calling to recruit participants for the study. We contacted 29,893 customers via email or postcard mailer, asking them to complete a brief survey to verify their address, provide demographic details relevant to sampling, and give details about their availability for a site visit. The Cadmus team drew the sample for this study from 3,793,405 unique households served by the utilities, representing 80% of all zip codes in the state. Of those contacted, 1,165 customers completed the survey (for a 4% response rate).

We mailed a postcard to each sampled customer and sent them an email that introduced the study, explained the study process and objectives, and asked them to participate. Willing recipients went online and completed a short web survey with some basic pre-screening questions (this survey is available in *Appendix A*). This survey also asked customers about their willingness to participate in a site visit.

Two-thirds of the customers who completed the survey did not qualify for the study for one or more of the following reasons:

- The sample quota was full
- The customer could not answer the key demographic questions
- The customer was unable to accommodate a site visit to their home

The Cadmus team contacted the remaining 389 customers who did qualify for the study to confirm their survey answers and schedule a site visit. Customers were not non-responsive to outreach after completing their survey were contacted over email, followed up with phone calls. Customers were offered timeslots for technicians to visit their homes, and if no timeslot were possible for the customer, they were added to a reserve list and were contacted in cases of canceled appointments.

Of the 389 qualifying customers, the team was able to schedule visits at 197 dwellings. Of the site visits at 197 dwellings, we included details from 195 completed visits in the final analysis results. Typically, two Cadmus team technicians visited each home for two to three hours per visit; however, in some instances, we returned to accommodate a customer's schedule due to the visit length.

29,893	1,165	389
Households Contacted	Households Completed Survey	Households Qualified for a Site Visit

The team offered each customer a standard incentive of $100 for allowing us to conduct a site visit. In January 2020, we offered customers an additional $50 bonus incentive to participate in furnace metering during the site visit. In July 2020, we increased the standard incentive to $200 with an additional $50 for customers with a natural gas furnace.

Site Visit Process

Each site visit was two to three hours in duration. The team began each visit with a short, informal interview to confirm data from the web survey. We also used this interview to gather information about the customer's habits related to operating their heating and cooling systems and to answer their questions about the site visit process.

We began the primary data collection outside by measuring the home and gathering data on the foundation type, exterior insulation, soffit venting, roof type, and home characteristics. Then we collected data inside the home, starting with the attic, by measuring insulation levels and calculating square footage for each area. We collected window details including type, shading, and size. The team typically went into every room to verify window details and assess the evidence of wall insulation: this included the inside of sink cabinets, closets, and other areas where unfinished walls were often exposed.

Then the Cadmus team assessed the crawl space or basement of the home, where mechanical equipment is most often installed. We collected nameplate details and U.S. Department of Energy efficiency labels from all mechanical equipment (space heating and cooling, water heating, and humidifying and dehumidifying equipment, as well as secondary and seasonally installed equipment such as window air conditioners). The team inspected the home distribution system to look for insulation and evidence of sealing materials in unconditioned spaces of the home.

The team also installed an Onset UX-90 indoor temperature and relative humidity logger inside the customer's home near the thermostat on the main floor. Customers were able to decline having the thermostat logger installed at their discretion. They were assured the data collected by the thermostat logger would remain anonymous and would only be reported in aggregate with data from other customers in similar home. These loggers will remain installed for approximately one year. As of March 2021, 53 of the 180 installed loggers have been removed. The remainder are anticipated to be removed by July of 2021.

In January 2020, the team began installing Onset UX90-004 furnace runtime loggers and Verris-Halkeye current transformers in customer's homes with fuel fired furnaces. These loggers were installed on the wiring between the furnace control board and the gas valve on the furnace. The current transformers monitor the signal sent by the control board to the gas valve supplying gas to the burner. All customers in Climate Zone 5 with fuel fired heating equipment were surveyed about their willingness to have their natural gas furnace monitored. The furnace monitoring was not a requirement to participate in the study, however, participating customers were given an additional $50 incentive. These loggers are scheduled to be removed from customer homes by June of 2021.

Data Quality Control and Processing

The team implemented a quality assurance plan to assure the delivery of high-quality products and services to the Michigan utilities and stakeholders. Cadmus' quality assurance steps are intended to ensure that we:

- Provide research and analyses that achieve Consumers Energy's and DTE Energy's research objectives and priorities;
- Deliver the tasks and activities outlined in the Housing Baseline Study Evaluation Work Scope;[18]
- Rely on data collection and analytical methods that are consistent with current industry best practices and are appropriate to achieve the intended objectives of the research;
- Provide valuable feedback to help improve the accuracy of savings calculations in the MEMD;
- Fully document research findings and use logical inferences to draw useful conclusions and actionable recommendations;
- Provide results that are free of analytical errors and based on accurate, unbiased data and assumptions; and
- Produce well organized deliverables that are free of spelling, grammatical, and formatting errors.

Quality assurance was broken out into three key categories including: Quality of Data Collection, Data Handling and Cleansing Personally Identifiable Information (PII), and Analysis Review.

[18] *Housing Baseline Study Evaluation Work Scope*, CADMUS April 17, 2018

- The team ensured the sampling plan and data collection instruments met the project goals.
- The team ensured the customer surveys and recruitment materials were properly formatted and met customer contact guidelines.
- The team ensured the customer recruitment survey was regularly monitored and accurately captured necessarily data.
- The team tested the data collection tool in the field prior to starting data collection.
- The team incorporated automated quality assurance tests into the data collection tool to help field technicians address data quality.
- The team had a second technician review data collected by the site technician to identify inconsistent, missing, or incorrect information.
- The team reviewed compiled datasets to remove erroneous or incorrect data.

QUALITY OF DATA COLLECTION

Ensure data collected was complete, accurate, free of bias and captured all necessary information to complete research objectives.

- The team removed PII according to standards approved by Consumers Energy and DTE Energy from all customer datasets and replaced it with randomly-generated identification numbers.
- The team used standardized data request methods and securely transferred information from Consumers Energy and DTE Energy.
- The team stored customer data on encrypted servers.
- The team maintained records of user access to folders containing PII.

DATA HANDLING AND CLEANSING PII

Implement corporate standard practices and protocols regarding data handling to protect customer data and ensure security.

- The team replicated the analysis code using manual calculations.
- The team used a second party to review and re-run the analysis code.
- The team reviewed all summary data in conjunction with granular datasets to identify outliers.
- The team provided second parties with regular extracts of collected datasets for review.

ANALYSIS REVIEW

Ensured that all analysis was grounded in analytical best practices and leveraged flexible strategies to expedite quantitative and qualitative results.

Weighting Results

The Cadmus team developed weighting criteria for cross-strata and summary results to report data in this study by analyzing customer characteristics including climate zone, home type, ownership, and household income. The sample was chosen to provide 90% confidence at 20% relative precision at the main strata level, including climate zone and home type. Additional sampling at the sub-strata level included home ownership and household income. Home ownership and household income were targeted based on their relative distribution in the population to assure the sample represented the known cross section of households in Michigan.

The team analyzed the study sample at the sub-strata level to determine if the sample was significantly skewed from the population using a chi-squared test. At each strata the chi-squared value was significantly higher than the critical value of 0.05, indicating the sample was not significantly skewed. From this analysis, the team determined that weighting at the sub-strata level was not necessary as the sample was chosen to represent the population at that level.

Table 33 shows the population and sample of customers including distribution of the population and the sample and the results of the chi-squared significance test.

Table 33. Population and Sample Distribution Among Sub-Strata

Home Type	Ownership Type	Household Income	N	n	Distribution of the Population	Distribution of the Sample	X^2 P
Southern - Climate Zone 5							
Single-Family	Owned	<$40,000/year	820,258	14	0.340	0.275	0.998
		≥$40,000/year	1,251,234	30	0.518	0.588	
	Rented	<$40,000/year	135,985	4	0.056	0.078	
		≥$40,000/year	207,433	3	0.086	0.059	
Multifamily	Owner	<$40,000/year	65,972	7	0.081	0.132	0.985
		≥$40,000/year	100,634	9	0.124	0.170	
	Renter	<$40,000/year	255,542	21	0.315	0.396	
		≥$40,000/year	389,807	16	0.480	0.302	
Northern - Climate Zone 6							
Single-Family	Owner	<$40,000/year	100,915	17	0.351	0.415	0.998
		≥$40,000/year	153,937	19	0.536	0.463	
	Renter	<$40,000/year	12,868	3	0.045	0.073	
		≥$40,000/year	19,629	2	0.068	0.049	
Multifamily	Owner	<$40,000/year	2,678	4	0.063	0.082	0.969
		≥$40,000/year	4,085	9	0.096	0.184	
	Renter	<$40,000/year	14,235	22	0.333	0.449	
		≥$40,000/year	21,714	14	0.508	0.286	

Note: N is the population of customers in the lower peninsula of Michigan from the 2015 American Community Survey, n is the sample of customers analyzed in this study. The X^2 P (chi-squared) indicates the significance of the estimate, if the value is less than 0.05, this indicates the substrata has significant difference. With P-value in the 0.90 and above, there is no significant difference between the sample and the population estimates.

Since the sample was not skewed at the sub-strata level, weighting was applied to the main strata categories of home type and climate zone. The largest population were single-family homes in southern Michigan with each sampled home representing 46,441 households. The smallest population were multifamily homes in climate zone 6 with each sampled home representing 872 households. Table 34 shows the sample weights applied in weighted summary data.

Table 34. Weighting Applied

Climate Zone	Home Type	N	n	Weight
Southern - Climate Zone 5	Single-Family	2,414,910	52	46,440.58
	Multifamily	811,955	53	15,319.91
Northern - Climate Zone 6	Single-Family	287,349	41	7,008.51
	Multifamily	42,712	49	871.67

Note: N is the population of customers in the lower peninsula of Michigan from the 2015 American Community Survey, n is the sample of customers analyzed in this study.

KITCHEN APPLIANCES...Q1a. Please describe your primary cooking range/stovetop.

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	117	36	34	26	21	31	45	12	9	81	23	8	35	32	11	8
	1.9%	3.6%	1.6%	1.6%	1.3%	4.3%	1.8%	1.0%	0.8%	1.9%	1.7%	2.0%	1.9%	2.0%	0.9%	0.8%
TOTAL ANSWER	**6149**	**983**	**2286**	**1646**	**1208**	**701**	**2099**	**1470**	**1373**	**4093**	**1559**	**410**	**1951**	**1571**	**1199**	**775**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Electric	3127	374	1183	898	661	352	1090	790	628	2197	696	177	830	847	667	376
	51.5%	38.9%	52.8%	55.1%	55.1%	51.7%	53.0%	53.6%	46.3%	54.5%	44.2%	42.7%	41.6%	53.9%	57.2%	49.4%
Gas (natural or propane)	3007	603	1098	747	544	348	1002	677	742	1887	858	233	1114	723	526	399
	48.2%	60.3%	46.9%	44.8%	44.6%	48.0%	46.7%	46.1%	53.5%	45.2%	55.3%	57.3%	58.0%	46.1%	42.1%	50.6%
None	15	6	5	1	3	1	7	3	3	9	5	-	7	1	6	-
	0.3%	0.8%	0.3%	0.1%	0.3%	0.3%	0.3%	0.3%	0.2%	0.3%	0.5%	0.0%	0.4%	/	0.7%	0.0%
Total having cooking range/stovetop	6134	977	2281	1645	1205	700	2092	1467	1370	4084	1554	410	1944	1570	1193	775
	99.7%	99.2%	99.8%	99.9%	99.7%	99.7%	99.7%	99.7%	99.8%	99.7%	99.5%	100.0%	99.6%	100.0%	99.3%	100.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q1b. Please describe your primary type of oven.

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	142 2.2%	57 5.8%	34 1.2%	30 1.6%	21 1.6%	48 6.7%	54 2.1%	18 1.1%	6 0.3%	101 2.3%	26 1.6%	9 1.6%	57 2.8%	32 1.8%	12 0.8%	13 1.8%
TOTAL ANSWER	**6124** **100.0%**	**962** **100.0%**	**2286** **100.0%**	**1642** **100.0%**	**1208** **100.0%**	**684** **100.0%**	**2090** **100.0%**	**1464** **100.0%**	**1376** **100.0%**	**4073** **100.0%**	**1556** **100.0%**	**409** **100.0%**	**1929** **100.0%**	**1571** **100.0%**	**1198** **100.0%**	**770** **100.0%**
Electric	3481 56.4%	399 42.1%	1336 58.8%	1026 60.2%	707 58.6%	353 53.0%	1142 55.4%	864 57.3%	817 58.9%	2418 58.8%	797 50.3%	207 51.1%	925 46.0%	941 58.3%	754 63.9%	452 58.6%
Gas (natural or propane)	2630 43.4%	558 57.3%	947 41.1%	613 39.6%	499 41.2%	330 46.8%	942 44.2%	598 42.6%	555 40.8%	1647 41.0%	756 49.5%	201 48.4%	999 53.7%	628 41.7%	440 35.6%	318 41.4%
None	13 0.2%	5 0.6%	3 0.1%	3 0.2%	2 0.2%	1 0.2%	6 0.4%	2 0.1%	4 0.3%	8 0.2%	3 0.2%	1 0.5%	5 0.3%	2 /	4 0.5%	- 0.0%
Total having oven	6111 99.8%	957 99.4%	2283 99.9%	1639 99.8%	1206 99.8%	683 99.8%	2084 99.6%	1462 99.8%	1372 99.7%	4065 99.8%	1553 99.8%	408 99.5%	1924 99.7%	1569 100.0%	1194 99.5%	770 100.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q1b-1. Is your oven self-cleaning?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	373	96	106	103	68	94	140	51	40	267	67	24	125	90	59	34
	5.9%	9.7%	4.4%	6.0%	5.3%	12.8%	6.3%	3.5%	2.5%	6.3%	4.1%	5.7%	6.4%	5.1%	4.9%	4.5%
TOTAL ANSWER	**5893**	**923**	**2214**	**1569**	**1161**	**638**	**2004**	**1431**	**1342**	**3907**	**1515**	**394**	**1861**	**1513**	**1151**	**749**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Yes	4443	592	1697	1225	908	313	1411	1158	1176	2884	1206	304	1368	1193	949	641
	70.4%	60.1%	70.9%	73.2%	74.3%	44.4%	66.4%	75.9%	84.5%	68.7%	75.6%	73.0%	70.8%	74.7%	78.0%	82.8%
No	1450	331	517	344	253	325	593	273	166	1023	309	90	493	320	202	108
	29.6%	39.9%	29.1%	26.8%	25.7%	55.6%	33.6%	24.1%	15.5%	31.3%	24.4%	27.0%	29.2%	25.3%	22.0%	17.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q2. How many microwave ovens are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	19	4	3	7	5	1	6	2	1	11	5	2	5	5	-	4
	0.3%	0.4%	0.1%	0.4%	0.3%	0.1%	0.3%	0.1%	/	0.3%	0.2%	0.4%	0.2%	0.3%	0.0%	0.5%
TOTAL ANSWER	**6247**	**1015**	**2317**	**1665**	**1224**	**731**	**2138**	**1480**	**1381**	**4163**	**1577**	**416**	**1981**	**1598**	**1210**	**779**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
One	5804	914	2162	1548	1156	666	1990	1373	1291	3878	1467	377	1839	1484	1134	730
	92.6%	89.6%	92.7%	93.3%	94.1%	90.9%	92.5%	92.5%	93.5%	92.8%	93.1%	88.7%	92.4%	92.0%	94.2%	94.4%
Two or more	232	41	80	75	34	20	61	63	71	133	69	28	63	55	57	42
	3.0%	3.3%	2.8%	3.4%	2.4%	2.1%	2.4%	3.0%	4.9%	2.5%	3.6%	7.2%	2.7%	2.8%	3.8%	4.8%
None	211	60	75	42	34	45	87	44	19	152	41	11	79	59	19	7
	4.4%	7.1%	4.5%	3.3%	3.5%	7.0%	5.1%	4.5%	1.6%	4.7%	3.3%	4.1%	4.9%	5.2%	2.0%	0.8%
Total having microwave	6036	955	2242	1623	1190	686	2051	1436	1362	4011	1536	405	1902	1539	1191	772
	95.6%	92.9%	95.5%	96.7%	96.5%	93.0%	94.9%	95.5%	98.4%	95.3%	96.7%	95.9%	95.1%	94.8%	98.0%	99.2%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q3. What type of refrigerator is used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	46 0.7%	14 1.3%	8 0.4%	10 0.6%	14 0.9%	8 0.9%	17 0.7%	5 0.2%	2 0.1%	30 0.7%	6 0.3%	6 1.6%	12 0.6%	11 0.6%	3 0.1%	6 0.9%
TOTAL ANSWER	**6220** **100.0%**	**1005** **100.0%**	**2312** **100.0%**	**1662** **100.0%**	**1215** **100.0%**	**724** **100.0%**	**2127** **100.0%**	**1477** **100.0%**	**1380** **100.0%**	**4144** **100.0%**	**1576** **100.0%**	**412** **100.0%**	**1974** **100.0%**	**1592** **100.0%**	**1207** **100.0%**	**777** **100.0%**
Electric (frost free)	5717 89.6%	860 83.5%	2158 90.9%	1550 90.7%	1127 91.3%	609 82.6%	1933 88.5%	1370 90.6%	1320 93.9%	3844 90.5%	1433 88.0%	368 88.6%	1804 89.5%	1481 91.2%	1155 94.4%	732 92.3%
Electric (manual defrost)	490 10.1%	140 15.9%	150 8.8%	109 9.2%	87 8.5%	111 16.8%	190 11.3%	106 9.3%	58 5.9%	291 9.2%	139 11.6%	44 11.4%	165 10.1%	111 8.8%	51 5.5%	44 7.4%
None	13 0.3%	5 0.6%	4 0.3%	3 0.1%	1 0.2%	4 0.6%	4 0.2%	1 0.1%	2 0.2%	9 0.3%	4 0.4%	- 0.0%	5 0.4%	- 0.0%	1 0.1%	1 0.3%
Total having refrigerator	6207 99.7%	1000 99.4%	2308 99.7%	1659 99.9%	1214 99.9%	720 99.4%	2123 99.8%	1476 99.9%	1378 99.8%	4135 99.7%	1572 99.6%	412 100.0%	1969 99.7%	1592 100.0%	1206 99.9%	776 99.7%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q4. Do you have a second refrigerator in use at this home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	110 1.6%	25 2.0%	32 1.2%	33 1.7%	20 1.7%	23 2.8%	28 1.1%	16 0.9%	18 1.3%	71 1.4%	26 1.6%	8 2.2%	30 1.4%	22 1.2%	18 1.3%	15 1.7%
TOTAL ANSWER	**6156 100.0%**	**994 100.0%**	**2288 100.0%**	**1639 100.0%**	**1209 100.0%**	**709 100.0%**	**2116 100.0%**	**1466 100.0%**	**1364 100.0%**	**4103 100.0%**	**1556 100.0%**	**410 100.0%**	**1956 100.0%**	**1581 100.0%**	**1192 100.0%**	**768 100.0%**
Yes, electric frost free	1355 16.1%	159 11.4%	496 15.6%	381 16.8%	313 20.2%	57 6.2%	324 11.3%	343 16.4%	491 29.4%	737 12.3%	466 24.3%	137 29.2%	359 14.0%	411 19.4%	336 21.8%	202 19.8%
Yes, electric manual defrost	374 4.9%	51 4.5%	149 4.7%	83 4.0%	91 7.3%	25 2.5%	123 4.6%	105 5.5%	93 6.3%	221 4.2%	104 5.9%	46 9.9%	147 6.3%	89 4.4%	76 5.1%	43 5.4%
Yes, portable	589 8.1%	79 6.3%	221 8.6%	173 8.6%	110 8.0%	42 4.3%	161 6.2%	155 9.0%	186 13.0%	344 7.0%	187 10.1%	54 14.5%	186 8.7%	151 8.2%	129 9.4%	91 10.4%
No	3838 70.9%	705 77.8%	1422 71.1%	1002 70.6%	695 64.5%	585 87.0%	1508 77.9%	863 69.1%	594 51.3%	2801 76.5%	799 59.7%	173 46.4%	1264 71.0%	930 68.0%	651 63.7%	432 64.4%
Total having second refrigerator	2318 29.1%	289 22.2%	866 28.9%	637 29.4%	514 35.5%	124 13.0%	608 22.1%	603 30.9%	770 48.7%	1302 23.6%	757 40.3%	237 53.6%	692 29.0%	651 31.9%	541 36.3%	336 35.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q5. Do you have a separate food freezer? (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	66	23	12	17	14	23	22	6	3	45	11	2	11	13	9	8
	1.0%	2.1%	0.5%	0.9%	1.4%	3.0%	1.0%	0.4%	0.2%	1.0%	0.6%	0.4%	0.5%	0.9%	0.7%	1.1%
TOTAL ANSWER	**6200**	**996**	**2308**	**1655**	**1215**	**709**	**2122**	**1476**	**1379**	**4129**	**1571**	**416**	**1975**	**1590**	**1201**	**775**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Yes - upright, manual defrost	703	88	250	177	186	74	216	184	149	425	209	61	217	203	161	73
	8.6%	6.5%	8.7%	7.6%	12.0%	8.5%	7.4%	8.3%	9.1%	7.6%	10.9%	11.6%	8.9%	9.8%	10.5%	7.9%
Yes - upright, frost free	607	88	203	165	149	46	196	152	159	371	178	55	197	156	129	87
	8.2%	7.9%	7.1%	8.8%	9.7%	6.2%	7.4%	8.6%	9.9%	7.3%	10.2%	11.9%	8.7%	8.1%	8.4%	9.6%
Yes - chest, manual defrost	839	124	333	182	197	76	287	198	220	499	254	80	265	219	176	116
	11.7%	11.0%	12.3%	9.2%	15.1%	8.8%	11.3%	11.9%	14.3%	10.2%	14.8%	19.3%	11.9%	12.2%	12.7%	13.5%
Yes - chest, frost free	357	78	120	77	81	45	128	79	78	184	135	34	126	98	58	41
	4.9%	6.8%	4.1%	3.9%	6.0%	5.2%	4.9%	4.5%	5.2%	3.6%	7.9%	7.4%	5.3%	5.2%	4.6%	4.8%
No	3783	625	1434	1075	631	476	1336	878	790	2698	827	195	1193	937	704	467
	67.7%	68.1%	68.9%	71.3%	59.2%	72.1%	70.2%	67.4%	62.5%	72.1%	58.0%	51.6%	66.1%	65.9%	65.8%	65.1%
Net having separate food freezer	2506	378	906	601	613	241	827	613	606	1479	776	230	805	676	524	317
	33.4%	32.2%	32.2%	29.5%	42.8%	28.7%	31.0%	33.3%	38.5%	28.7%	43.8%	50.2%	34.8%	35.3%	36.1%	35.9%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q6. Do you have an automatic dishwasher?

	Total Sample	Region: Detroit	Region: West	Region: North-west	Region: North-east	Income: < $20K	Income: $20K-$59K	Income: $60K-$99K	Income: $100K+	Persons in Household: 1-2	Persons in Household: 3-4	Persons in Household: 5+	Year Residence was Built: < 1960	Year Residence was Built: 1960-1979	Year Residence was Built: 1980-1999	Year Residence was Built: 2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	48 0.7%	13 1.1%	13 0.5%	16 0.9%	6 0.5%	14 1.9%	11 0.5%	5 0.2%	6 0.4%	33 0.8%	9 0.4%	2 0.4%	11 0.5%	13 0.8%	9 0.7%	1 0.1%
TOTAL ANSWER	**6218** **100.0%**	**1006** **100.0%**	**2307** **100.0%**	**1656** **100.0%**	**1223** **100.0%**	**718** **100.0%**	**2133** **100.0%**	**1477** **100.0%**	**1376** **100.0%**	**4141** **100.0%**	**1573** **100.0%**	**416** **100.0%**	**1975** **100.0%**	**1590** **100.0%**	**1201** **100.0%**	**782** **100.0%**
Yes	4734 73.1%	456 41.8%	1921 80.2%	1396 82.3%	940 73.6%	296 39.5%	1453 66.5%	1267 83.6%	1317 94.8%	3110 72.1%	1251 77.0%	321 74.8%	1252 60.8%	1314 79.5%	1092 89.1%	738 93.1%
No	1484 26.9%	550 58.2%	386 19.8%	260 17.7%	283 26.4%	422 60.5%	680 33.5%	210 16.4%	59 5.2%	1031 27.9%	322 23.0%	95 25.2%	723 39.2%	276 20.5%	109 10.9%	44 6.9%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

KITCHEN APPLIANCES...Q7. Please check all of the following that you have replaced in the last 24 months. (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	3880	635	1430	1051	748	470	1371	854	829	2717	881	224	1212	968	706	511
	64.1%	63.5%	64.6%	64.3%	63.3%	65.5%	65.6%	61.0%	62.0%	67.4%	56.7%	54.2%	61.0%	62.5%	60.9%	69.8%
TOTAL ANSWER	**2386**	**384**	**890**	**621**	**481**	**262**	**773**	**628**	**553**	**1457**	**701**	**194**	**774**	**635**	**504**	**272**
	35.9%	**36.5%**	**35.4%**	**35.7%**	**36.7%**	**34.5%**	**34.4%**	**39.0%**	**38.0%**	**32.6%**	**43.3%**	**45.8%**	**39.0%**	**37.5%**	**39.1%**	**30.2%**
Range/stovetop	822	128	310	212	166	78	230	236	214	495	252	60	263	224	181	96
	12.0%	12.0%	12.1%	11.8%	12.1%	10.5%	9.9%	14.4%	14.5%	10.6%	15.5%	14.5%	12.9%	13.2%	13.8%	10.5%
Automatic dishwasher	848	80	348	240	176	40	221	248	284	511	261	66	233	246	223	120
	12.2%	6.9%	13.2%	13.5%	13.0%	5.2%	9.9%	14.2%	19.8%	10.9%	15.5%	15.7%	11.1%	14.0%	17.9%	13.7%
Oven	640	85	248	171	131	48	178	179	186	373	204	51	202	172	149	72
	9.6%	8.3%	9.7%	9.9%	9.9%	6.7%	8.1%	10.9%	13.1%	8.3%	12.6%	13.1%	10.3%	9.9%	11.9%	8.4%
Microwave	1156	188	435	301	226	118	375	299	274	700	345	97	364	292	236	152
	17.4%	18.5%	17.3%	16.9%	17.4%	15.5%	17.0%	18.2%	19.0%	15.9%	21.3%	21.8%	18.0%	17.2%	18.5%	16.8%
Refrigerator	1145	185	451	289	215	132	361	304	279	699	333	95	393	289	238	135
	17.6%	18.4%	18.0%	17.2%	16.4%	17.9%	16.2%	19.3%	19.5%	15.6%	21.5%	23.8%	20.5%	16.7%	19.0%	15.3%
Food freezer	207	37	67	51	51	23	61	58	54	105	75	25	72	55	41	24
	2.9%	3.7%	2.4%	2.6%	3.8%	2.5%	2.6%	3.1%	3.8%	2.2%	4.5%	6.0%	3.5%	3.0%	3.1%	2.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Source: 2016 Residential Customer Appliance Saturation Study

Ipsos RDA

LAUNDRY EQUIPMENT...Q8. Do you have your own clothes washer?

	Total Sample A	Region: Detroit B	Region: West C	Region: North-west D	Region: North-east E	Income: < $20K F	Income: $20K-$59K G	Income: $60K-$99K H	Income: $100K+ I	Persons in Household: 1-2 J	Persons in Household: 3-4 K	Persons in Household: 5+ L	Year Residence was Built: < 1960 M	Year Residence was Built: 1960-1979 N	Year Residence was Built: 1980-1999 O	Year Residence was Built: 2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	14 0.2%	4 0.3%	2 0.1%	5 0.2%	3 0.3%	4 0.5%	2 /	1 /	2 0.1%	11 0.2%	1 /	- 0.0%	2 0.1%	3 0.1%	3 0.2%	1 0.1%
TOTAL ANSWER	**6252** **100.0%**	**1015** **100.0%**	**2318** **100.0%**	**1667** **100.0%**	**1226** **100.0%**	**728** **100.0%**	**2142** **100.0%**	**1481** **100.0%**	**1380** **100.0%**	**4163** **100.0%**	**1581** **100.0%**	**418** **100.0%**	**1984** **100.0%**	**1600** **100.0%**	**1207** **100.0%**	**782** **100.0%**
Yes	5718 87.0%	864 80.9%	2132 86.8%	1543 88.1%	1155 91.4%	527 66.7%	1909 83.5%	1415 91.9%	1369 98.3%	3732 84.7%	1511 92.7%	406 94.4%	1906 94.6%	1483 88.7%	1160 93.5%	758 95.1%
No	534 13.0%	151 19.1%	186 13.2%	124 11.9%	71 8.6%	201 33.3%	233 16.5%	66 8.1%	11 1.7%	431 15.3%	70 7.3%	12 5.6%	78 5.4%	117 11.3%	47 6.5%	24 4.9%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

LAUNDRY EQUIPMENT...Q9. Do you have your own clothes dryer?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	44 0.7%	13 1.5%	10 0.4%	14 0.8%	7 0.6%	12 1.8%	14 0.7%	2 0.2%	5 0.3%	31 0.8%	6 0.3%	3 0.8%	6 0.3%	14 0.9%	7 0.6%	3 0.4%
TOTAL ANSWER	**6222 100.0%**	**1006 100.0%**	**2310 100.0%**	**1658 100.0%**	**1222 100.0%**	**720 100.0%**	**2130 100.0%**	**1480 100.0%**	**1377 100.0%**	**4143 100.0%**	**1576 100.0%**	**415 100.0%**	**1980 100.0%**	**1589 100.0%**	**1203 100.0%**	**780 100.0%**
Yes, electric	2422 37.4%	309 28.6%	921 38.7%	629 35.8%	551 44.9%	260 33.2%	839 36.3%	583 39.4%	514 37.5%	1645 37.7%	577 35.8%	167 39.6%	714 34.3%	635 37.2%	509 43.1%	314 42.6%
Yes, gas (natural or propane)	3221 48.6%	521 49.0%	1196 47.6%	899 51.7%	593 45.6%	243 30.8%	1038 45.9%	825 51.9%	852 60.8%	2038 46.0%	919 56.0%	232 53.2%	1155 58.1%	829 50.5%	647 50.4%	442 52.5%
No	579 14.1%	176 22.4%	193 13.8%	130 12.5%	78 9.5%	217 36.1%	253 17.8%	72 8.8%	11 1.7%	460 16.4%	80 8.2%	16 7.2%	111 7.6%	125 12.3%	47 6.5%	24 5.0%
Total having clothes dryer	5643 86.0%	830 77.6%	2117 86.2%	1528 87.5%	1144 90.5%	503 63.9%	1877 82.2%	1408 91.2%	1366 98.3%	3683 83.6%	1496 91.8%	399 92.8%	1869 92.4%	1464 87.7%	1156 93.5%	756 95.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LAUNDRY EQUIPMENT...Q10. What fuel is used for water heating?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	114 1.8%	31 3.2%	31 1.3%	28 1.6%	24 1.9%	32 4.2%	41 1.8%	9 0.7%	6 0.3%	78 1.8%	27 1.7%	- 0.0%	26 1.3%	26 1.7%	11 0.8%	9 1.1%
TOTAL ANSWER	**6152** **100.0%**	**988** **100.0%**	**2289** **100.0%**	**1644** **100.0%**	**1205** **100.0%**	**700** **100.0%**	**2103** **100.0%**	**1473** **100.0%**	**1376** **100.0%**	**4096** **100.0%**	**1555** **100.0%**	**418** **100.0%**	**1960** **100.0%**	**1577** **100.0%**	**1199** **100.0%**	**774** **100.0%**
Electricity	850 13.5%	119 12.0%	296 12.6%	183 11.9%	245 19.0%	125 15.9%	344 15.5%	188 13.0%	121 8.8%	560 12.9%	212 14.2%	62 15.9%	268 12.9%	222 13.8%	146 12.7%	108 15.0%
Gas (natural or propane)	4863 75.5%	742 71.3%	1825 75.2%	1369 78.8%	910 75.0%	431 58.5%	1581 71.8%	1215 78.4%	1228 87.7%	3193 74.3%	1278 79.3%	340 77.6%	1648 83.9%	1274 78.3%	998 79.3%	634 78.3%
Hot water furnished by landlord	410 10.4%	117 15.6%	163 12.0%	88 8.9%	40 5.0%	138 24.7%	167 12.1%	62 7.9%	23 3.1%	321 12.1%	60 6.1%	15 6.3%	39 2.8%	80 7.8%	46 7.2%	29 6.2%
Other	29 0.6%	10 1.1%	5 0.2%	4 0.4%	10 1.0%	6 0.9%	11 0.6%	8 0.7%	4 0.4%	22 0.7%	5 0.4%	1 0.2%	5 0.4%	1 0.1%	9 0.8%	3 0.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LAUNDRY EQUIPMENT...Q11. Please check all of the following that you have replaced in the last 24 months. (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	4395 72.4%	730 72.9%	1645 73.6%	1171 72.0%	833 70.1%	567 78.2%	1529 73.8%	1019 72.0%	899 66.4%	3047 75.3%	1030 66.6%	254 62.4%	1309 66.6%	1136 72.7%	814 69.6%	560 74.6%
TOTAL ANSWER	**1871 27.6%**	**289 27.1%**	**675 26.4%**	**501 28.0%**	**396 29.9%**	**165 21.8%**	**615 26.2%**	**463 28.0%**	**483 33.6%**	**1127 24.7%**	**552 33.4%**	**164 37.6%**	**677 33.4%**	**467 27.3%**	**396 30.4%**	**223 25.4%**
Clothes washer	1073 15.9%	154 14.5%	384 14.8%	295 17.0%	233 17.6%	97 12.2%	337 14.4%	276 16.6%	282 20.3%	627 13.7%	323 19.9%	108 25.7%	381 18.8%	274 16.2%	232 18.0%	128 14.5%
Clothes dryer	890 13.5%	131 12.5%	324 12.9%	235 14.1%	193 14.6%	73 9.4%	278 12.2%	229 14.7%	251 18.1%	510 11.3%	272 17.4%	93 22.9%	314 15.6%	231 14.0%	179 14.5%	116 13.6%
Water heater	890 13.0%	149 13.6%	317 12.3%	244 13.5%	176 13.1%	71 9.6%	297 12.6%	219 13.2%	226 15.5%	558 12.3%	247 14.6%	72 15.4%	315 15.7%	220 12.2%	191 14.4%	114 13.4%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

HEATING AND COOLING...Q12. What is the principal fuel used for heating your home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	73 1.3%	25 2.6%	17 0.9%	18 1.1%	13 1.3%	21 3.5%	25 1.1%	5 0.4%	4 0.3%	51 1.3%	11 0.7%	4 1.7%	20 1.1%	6 0.3%	11 1.1%	7 0.9%
TOTAL ANSWER	**6193** **100.0%**	**994** **100.0%**	**2303** **100.0%**	**1654** **100.0%**	**1216** **100.0%**	**711** **100.0%**	**2119** **100.0%**	**1477** **100.0%**	**1378** **100.0%**	**4123** **100.0%**	**1571** **100.0%**	**414** **100.0%**	**1966** **100.0%**	**1597** **100.0%**	**1199** **100.0%**	**776** **100.0%**
Electricity	571 11.1%	116 13.1%	206 11.4%	129 9.7%	114 10.6%	123 18.6%	217 12.0%	111 9.9%	84 7.3%	375 11.0%	142 11.0%	43 12.9%	113 6.5%	131 9.3%	102 11.0%	85 13.0%
Gas	5457 86.3%	854 83.9%	2050 86.6%	1500 88.8%	1035 84.2%	556 76.5%	1829 84.9%	1337 88.3%	1274 91.2%	3628 86.1%	1397 87.1%	363 85.4%	1815 91.6%	1417 87.7%	1068 87.0%	682 86.1%
Other	165 2.6%	24 3.0%	47 2.0%	25 1.5%	67 5.2%	32 4.9%	73 3.1%	29 1.8%	20 1.5%	120 2.9%	32 1.9%	8 1.7%	38 1.9%	49 3.0%	29 2.0%	9 0.9%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q13. What type of heating system is principally used to heat this residence?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	215	61	66	49	38	84	59	21	12	141	37	17	48	41	25	22
	3.5%	6.4%	2.7%	3.0%	2.9%	11.7%	2.5%	1.2%	0.9%	3.4%	2.3%	5.0%	2.5%	2.4%	2.3%	3.0%
TOTAL ANSWER	**6051**	**958**	**2254**	**1623**	**1191**	**648**	**2085**	**1461**	**1370**	**4033**	**1545**	**401**	**1938**	**1562**	**1185**	**761**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Forced air (warm air with blower)	5101	734	1940	1416	991	464	1698	1277	1238	3388	1311	344	1636	1338	1058	695
	81.6%	72.6%	83.1%	84.9%	81.7%	68.3%	78.8%	84.8%	89.5%	81.1%	82.5%	84.2%	83.5%	84.7%	86.4%	89.4%
Gravity warm air	40	18	8	10	4	14	14	6	3	28	12	-	23	1	3	1
	0.8%	2.3%	0.4%	0.6%	0.4%	2.7%	0.7%	0.6%	0.0%	0.8%	1.0%	0.0%	1.2%	/	0.2%	0.3%
Steam or hot water	255	62	89	43	60	35	95	55	44	185	52	14	137	64	26	5
	4.2%	7.3%	3.8%	2.6%	4.6%	5.6%	4.5%	3.4%	3.2%	4.6%	3.3%	3.1%	7.0%	3.8%	2.1%	0.6%
Baseboard, ceiling or radiant	313	49	103	93	66	57	147	53	35	231	69	10	76	93	34	11
	6.5%	6.7%	6.0%	6.9%	6.7%	10.3%	8.7%	4.6%	2.8%	7.3%	4.8%	3.9%	4.2%	6.8%	4.2%	2.0%
Individual room heaters	52	20	14	5	11	17	24	7	3	34	15	1	19	10	5	5
	1.0%	2.2%	0.9%	0.3%	1.2%	2.8%	1.3%	0.6%	0.3%	1.0%	1.1%	0.2%	0.9%	0.6%	0.8%	1.1%
Heat pump (with gas, oil, or L.P. furnace)	170	51	60	32	27	42	68	35	22	97	52	20	30	36	29	19
	3.5%	5.7%	3.5%	2.7%	2.6%	7.3%	3.8%	3.3%	1.8%	3.0%	4.7%	5.6%	2.0%	2.7%	3.0%	3.1%
Heat pump (all electric)	81	21	25	22	13	17	31	16	9	50	21	6	12	14	12	17
	1.7%	2.7%	1.6%	1.8%	1.3%	2.5%	1.8%	1.9%	1.0%	1.7%	1.7%	1.4%	0.8%	1.0%	1.5%	2.8%
Heat pump (ground water source)	39	3	15	2	19	2	8	12	16	20	13	6	5	6	18	8
	0.7%	0.5%	0.7%	0.2%	1.5%	0.5%	0.4%	0.8%	1.4%	0.5%	0.9%	1.6%	0.4%	0.4%	1.8%	0.7%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q14. Do you use more than one thermostat to control the heating in your home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	18 0.3%	3 0.2%	7 0.3%	3 0.2%	5 0.5%	4 0.6%	2 0.1%	3 0.2%	1 0.1%	9 0.2%	6 0.4%	- 0.0%	2 0.2%	5 0.3%	2 0.1%	- 0.0%
TOTAL ANSWER	**6248** **100.0%**	**1016** **100.0%**	**2313** **100.0%**	**1669** **100.0%**	**1224** **100.0%**	**728** **100.0%**	**2142** **100.0%**	**1479** **100.0%**	**1381** **100.0%**	**4165** **100.0%**	**1576** **100.0%**	**418** **100.0%**	**1984** **100.0%**	**1598** **100.0%**	**1208** **100.0%**	**783** **100.0%**
Yes	664 9.4%	78 7.6%	235 8.9%	189 9.7%	157 11.3%	46 6.7%	182 7.2%	153 9.3%	231 15.1%	405 8.2%	189 11.1%	65 16.2%	184 8.3%	194 11.3%	125 9.0%	107 12.1%
No	5584 90.6%	938 92.4%	2078 91.1%	1480 90.3%	1067 88.7%	682 93.3%	1960 92.8%	1326 90.7%	1150 84.9%	3760 91.8%	1387 88.9%	353 83.8%	1800 91.7%	1404 88.7%	1083 91.0%	676 87.9%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

Q15. Do you have a programmable thermostat?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	70 1.1%	17 1.6%	23 1.0%	13 0.7%	17 1.4%	22 2.8%	21 0.8%	7 0.5%	2 0.1%	48 1.2%	16 0.8%	2 0.4%	20 0.8%	14 0.8%	8 0.6%	5 1.0%
TOTAL ANSWER	**6196 100.0%**	**1002 100.0%**	**2297 100.0%**	**1659 100.0%**	**1212 100.0%**	**710 100.0%**	**2123 100.0%**	**1475 100.0%**	**1380 100.0%**	**4126 100.0%**	**1566 100.0%**	**416 100.0%**	**1966 100.0%**	**1589 100.0%**	**1202 100.0%**	**778 100.0%**
Yes	4348 67.3%	597 57.9%	1678 69.1%	1235 71.5%	817 65.9%	365 49.0%	1275 58.1%	1126 74.0%	1211 87.3%	2750 63.4%	1225 77.0%	325 78.2%	1354 68.4%	1133 68.1%	936 74.8%	624 79.5%
No	1848 32.7%	405 42.1%	619 30.9%	424 28.5%	395 34.1%	345 51.0%	848 41.9%	349 26.0%	169 12.7%	1376 36.6%	341 23.0%	91 21.8%	612 31.6%	456 31.9%	266 25.2%	154 20.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q16. Is any type of supplemental heating used? (exclude fireplace or heat pump system) (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	118 1.6%	28 2.5%	31 1.2%	25 1.2%	33 2.3%	25 3.1%	36 1.4%	14 0.8%	17 0.9%	80 1.7%	26 1.3%	4 1.0%	33 1.5%	23 1.3%	21 1.3%	19 2.2%
TOTAL ANSWER	**6148 100.0%**	**991 100.0%**	**2289 100.0%**	**1647 100.0%**	**1196 100.0%**	**707 100.0%**	**2108 100.0%**	**1468 100.0%**	**1365 100.0%**	**4094 100.0%**	**1556 100.0%**	**414 100.0%**	**1953 100.0%**	**1580 100.0%**	**1189 100.0%**	**764 100.0%**
Yes, electric built-in	144 2.4%	30 3.4%	49 2.1%	31 1.9%	34 2.8%	21 3.8%	34 1.4%	43 3.3%	32 2.0%	83 1.8%	41 3.3%	14 3.8%	45 2.3%	30 1.8%	31 2.3%	17 3.0%
Yes, electric portable (plug-in heater)	1157 18.4%	229 22.9%	426 17.7%	297 18.3%	199 15.7%	129 16.5%	378 17.7%	310 20.1%	263 20.0%	728 17.6%	317 19.6%	97 22.1%	470 24.0%	261 16.4%	204 16.8%	122 14.9%
Yes, both electric built-in and portable	60 0.9%	15 1.4%	19 0.7%	16 0.9%	10 0.9%	5 0.7%	22 0.8%	14 0.9%	13 1.1%	37 0.8%	19 1.2%	4 0.9%	27 1.3%	12 0.7%	11 0.9%	7 0.9%
Yes, other	297 3.9%	38 2.9%	110 3.9%	68 3.5%	80 5.8%	23 2.8%	97 3.3%	76 4.6%	77 4.9%	201 4.0%	77 3.7%	18 4.9%	114 4.8%	83 3.9%	65 5.1%	19 2.4%
No	4517 74.8%	686 70.1%	1692 75.9%	1244 76.0%	877 75.1%	531 76.6%	1583 77.0%	1038 71.8%	983 72.1%	3065 76.1%	1108 72.6%	282 68.7%	1308 68.1%	1199 77.5%	885 75.4%	602 79.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q17. Do you have a whole-house central air conditioning system (including heat pump)?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	54 1.0%	18 1.7%	11 0.6%	16 1.1%	9 0.8%	19 2.8%	10 0.5%	6 0.5%	2 0.1%	34 0.9%	8 0.6%	3 0.6%	11 0.6%	8 0.6%	9 0.7%	4 0.7%
TOTAL ANSWER	**6212 100.0%**	**1001 100.0%**	**2309 100.0%**	**1656 100.0%**	**1220 100.0%**	**713 100.0%**	**2134 100.0%**	**1476 100.0%**	**1380 100.0%**	**4140 100.0%**	**1574 100.0%**	**415 100.0%**	**1975 100.0%**	**1595 100.0%**	**1201 100.0%**	**779 100.0%**
Yes, central air conditioning	4770 73.6%	581 53.4%	1907 79.1%	1375 80.4%	889 70.7%	337 47.1%	1515 68.2%	1247 81.6%	1260 90.0%	3161 72.9%	1241 76.0%	315 74.4%	1337 64.8%	1299 78.4%	1068 88.0%	719 90.5%
Yes, heat pump	93 1.5%	11 1.6%	36 1.5%	15 1.0%	31 2.2%	12 2.1%	24 1.1%	25 1.5%	31 2.5%	55 1.2%	29 2.2%	8 2.3%	19 1.0%	17 1.2%	33 2.6%	18 2.6%
No	1349 24.9%	409 45.0%	366 19.4%	266 18.6%	300 27.1%	364 50.8%	595 30.7%	204 16.9%	89 7.5%	924 25.9%	304 21.8%	92 23.3%	619 34.2%	279 20.4%	100 9.4%	42 6.9%
Total having whole-house central AC system	4863 75.1%	592 55.0%	1943 80.6%	1390 81.4%	920 72.9%	349 49.2%	1539 69.3%	1272 83.2%	1291 92.5%	3216 74.1%	1270 78.2%	323 76.7%	1356 65.8%	1316 79.6%	1101 90.6%	737 93.1%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q18. How many room air conditioners, indivdual or through the wall units do you have?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	77 1.1%	13 1.0%	24 0.8%	21 1.2%	19 1.7%	19 2.8%	20 0.7%	14 0.7%	6 0.4%	54 1.2%	16 0.7%	2 0.4%	21 1.0%	22 1.1%	6 0.3%	12 1.6%
TOTAL ANSWER	**6189** **100.0%**	**1006** **100.0%**	**2296** **100.0%**	**1651** **100.0%**	**1210** **100.0%**	**713** **100.0%**	**2124** **100.0%**	**1468** **100.0%**	**1376** **100.0%**	**4120** **100.0%**	**1566** **100.0%**	**416** **100.0%**	**1965** **100.0%**	**1581** **100.0%**	**1204** **100.0%**	**771** **100.0%**
One	1013 19.5%	260 28.2%	322 17.9%	234 17.3%	193 18.3%	207 31.7%	396 22.2%	202 16.9%	147 11.8%	672 19.8%	257 18.5%	69 20.2%	412 23.1%	214 16.5%	120 12.1%	70 12.4%
Two	365 6.0%	97 10.4%	109 4.8%	80 4.7%	77 6.4%	63 7.9%	159 7.5%	69 5.0%	49 3.6%	228 5.7%	96 6.1%	33 9.0%	175 8.6%	68 4.8%	34 2.8%	20 2.7%
Three or more	291 4.7%	69 6.2%	78 3.2%	79 5.6%	63 4.9%	54 7.3%	125 5.2%	57 4.3%	33 2.4%	161 3.9%	93 6.3%	31 7.3%	116 4.8%	69 4.6%	32 3.3%	22 3.8%
None	4520 69.8%	580 55.2%	1787 74.1%	1258 72.4%	877 70.4%	389 53.1%	1444 65.1%	1140 73.8%	1147 82.2%	3059 70.6%	1120 69.1%	283 63.5%	1262 63.5%	1230 74.1%	1018 81.8%	659 81.1%
Total having AC unit(s)	1669 30.2%	426 44.8%	509 25.9%	393 27.6%	333 29.6%	324 46.9%	680 34.9%	328 26.2%	229 17.8%	1061 29.5%	446 30.9%	133 36.5%	703 36.5%	351 25.9%	186 18.2%	112 18.9%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q19. Is a dehumidifier used in this home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	54 0.7%	13 0.8%	16 0.5%	15 0.8%	10 0.9%	10 1.2%	18 0.7%	5 0.2%	5 0.3%	35 0.7%	10 0.5%	1 0.3%	15 0.6%	10 0.4%	6 0.5%	3 0.5%
TOTAL ANSWER	**6212 100.0%**	**1006 100.0%**	**2304 100.0%**	**1657 100.0%**	**1219 100.0%**	**722 100.0%**	**2126 100.0%**	**1477 100.0%**	**1377 100.0%**	**4139 100.0%**	**1572 100.0%**	**417 100.0%**	**1971 100.0%**	**1593 100.0%**	**1204 100.0%**	**780 100.0%**
Yes	2675 38.2%	335 29.9%	1048 39.9%	760 40.8%	519 38.4%	146 18.6%	752 30.8%	715 43.4%	784 54.0%	1679 35.3%	767 45.6%	193 43.0%	879 42.5%	754 42.6%	594 44.0%	334 37.5%
No	3537 61.8%	671 70.1%	1256 60.1%	897 59.2%	700 61.6%	576 81.4%	1374 69.2%	762 56.6%	593 46.0%	2460 64.7%	805 54.4%	224 57.0%	1092 57.5%	839 57.4%	610 56.0%	446 62.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

HEATING AND COOLING...Q20. Please check all of the following that you have replaced in the last 24 months. (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	4562	738	1709	1204	895	577	1627	1064	904	3122	1089	273	1381	1143	854	615
	74.1%	75.0%	75.0%	72.8%	73.8%	81.1%	76.9%	72.6%	65.6%	76.3%	69.2%	66.3%	69.8%	72.4%	72.1%	80.4%
TOTAL ANSWER	**1704**	**281**	**611**	**468**	**334**	**155**	**517**	**418**	**478**	**1052**	**493**	**145**	**605**	**460**	**356**	**168**
	25.9%	**25.0%**	**25.0%**	**27.2%**	**26.2%**	**18.9%**	**23.1%**	**27.4%**	**34.4%**	**23.7%**	**30.8%**	**33.7%**	**30.2%**	**27.6%**	**27.9%**	**19.6%**
Furnace	607	94	206	186	116	52	189	146	164	388	168	46	210	164	152	51
	8.4%	8.0%	7.6%	9.5%	8.4%	6.5%	7.4%	8.5%	10.7%	7.8%	9.8%	10.1%	9.7%	9.0%	10.8%	5.7%
Thermostat	910	143	349	253	160	79	259	235	273	552	268	85	314	248	189	109
	13.7%	12.2%	14.3%	14.8%	12.1%	9.8%	10.9%	15.3%	20.4%	12.1%	17.6%	18.9%	15.5%	14.8%	15.1%	12.8%
Dehumidifier	427	45	167	139	73	16	99	128	147	261	124	36	155	119	100	43
	6.2%	4.4%	6.7%	7.1%	5.2%	2.0%	4.3%	7.7%	10.4%	5.5%	7.5%	8.4%	7.7%	6.5%	7.6%	5.0%
Room AC	223	63	71	42	47	40	91	38	36	134	65	21	123	39	21	7
	4.0%	6.5%	3.2%	3.3%	4.8%	4.9%	5.0%	3.1%	2.8%	3.7%	4.5%	5.3%	6.7%	2.8%	1.8%	1.5%
Whole-house central AC	456	50	172	137	93	24	121	114	157	290	133	30	131	133	125	51
	6.3%	4.0%	6.2%	7.2%	7.0%	2.9%	5.3%	6.4%	10.3%	5.8%	7.6%	6.7%	6.1%	7.1%	8.8%	5.6%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q21. Please check any of the following equipment or appliances you use around your home. (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	278	63	79	94	41	41	101	36	60	175	71	20	93	63	49	31
	4.6%	6.9%	3.4%	5.6%	3.4%	6.1%	4.8%	2.5%	4.7%	4.4%	4.7%	4.7%	5.1%	3.5%	4.2%	4.2%
TOTAL ANSWER	**5988**	**956**	**2241**	**1578**	**1188**	**691**	**2043**	**1446**	**1322**	**3999**	**1511**	**398**	**1893**	**1540**	**1161**	**752**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Swimming pool filter pump	344	24	132	86	100	12	97	95	121	142	148	54	102	109	84	43
	4.4%	1.4%	4.7%	4.2%	6.4%	1.5%	3.4%	4.9%	7.7%	2.4%	8.4%	12.7%	4.1%	5.5%	5.8%	4.9%
Swimming pool heater	103	2	41	40	19	2	9	26	59	47	45	11	13	34	37	19
	1.3%	0.1%	1.2%	2.0%	1.4%	0.4%	0.4%	1.3%	3.7%	0.8%	2.4%	2.7%	0.3%	1.7%	2.8%	2.2%
Electric heated whirlpool/ jacuzzi/hot tub	209	11	85	62	49	3	45	58	86	123	68	18	54	49	72	32
	2.6%	0.8%	2.7%	2.7%	3.6%	0.4%	1.6%	2.9%	5.4%	2.1%	3.6%	4.2%	2.1%	2.1%	5.4%	3.6%
Satellite dish	923	144	322	147	306	91	329	213	226	559	267	86	238	219	228	154
	13.3%	13.6%	12.0%	7.9%	23.8%	11.8%	13.7%	12.4%	14.6%	11.8%	16.3%	18.5%	11.5%	12.1%	17.0%	19.0%
Heated waterbed	39	8	19	5	7	3	16	9	8	25	11	2	19	7	4	3
	0.5%	0.7%	0.7%	0.3%	0.5%	0.7%	0.5%	0.4%	0.7%	0.5%	0.6%	0.4%	0.9%	0.5%	0.3%	0.2%
One	33	6	16	5	6	2	15	7	6	21	9	2	16	7	2	3
	0.4%	0.3%	0.6%	0.3%	0.4%	0.4%	0.5%	0.3%	0.5%	0.4%	0.4%	0.4%	0.8%	0.5%	0.1%	0.2%
Two or more	3	1	1	-	1	-	1	1	1	2	1	-	2	-	1	-
	/	0.1%	/	0.0%	0.1%	0.0%	/	/	0.1%	/	/	0.0%	0.1%	0.0%	0.1%	0.0%
None of the above	4639	784	1743	1310	784	587	1598	1117	944	3227	1082	262	1515	1194	836	544
	81.2%	84.6%	81.7%	86.4%	69.5%	86.4%	82.2%	81.5%	75.4%	84.4%	74.4%	69.3%	82.7%	81.6%	75.7%	74.8%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q22. How many TV sets are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	41 0.6%	13 1.1%	14 0.6%	7 0.4%	7 0.5%	10 1.3%	11 0.4%	4 0.2%	5 0.5%	24 0.5%	7 0.5%	2 0.3%	10 0.5%	11 0.7%	5 0.4%	3 0.3%
TOTAL ANSWER	**6225 100.0%**	**1006 100.0%**	**2306 100.0%**	**1665 100.0%**	**1222 100.0%**	**722 100.0%**	**2133 100.0%**	**1478 100.0%**	**1377 100.0%**	**4150 100.0%**	**1575 100.0%**	**416 100.0%**	**1976 100.0%**	**1592 100.0%**	**1205 100.0%**	**780 100.0%**
One	1477 29.7%	244 30.3%	569 31.1%	397 29.6%	260 26.2%	242 36.9%	589 33.5%	305 27.8%	217 20.3%	1167 33.9%	231 19.8%	51 15.2%	492 31.1%	363 27.3%	223 24.2%	159 25.7%
Two	2313 37.6%	354 34.8%	829 35.8%	632 40.2%	489 40.0%	281 38.6%	839 39.1%	518 35.3%	466 35.8%	1699 40.9%	484 31.3%	99 24.1%	709 35.6%	644 41.6%	467 38.9%	254 34.2%
Three or more	2343 30.5%	392 32.5%	863 30.1%	615 28.4%	463 32.7%	178 20.5%	671 25.1%	637 34.9%	684 42.6%	1219 22.9%	846 47.2%	259 58.6%	751 31.5%	565 28.8%	504 35.7%	354 37.8%
None	92 2.2%	16 2.4%	45 3.0%	21 1.8%	10 1.1%	21 4.0%	34 2.3%	18 2.0%	10 1.3%	65 2.3%	14 1.7%	7 2.1%	24 1.8%	20 2.3%	11 1.2%	13 2.3%
Total having TV set	6133 97.8%	990 97.6%	2261 97.0%	1644 98.2%	1212 98.9%	701 96.0%	2099 97.8%	1460 98.0%	1367 98.7%	4085 97.7%	1561 98.3%	409 97.9%	1952 98.2%	1572 97.7%	1194 98.8%	767 97.7%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q22a. Describe the most frequently used TV - Type

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
		Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	776 12.4%	181 18.4%	253 11.2%	200 11.4%	140 11.1%	201 28.0%	284 12.5%	95 6.5%	57 4.2%	570 13.6%	132 8.0%	36 9.3%	225 11.0%	191 12.4%	109 9.3%	74 9.7%
TOTAL ANSWER	**5490 100.0%**	**838 100.0%**	**2067 100.0%**	**1472 100.0%**	**1089 100.0%**	**531 100.0%**	**1860 100.0%**	**1387 100.0%**	**1325 100.0%**	**3604 100.0%**	**1450 100.0%**	**382 100.0%**	**1761 100.0%**	**1412 100.0%**	**1101 100.0%**	**709 100.0%**
Plasma	786 13.4%	120 13.7%	276 12.9%	225 13.8%	159 13.6%	92 16.9%	245 12.4%	198 13.3%	195 14.2%	478 12.3%	243 16.3%	57 14.5%	230 12.0%	208 13.8%	157 13.6%	105 13.6%
LED	2760 50.3%	403 45.9%	1043 50.7%	763 52.8%	543 49.6%	217 39.7%	894 47.8%	736 53.6%	717 55.5%	1789 49.3%	750 53.1%	195 50.1%	890 50.3%	694 50.0%	565 50.5%	375 54.9%
LCD	1336 25.3%	185 24.3%	547 26.5%	335 24.2%	263 25.3%	107 21.3%	449 25.7%	352 26.3%	357 27.2%	859 25.3%	364 24.6%	103 29.2%	430 25.9%	353 25.5%	278 26.7%	173 23.6%
Front/rear projection	106 1.7%	18 2.6%	38 1.6%	25 1.2%	24 1.9%	13 2.1%	34 2.0%	24 1.3%	26 1.2%	69 1.6%	32 2.1%	5 1.1%	29 1.5%	26 1.6%	21 1.5%	14 1.3%
Traditional (CRT or solid state)	502 9.3%	112 13.5%	163 8.3%	124 8.0%	100 9.6%	102 20.0%	238 12.1%	77 5.5%	30 1.9%	409 11.5%	61 3.9%	22 5.1%	182 10.3%	131 9.1%	80 7.7%	42 6.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q22a. Describe the most frequently used TV - Size

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	507 8.4%	127 13.5%	162 7.5%	130 7.6%	87 6.8%	135 19.1%	173 8.0%	56 4.3%	35 2.9%	358 8.9%	88 5.7%	28 7.3%	168 8.5%	106 7.1%	68 6.1%	51 6.7%
TOTAL ANSWER	**5759 100.0%**	**892 100.0%**	**2158 100.0%**	**1542 100.0%**	**1142 100.0%**	**597 100.0%**	**1971 100.0%**	**1426 100.0%**	**1347 100.0%**	**3816 100.0%**	**1494 100.0%**	**390 100.0%**	**1818 100.0%**	**1497 100.0%**	**1142 100.0%**	**732 100.0%**
Under 19"	103 1.9%	33 3.8%	30 1.6%	20 1.2%	17 1.7%	32 5.6%	48 2.3%	7 0.5%	7 0.4%	87 2.4%	11 0.6%	3 0.8%	30 1.7%	29 2.1%	14 1.3%	5 0.9%
19"-39"	1767 32.7%	353 42.6%	646 32.0%	413 28.6%	348 32.0%	287 49.4%	755 40.6%	364 25.8%	223 17.2%	1315 36.6%	334 23.3%	92 22.9%	648 37.5%	439 31.5%	300 28.3%	160 22.4%
40"-59"	3256 55.8%	454 48.5%	1240 57.0%	915 59.1%	635 54.6%	259 42.1%	1054 51.8%	886 62.8%	838 63.2%	2051 52.9%	949 63.5%	228 58.8%	1002 53.9%	867 56.7%	669 58.2%	420 58.2%
60"-73"	605 9.2%	49 4.9%	236 9.2%	185 10.5%	132 11.0%	17 2.6%	105 4.9%	164 10.6%	272 18.7%	348 7.8%	189 11.8%	65 17.0%	134 6.7%	153 9.2%	155 11.9%	141 17.9%
Other	28 0.4%	3 0.2%	6 0.2%	9 0.6%	10 0.7%	2 0.3%	9 0.4%	5 0.3%	7 0.5%	15 0.3%	11 0.8%	2 0.5%	4 0.2%	9 0.5%	4 0.3%	6 0.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q22c. Describe the second most frequently used TV - Type

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	2125 39.1%	396 44.2%	795 40.4%	557 38.2%	370 33.4%	378 53.8%	827 43.2%	396 33.4%	273 24.1%	1610 43.7%	373 28.0%	82 21.9%	690 40.1%	522 36.7%	320 31.5%	221 33.0%
TOTAL ANSWER	**4141 100.0%**	**623 100.0%**	**1525 100.0%**	**1115 100.0%**	**859 100.0%**	**354 100.0%**	**1317 100.0%**	**1086 100.0%**	**1109 100.0%**	**2564 100.0%**	**1209 100.0%**	**336 100.0%**	**1296 100.0%**	**1081 100.0%**	**890 100.0%**	**562 100.0%**
Plasma	388 8.9%	62 10.5%	130 7.8%	114 9.5%	79 8.5%	45 12.1%	114 8.3%	97 8.8%	98 7.8%	219 7.7%	128 11.0%	38 10.8%	108 7.8%	101 8.2%	88 10.7%	55 8.7%
LED	2007 47.5%	285 43.5%	744 48.0%	568 50.1%	405 46.7%	136 35.1%	615 46.8%	542 49.1%	570 50.9%	1246 47.3%	591 48.5%	160 47.2%	628 46.9%	509 47.5%	442 47.7%	290 53.6%
LCD	1101 27.4%	160 25.6%	426 28.6%	275 26.8%	232 27.2%	75 21.3%	321 24.8%	308 29.7%	342 32.9%	629 26.1%	362 29.5%	99 30.5%	339 27.8%	277 26.0%	250 28.3%	164 29.7%
Front/rear projection	72 1.7%	10 1.6%	26 1.7%	16 1.2%	18 2.1%	6 1.7%	25 1.9%	21 1.5%	20 1.8%	39 1.4%	23 1.9%	10 3.6%	16 1.1%	19 1.9%	16 2.1%	16 1.9%
Traditional (CRT or solid state)	573 14.5%	106 18.8%	199 13.9%	142 12.4%	125 15.5%	92 29.8%	242 18.2%	118 10.9%	79 6.6%	431 17.5%	105 9.1%	29 7.9%	205 16.4%	175 16.4%	94 11.2%	37 6.1%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q22d. Describe the second most frequently used TV - Size

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	1977	373	743	512	342	356	776	373	256	1508	333	82	649	472	294	215
	37.2%	42.6%	38.5%	35.8%	32.0%	51.1%	41.3%	32.7%	23.3%	41.7%	25.9%	22.3%	38.5%	33.9%	29.6%	32.6%
TOTAL ANSWER	**4289**	**646**	**1577**	**1160**	**887**	**376**	**1368**	**1109**	**1126**	**2666**	**1249**	**336**	**1337**	**1131**	**916**	**568**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Under 19"	348	52	114	97	85	44	146	85	52	263	68	11	129	91	73	27
	8.7%	8.9%	8.0%	8.4%	10.6%	13.1%	11.6%	7.5%	4.3%	10.7%	5.4%	3.3%	10.0%	9.0%	8.7%	4.8%
19"-39"	2306	371	860	602	464	235	825	569	505	1513	616	157	768	621	465	259
	54.7%	57.8%	55.9%	52.9%	52.6%	62.6%	61.7%	50.8%	45.7%	57.9%	48.8%	48.3%	57.4%	54.9%	52.5%	47.0%
40"-59"	1408	189	520	397	295	83	358	401	476	778	480	140	388	371	313	236
	31.7%	28.5%	31.0%	33.9%	32.3%	20.8%	24.2%	36.9%	42.3%	27.7%	39.0%	40.8%	28.9%	31.4%	32.2%	41.6%
60"-73"	201	30	71	56	41	11	33	49	86	101	75	23	46	42	59	43
	4.3%	4.1%	4.3%	4.1%	4.3%	2.5%	2.1%	4.4%	7.1%	3.3%	6.1%	6.0%	3.3%	4.3%	5.9%	6.1%
Other	26	4	12	8	2	3	6	5	7	11	10	5	6	6	6	3
	0.6%	0.7%	0.8%	0.7%	0.2%	1.0%	0.4%	0.4%	0.6%	0.4%	0.7%	1.6%	0.4%	0.4%	0.7%	0.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q23a. How many combined DVR/cable TV boxes are used?

	Total Sample	Region				Income			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+
	A	B	C	D	E	F	G	H	I
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%
DON'T KNOW/NO ANSWER	371 5.3%	72 6.4%	114 4.5%	113 6.1%	72 5.0%	60 7.3%	160 6.6%	46 2.6%	33 2.1%
TOTAL ANSWER	**5895** **100.0%**	**947** **100.0%**	**2206** **100.0%**	**1559** **100.0%**	**1157** **100.0%**	**672** **100.0%**	**1984** **100.0%**	**1436** **100.0%**	**1349** **100.0%**
One	2039 32.9%	290 29.6%	789 34.2%	562 33.9%	391 32.0%	184 25.6%	662 32.2%	528 34.9%	494 35.3%
Two	1048 15.8%	183 17.1%	362 14.5%	290 16.5%	207 16.2%	99 13.2%	335 15.0%	260 15.8%	275 18.5%
Three or more	716 9.4%	106 8.1%	263 9.3%	199 9.4%	144 10.4%	44 4.9%	192 6.8%	194 10.7%	232 14.9%
None	2092 41.9%	368 45.2%	792 42.0%	508 40.2%	415 41.4%	345 56.3%	795 46.0%	454 38.6%	348 31.3%
Total having combined DVR/cable TV box	3803 58.1%	579 54.8%	1414 58.0%	1051 59.8%	742 58.6%	327 43.7%	1189 54.0%	982 61.4%	1001 68.7%

	Persons in Household			Year Residence was Built			
	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	J	K	L	M	N	O	P
SAMPLE SIZE	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	275 5.8%	62 3.6%	15 3.8%	109 5.1%	86 4.7%	72 5.5%	35 4.5%
TOTAL ANSWER	**3899** **100.0%**	**1520** **100.0%**	**403** **100.0%**	**1877** **100.0%**	**1517** **100.0%**	**1138** **100.0%**	**748** **100.0%**
One	1418 34.5%	489 29.6%	106 27.3%	623 32.4%	553 34.1%	381 32.0%	302 40.7%
Two	675 15.2%	280 16.8%	81 19.3%	337 15.9%	275 15.9%	217 17.1%	133 16.6%
Three or more	367 6.8%	263 14.9%	79 17.7%	218 8.6%	176 9.4%	177 13.5%	102 10.8%
None	1439 43.5%	488 38.7%	137 35.7%	699 43.1%	513 40.6%	363 37.4%	211 31.9%
Total having combined DVR/cable TV box	2460 56.5%	1032 61.3%	266 64.3%	1178 56.9%	1004 59.4%	775 62.6%	537 68.1%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q23b. How many stand-alone cable TV boxes are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	759 10.5%	130 11.4%	260 9.4%	217 11.2%	152 11.1%	98 12.6%	284 11.6%	135 6.8%	131 8.1%	545 11.1%	165 9.2%	28 5.9%	232 9.9%	210 11.8%	141 10.4%	80 9.1%
TOTAL ANSWER	**5507 100.0%**	**889 100.0%**	**2060 100.0%**	**1455 100.0%**	**1077 100.0%**	**634 100.0%**	**1860 100.0%**	**1347 100.0%**	**1251 100.0%**	**3629 100.0%**	**1417 100.0%**	**390 100.0%**	**1754 100.0%**	**1393 100.0%**	**1069 100.0%**	**703 100.0%**
One	1366 25.3%	189 20.8%	537 26.5%	379 27.6%	258 23.6%	148 23.1%	479 25.9%	339 25.5%	290 24.4%	965 26.7%	302 21.7%	84 22.4%	444 24.5%	341 26.5%	255 25.3%	168 24.0%
Two	847 13.3%	141 14.2%	326 13.8%	204 11.1%	170 14.4%	88 12.0%	290 13.7%	191 11.8%	212 14.7%	590 13.8%	207 13.0%	42 9.0%	253 12.8%	220 13.2%	199 16.4%	113 14.8%
Three or more	519 7.1%	94 8.4%	183 6.3%	130 6.5%	110 8.6%	33 4.1%	148 6.1%	140 7.7%	150 9.4%	261 5.1%	183 11.0%	68 15.3%	156 6.9%	129 7.4%	113 7.9%	85 9.2%
None	2775 54.3%	465 56.6%	1014 53.4%	742 54.8%	539 53.4%	365 60.8%	943 54.3%	677 55.0%	599 51.5%	1813 54.4%	725 54.3%	196 53.3%	901 55.8%	703 52.9%	502 50.4%	337 52.0%
Total having stand-alone cable TV box	2732 45.7%	424 43.4%	1046 46.6%	713 45.3%	538 46.6%	269 39.2%	917 45.7%	670 45.0%	652 48.5%	1816 45.6%	692 45.7%	194 46.7%	853 44.1%	690 47.1%	567 49.6%	366 48.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

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OTHER APPLIANCES AND EQUIPMENT...Q23c. How many stand-alone DVRs are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	1104 15.3%	174 14.5%	400 15.0%	319 16.5%	211 15.0%	134 16.2%	382 15.9%	195 10.6%	233 14.5%	770 15.8%	250 14.0%	52 11.2%	337 14.6%	292 16.7%	217 15.3%	125 14.4%
TOTAL ANSWER	**5162 100.0%**	**845 100.0%**	**1920 100.0%**	**1353 100.0%**	**1018 100.0%**	**598 100.0%**	**1762 100.0%**	**1287 100.0%**	**1149 100.0%**	**3404 100.0%**	**1332 100.0%**	**366 100.0%**	**1649 100.0%**	**1311 100.0%**	**993 100.0%**	**658 100.0%**
One	913 15.9%	157 16.5%	323 15.3%	243 15.4%	189 17.6%	101 14.8%	345 16.8%	235 16.3%	158 12.9%	673 17.4%	182 12.6%	52 13.4%	304 16.2%	247 16.8%	195 19.1%	100 14.9%
Two	208 3.3%	34 3.3%	70 2.9%	56 3.2%	47 4.0%	26 3.6%	68 3.4%	56 3.2%	47 3.2%	139 3.3%	50 3.1%	17 4.0%	69 3.2%	52 3.4%	42 3.2%	22 2.6%
Three or more	71 1.1%	18 1.9%	31 1.3%	18 1.0%	4 0.3%	6 0.8%	22 1.0%	14 0.8%	23 1.9%	32 0.7%	29 2.0%	8 1.9%	21 1.1%	20 1.1%	15 1.0%	6 1.0%
None	3970 79.7%	636 78.3%	1496 80.5%	1036 80.4%	778 78.1%	465 80.8%	1327 78.8%	982 79.7%	921 82.0%	2560 78.6%	1071 82.3%	289 80.7%	1255 79.5%	992 78.7%	741 76.7%	530 81.5%
Total having stand-alone DVR	1192 20.3%	209 21.7%	424 19.5%	317 19.5%	240 21.9%	133 19.2%	435 21.2%	305 20.3%	228 18.0%	844 21.4%	261 17.7%	77 19.3%	394 20.5%	319 21.3%	252 23.3%	128 18.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Ipsos RDA

OTHER APPLIANCES AND EQUIPMENT...Q24. How many digital TV converters are used?

	Total Sample A	Region: Detroit B	Region: West C	Region: North-west D	Region: North-east E	Income: < $20K F	Income: $20K-$59K G	Income: $60K-$99K H	Income: $100K+ I	Persons in Household: 1-2 J	Persons in Household: 3-4 K	Persons in Household: 5+ L	Year Residence was Built: < 1960 M	Year Residence was Built: 1960-1979 N	Year Residence was Built: 1980-1999 O	Year Residence was Built: 2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	272 3.5%	35 2.9%	103 3.5%	81 3.8%	53 3.6%	28 3.6%	100 3.6%	38 1.7%	26 1.4%	202 3.8%	45 2.3%	8 1.8%	70 2.9%	76 3.8%	49 3.3%	24 2.7%
TOTAL ANSWER	**5994 100.0%**	**984 100.0%**	**2217 100.0%**	**1591 100.0%**	**1176 100.0%**	**704 100.0%**	**2044 100.0%**	**1444 100.0%**	**1356 100.0%**	**3972 100.0%**	**1537 100.0%**	**410 100.0%**	**1916 100.0%**	**1527 100.0%**	**1161 100.0%**	**759 100.0%**
One	1034 17.3%	182 19.0%	384 17.0%	288 17.9%	178 15.4%	144 21.0%	376 18.0%	243 17.2%	193 13.8%	739 18.6%	222 14.0%	54 13.6%	349 18.8%	274 17.8%	163 13.7%	129 16.1%
Two	513 7.7%	109 9.9%	165 6.6%	133 7.6%	106 8.0%	83 11.1%	178 7.7%	105 5.7%	99 6.8%	368 8.1%	104 6.2%	33 7.5%	169 7.6%	146 8.5%	97 8.2%	54 7.1%
Three or more	316 3.8%	47 4.3%	108 3.2%	96 4.3%	64 4.1%	30 3.6%	74 2.4%	92 4.6%	93 5.6%	182 3.2%	108 5.7%	24 4.8%	87 3.5%	81 3.9%	76 4.7%	46 4.4%
None	4131 71.2%	646 66.8%	1560 73.2%	1074 70.2%	828 72.5%	447 64.3%	1416 71.9%	1004 72.5%	971 73.8%	2683 70.1%	1103 74.1%	299 74.1%	1311 70.1%	1026 69.8%	825 73.4%	530 72.4%
Total having digital TV converter	1863 28.8%	338 33.2%	657 26.8%	517 29.8%	348 27.5%	257 35.7%	628 28.1%	440 27.5%	385 26.2%	1289 29.9%	434 25.9%	111 25.9%	605 29.9%	501 30.2%	336 26.6%	229 27.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Source: 2016 Residential Customer Appliance Saturation Study

Ipsos RDA

OTHER APPLIANCES AND EQUIPMENT...Q25. How many VCRs are used?

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
		Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	142 2.0%	32 2.6%	43 1.7%	40 2.0%	27 2.1%	25 3.4%	43 1.6%	20 1.3%	12 0.7%	102 2.1%	18 0.8%	7 1.6%	39 1.7%	38 2.0%	21 1.5%	15 1.8%
TOTAL ANSWER	**6124** **100.0%**	**987** **100.0%**	**2277** **100.0%**	**1632** **100.0%**	**1202** **100.0%**	**707** **100.0%**	**2101** **100.0%**	**1462** **100.0%**	**1370** **100.0%**	**4072** **100.0%**	**1564** **100.0%**	**411** **100.0%**	**1947** **100.0%**	**1565** **100.0%**	**1189** **100.0%**	**768** **100.0%**
One	1533 23.3%	228 22.7%	557 22.2%	410 23.0%	331 26.5%	192 26.8%	596 26.8%	350 20.5%	262 16.6%	1090 24.6%	331 20.0%	94 20.5%	511 25.0%	401 23.9%	308 24.7%	174 20.7%
Two	249 3.1%	41 3.6%	82 2.7%	65 2.8%	60 4.1%	29 4.3%	80 2.9%	59 2.8%	56 3.0%	167 3.2%	66 3.3%	13 2.2%	80 3.2%	63 2.9%	51 3.8%	31 3.3%
Three or more	48 0.6%	12 0.9%	17 0.4%	13 0.7%	6 0.3%	5 0.5%	10 0.4%	14 0.7%	15 0.8%	28 0.4%	17 0.9%	3 0.6%	15 0.5%	14 0.7%	8 0.6%	5 0.2%
None	4294 73.0%	706 72.8%	1621 74.7%	1144 73.5%	805 69.1%	481 68.4%	1415 69.9%	1039 76.0%	1037 79.6%	2787 71.8%	1150 75.8%	301 76.7%	1341 71.3%	1087 72.5%	822 70.9%	558 75.8%
Total having VCR	1830 27.0%	281 27.2%	656 25.3%	488 26.5%	397 30.9%	226 31.6%	686 30.1%	423 23.9%	333 20.4%	1285 28.2%	414 24.2%	110 23.3%	606 28.7%	478 27.4%	367 29.1%	210 24.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q26. How many DVD or Blu-ray players are used?

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
		Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	112 1.6%	22 1.8%	29 1.2%	37 1.8%	24 1.6%	20 2.5%	40 1.5%	10 0.5%	6 0.5%	82 1.7%	16 0.7%	3 0.9%	28 1.1%	21 1.2%	22 1.5%	13 1.9%
TOTAL ANSWER	**6154** **100.0%**	**997** **100.0%**	**2291** **100.0%**	**1635** **100.0%**	**1205** **100.0%**	**712** **100.0%**	**2104** **100.0%**	**1472** **100.0%**	**1376** **100.0%**	**4092** **100.0%**	**1566** **100.0%**	**415** **100.0%**	**1958** **100.0%**	**1582** **100.0%**	**1188** **100.0%**	**770** **100.0%**
One	3043 49.5%	411 40.5%	1195 51.8%	829 50.5%	598 51.8%	266 36.8%	1051 51.3%	792 53.0%	693 50.6%	2088 50.8%	762 48.6%	171 42.4%	979 50.5%	836 52.7%	589 48.4%	352 46.5%
Two	951 14.1%	146 14.0%	352 14.1%	252 13.5%	197 15.0%	77 10.0%	263 11.6%	271 16.3%	286 19.6%	517 11.6%	331 19.8%	97 22.6%	301 14.1%	217 13.1%	215 17.2%	143 15.8%
Three or more	219 3.0%	28 2.4%	83 2.8%	53 2.8%	54 4.3%	15 1.8%	55 2.3%	60 3.4%	72 4.7%	82 1.6%	94 5.8%	42 9.6%	68 3.1%	62 3.5%	39 2.5%	38 4.0%
None	1941 33.4%	412 43.1%	661 31.3%	501 33.2%	356 28.9%	354 51.4%	735 34.8%	349 27.3%	325 25.1%	1405 36.0%	379 25.8%	105 25.4%	610 32.3%	467 30.7%	345 31.9%	237 33.7%
Total having DVD/Blu-ray player	4213 66.6%	585 56.9%	1630 68.7%	1134 66.8%	849 71.1%	358 48.6%	1369 65.2%	1123 72.7%	1051 74.9%	2687 64.0%	1187 74.2%	310 74.6%	1348 67.7%	1115 69.3%	843 68.1%	533 66.3%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q27. How many desktop computers are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	89 1.3%	15 1.2%	31 1.1%	24 1.4%	19 1.6%	15 2.0%	34 1.5%	11 0.5%	4 0.3%	60 1.3%	15 0.9%	5 1.2%	18 0.9%	24 1.3%	18 1.4%	10 1.5%
TOTAL ANSWER	**6177 100.0%**	**1004 100.0%**	**2289 100.0%**	**1648 100.0%**	**1210 100.0%**	**717 100.0%**	**2110 100.0%**	**1471 100.0%**	**1378 100.0%**	**4114 100.0%**	**1567 100.0%**	**413 100.0%**	**1968 100.0%**	**1579 100.0%**	**1192 100.0%**	**773 100.0%**
One	2672 39.9%	369 34.2%	1021 40.9%	737 41.1%	537 41.9%	231 30.2%	914 40.1%	677 41.5%	625 43.4%	1791 39.2%	684 42.9%	172 40.1%	835 40.4%	715 41.8%	571 44.1%	343 41.8%
Two	525 7.1%	54 4.7%	221 7.7%	145 7.3%	101 7.5%	27 2.9%	140 5.5%	142 7.7%	179 11.9%	284 5.9%	184 9.7%	54 11.3%	174 7.3%	148 8.1%	100 7.1%	80 9.2%
Three or more	164 2.2%	12 0.9%	69 2.2%	56 3.0%	26 2.0%	8 0.8%	22 0.7%	45 2.9%	73 4.8%	69 1.3%	70 4.1%	23 5.2%	49 1.8%	41 2.3%	42 2.9%	28 3.6%
None	2816 50.8%	569 60.2%	978 49.2%	710 48.6%	546 48.6%	451 66.1%	1034 53.7%	607 47.9%	501 39.9%	1970 53.6%	629 43.3%	164 43.4%	910 50.5%	675 47.8%	479 45.9%	322 45.4%
Total having desktop computer	3361 49.2%	435 39.8%	1311 50.8%	938 51.4%	664 51.4%	266 33.9%	1076 46.3%	864 52.0%	877 60.1%	2144 46.3%	938 56.6%	249 56.6%	1058 49.5%	904 52.2%	713 54.1%	451 54.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q28. How many laptop computers are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	86 1.2%	17 1.4%	28 1.1%	25 1.2%	16 1.3%	18 2.1%	28 1.2%	10 0.5%	5 0.3%	55 1.2%	16 0.9%	2 0.7%	24 1.1%	21 1.3%	8 0.5%	10 1.3%
TOTAL ANSWER	**6180 100.0%**	**1002 100.0%**	**2292 100.0%**	**1647 100.0%**	**1213 100.0%**	**714 100.0%**	**2116 100.0%**	**1472 100.0%**	**1377 100.0%**	**4119 100.0%**	**1566 100.0%**	**416 100.0%**	**1962 100.0%**	**1582 100.0%**	**1202 100.0%**	**773 100.0%**
One	2669 44.5%	386 39.7%	992 45.1%	714 44.1%	566 48.0%	244 34.5%	1002 50.6%	728 50.1%	487 33.6%	1915 47.5%	579 37.9%	148 36.7%	865 45.1%	698 45.6%	512 43.0%	331 43.2%
Two	1333 21.1%	178 16.5%	556 23.5%	378 23.8%	213 16.1%	63 8.1%	332 14.4%	378 27.4%	466 35.5%	731 17.9%	488 30.1%	107 25.4%	396 19.7%	345 22.4%	298 24.1%	203 25.3%
Three or more	511 7.3%	63 5.0%	225 8.7%	139 7.9%	80 5.8%	15 1.6%	76 3.1%	126 8.0%	272 19.3%	132 3.0%	268 16.4%	108 23.8%	155 7.3%	118 5.7%	129 10.2%	90 11.7%
None	1667 27.1%	375 38.8%	519 22.7%	416 24.2%	354 30.1%	392 55.8%	706 31.9%	240 14.5%	152 11.6%	1341 31.6%	231 15.6%	53 14.1%	546 27.9%	421 26.3%	263 22.7%	149 19.8%
Total having laptop computer	4513 72.9%	627 61.2%	1773 77.3%	1231 75.8%	859 69.9%	322 44.2%	1410 68.1%	1232 85.5%	1225 88.4%	2778 68.4%	1335 84.4%	363 85.9%	1416 72.1%	1161 73.7%	939 77.3%	624 80.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q29. How many printer/scanner/copier/faxes are used?

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
		Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	54	14	17	18	5	12	12	5	4	29	12	2	14	10	6	5
	0.8%	1.4%	0.7%	1.0%	0.5%	1.6%	0.5%	0.3%	0.4%	0.7%	0.7%	0.7%	0.6%	0.7%	0.5%	0.8%
TOTAL ANSWER	**6212**	**1005**	**2303**	**1654**	**1224**	**720**	**2132**	**1477**	**1378**	**4145**	**1570**	**416**	**1972**	**1593**	**1204**	**778**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
One	4072	553	1535	1121	843	297	1356	1060	1029	2634	1098	303	1293	1098	841	551
	62.2%	51.6%	62.8%	64.7%	66.9%	38.9%	60.5%	68.2%	72.5%	59.6%	68.9%	70.6%	63.3%	66.6%	66.7%	67.9%
Two	514	59	219	152	81	19	128	136	181	314	164	34	139	146	133	80
	6.6%	4.7%	7.6%	7.2%	5.2%	2.1%	5.1%	7.3%	11.0%	5.8%	8.6%	7.9%	6.1%	7.6%	8.5%	8.6%
Three or more	90	11	45	22	12	2	20	26	34	59	24	6	33	23	24	9
	1.0%	0.7%	1.4%	0.9%	0.7%	0.1%	0.7%	1.3%	1.9%	1.0%	1.2%	0.9%	1.2%	1.0%	1.6%	1.0%
None	1536	382	504	359	288	402	628	255	134	1138	284	73	507	326	206	138
	30.2%	43.0%	28.2%	27.2%	27.2%	58.9%	33.7%	23.2%	14.6%	33.6%	21.3%	20.6%	29.4%	24.8%	23.2%	22.5%
Total having printer/scanner/copier/fax	4676	623	1799	1295	936	318	1504	1222	1244	3007	1286	343	1465	1267	998	640
	69.8%	57.0%	71.8%	72.8%	72.8%	41.1%	66.3%	76.9%	85.4%	66.4%	78.7%	79.4%	70.6%	75.2%	76.8%	77.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

OTHER APPLIANCES AND EQUIPMENT...Q30. How many game console systems are used?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	72 1.1%	18 1.5%	20 0.8%	18 1.0%	16 1.4%	20 2.6%	24 0.9%	3 0.1%	4 0.4%	48 1.1%	11 0.7%	2 0.7%	19 0.9%	16 0.9%	8 0.8%	8 1.2%
TOTAL ANSWER	**6194 100.0%**	**1001 100.0%**	**2300 100.0%**	**1654 100.0%**	**1213 100.0%**	**712 100.0%**	**2120 100.0%**	**1479 100.0%**	**1378 100.0%**	**4126 100.0%**	**1571 100.0%**	**416 100.0%**	**1967 100.0%**	**1587 100.0%**	**1202 100.0%**	**775 100.0%**
One	1599 25.8%	253 24.0%	598 27.0%	419 25.7%	324 25.5%	136 19.3%	496 24.1%	424 28.1%	453 33.6%	777 20.5%	637 38.2%	171 40.6%	508 25.0%	408 25.4%	300 26.4%	209 25.7%
Two	549 9.2%	75 7.4%	214 9.2%	150 10.0%	108 9.7%	48 6.3%	131 6.8%	151 11.6%	196 14.4%	149 4.7%	290 19.2%	108 25.0%	179 9.1%	118 8.4%	97 8.3%	111 13.9%
Three or more	217 3.6%	27 2.6%	78 3.3%	59 4.1%	51 4.4%	12 1.8%	61 3.2%	67 4.4%	74 5.5%	53 1.7%	107 6.9%	57 13.5%	70 3.5%	59 3.8%	37 2.5%	27 4.1%
None	3829 61.4%	646 66.0%	1410 60.5%	1026 60.2%	730 60.4%	516 72.6%	1432 65.9%	837 55.9%	655 46.5%	3147 73.1%	537 35.7%	80 20.9%	1210 62.4%	1002 62.4%	768 62.8%	428 56.3%
Total having game console system	2365 38.6%	355 34.0%	890 39.5%	628 39.8%	483 39.6%	196 27.4%	688 34.1%	642 44.1%	723 53.5%	979 27.0%	1034 64.3%	336 79.1%	757 37.6%	585 37.6%	434 37.2%	347 43.7%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Ipsos RDA

OTHER APPLIANCES AND EQUIPMENT...Q31. Please check all of the following that you have replaced in the last 24 months. (% Multiple Mentions)

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	4008 64.8%	675 66.9%	1436 63.1%	1072 64.9%	811 66.5%	511 70.5%	1431 67.3%	897 61.4%	806 58.8%	2751 66.6%	972 62.2%	221 52.1%	1256 63.5%	1020 65.3%	743 62.7%	509 66.2%
TOTAL ANSWER	**2258** **35.2%**	**344** **33.1%**	**884** **36.9%**	**600** **35.1%**	**418** **33.5%**	**221** **29.5%**	**713** **32.7%**	**585** **38.6%**	**576** **41.2%**	**1423** **33.4%**	**610** **37.8%**	**197** **47.9%**	**730** **36.5%**	**583** **34.7%**	**467** **37.3%**	**274** **33.8%**
TV	1423 22.2%	236 22.8%	541 22.2%	376 22.5%	263 21.2%	175 23.2%	468 21.7%	351 22.8%	336 24.0%	888 20.8%	384 24.2%	131 31.9%	469 23.6%	360 20.9%	269 22.3%	177 21.3%
Computer	1252 19.2%	164 15.4%	515 21.1%	334 19.5%	230 18.0%	75 10.2%	381 17.2%	345 22.9%	366 25.8%	760 17.6%	371 22.7%	112 26.7%	407 19.9%	332 19.4%	269 20.5%	155 19.6%
Whirlpool/jacuzzi/hot tub	28 0.3%	2 0.1%	11 0.3%	7 0.3%	8 0.7%	- 0.0%	6 0.2%	8 0.3%	11 0.7%	13 0.2%	12 0.5%	2 0.7%	6 0.1%	6 0.2%	12 1.0%	3 0.3%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q32a. About how many light bulbs are used inside your home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	62 1.0%	11 0.9%	24 1.1%	16 0.8%	11 1.0%	13 1.6%	14 0.6%	4 0.2%	5 0.4%	44 1.0%	9 0.7%	1 0.3%	13 0.8%	15 0.8%	11 1.0%	7 1.0%
TOTAL ANSWER	**6204** **100.0%**	**1008** **100.0%**	**2296** **100.0%**	**1656** **100.0%**	**1218** **100.0%**	**719** **100.0%**	**2130** **100.0%**	**1478** **100.0%**	**1377** **100.0%**	**4130** **100.0%**	**1573** **100.0%**	**417** **100.0%**	**1973** **100.0%**	**1588** **100.0%**	**1199** **100.0%**	**776** **100.0%**
Less than ten	749 14.4%	217 24.0%	222 12.3%	186 13.8%	124 11.3%	257 37.6%	295 16.0%	96 8.4%	30 2.9%	585 16.6%	97 7.7%	26 7.6%	210 12.1%	152 11.2%	96 9.8%	51 8.7%
10-19	1859 33.7%	394 40.9%	635 32.5%	451 31.0%	370 33.8%	315 44.7%	830 41.9%	412 32.4%	173 14.5%	1344 36.6%	397 27.6%	98 25.6%	687 36.2%	465 33.6%	261 26.0%	154 23.2%
20-29	1517 23.5%	207 19.2%	556 23.1%	429 24.7%	320 26.4%	94 11.5%	553 24.4%	418 27.4%	351 26.8%	990 22.7%	424 26.8%	94 21.6%	526 26.6%	420 25.5%	288 23.9%	191 23.7%
30-39	942 13.5%	100 8.3%	388 14.9%	254 14.2%	198 14.5%	31 3.7%	258 10.1%	271 16.7%	294 21.4%	561 11.9%	290 17.3%	83 19.4%	307 14.3%	256 14.5%	216 16.6%	139 17.8%
40-49	510 7.0%	45 4.3%	221 8.0%	143 7.1%	97 6.8%	15 1.8%	118 4.8%	140 7.6%	194 13.3%	297 5.9%	170 9.8%	41 9.4%	140 6.6%	149 7.6%	127 9.6%	84 9.1%
50 or more	627 7.9%	45 3.3%	274 9.2%	193 9.2%	109 7.2%	7 0.7%	76 2.8%	141 7.5%	335 21.1%	353 6.3%	195 10.8%	75 16.4%	103 4.2%	146 7.6%	211 14.1%	157 17.5%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q32b. How many of these are Compact Fluorescent Light (CFL) bulbs?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	250 3.9%	51 4.5%	83 3.4%	68 4.1%	47 3.9%	57 7.0%	88 4.0%	28 1.8%	23 1.6%	177 4.2%	44 2.4%	12 2.7%	64 3.2%	57 3.4%	33 2.7%	36 4.3%
TOTAL ANSWER	**6016** **100.0%**	**968** **100.0%**	**2237** **100.0%**	**1604** **100.0%**	**1182** **100.0%**	**675** **100.0%**	**2056** **100.0%**	**1454** **100.0%**	**1359** **100.0%**	**3997** **100.0%**	**1538** **100.0%**	**406** **100.0%**	**1922** **100.0%**	**1546** **100.0%**	**1177** **100.0%**	**747** **100.0%**
1%-25%	2044 32.3%	310 30.7%	767 32.5%	553 32.3%	411 33.7%	198 28.0%	695 32.9%	499 33.4%	456 30.8%	1407 33.2%	493 30.8%	117 27.9%	634 31.7%	548 33.3%	430 35.6%	245 31.9%
26%-50%	1071 17.4%	136 14.3%	420 17.7%	301 19.0%	210 17.0%	73 10.5%	310 15.0%	300 19.4%	307 23.3%	648 16.0%	324 20.3%	87 21.7%	332 17.6%	287 17.5%	222 18.2%	146 18.1%
51%-75%	737 12.1%	99 9.5%	309 14.1%	184 11.1%	142 11.9%	55 7.9%	239 11.7%	207 14.2%	190 13.7%	456 11.5%	223 14.4%	55 12.1%	228 11.6%	193 12.9%	158 13.8%	104 13.3%
76%-100%	963 17.5%	186 19.4%	357 17.7%	241 16.8%	175 16.3%	130 20.4%	351 17.7%	243 18.5%	209 17.0%	628 17.7%	253 17.3%	79 18.0%	341 19.1%	229 16.3%	166 14.4%	116 17.5%
None	1201 20.7%	237 26.1%	384 18.0%	325 20.8%	244 21.1%	219 33.2%	461 22.7%	205 14.5%	197 15.2%	858 21.6%	245 17.2%	68 20.3%	387 20.0%	289 20.0%	201 18.0%	136 19.2%
Total having CFL bulbs indoors	4815 79.3%	658 69.3%	1470 67.5%	1051 67.7%	771 66.3%	477 72.0%	1361 67.1%	955 66.6%	903 69.2%	2590 66.8%	1045 69.2%	289 72.1%	1288 68.3%	998 66.7%	747 64.4%	502 68.1%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q32c. How many of these are Light Emitting Diode (LED) bulbs?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	320 4.9%	68 5.5%	115 4.9%	81 4.7%	55 4.4%	75 9.1%	116 4.9%	31 2.2%	20 1.3%	233 5.4%	51 2.8%	13 2.8%	92 4.6%	72 3.9%	47 4.2%	31 3.9%
TOTAL ANSWER	**5946** **100.0%**	**951** **100.0%**	**2205** **100.0%**	**1591** **100.0%**	**1174** **100.0%**	**657** **100.0%**	**2028** **100.0%**	**1451** **100.0%**	**1362** **100.0%**	**3941** **100.0%**	**1531** **100.0%**	**405** **100.0%**	**1894** **100.0%**	**1531** **100.0%**	**1163** **100.0%**	**752** **100.0%**
1%-25%	1858 29.4%	253 25.2%	719 30.9%	511 30.0%	369 29.1%	145 19.9%	600 27.3%	499 32.3%	483 35.3%	1267 29.9%	465 29.1%	114 26.1%	599 31.1%	499 29.3%	382 31.0%	252 33.1%
26%-50%	768 12.5%	100 9.9%	300 12.6%	235 14.7%	132 11.4%	56 8.0%	210 10.5%	188 13.4%	255 17.9%	479 11.8%	217 13.8%	62 15.2%	229 12.0%	193 13.3%	177 14.3%	118 13.8%
51%-75%	490 8.1%	63 6.7%	207 9.1%	120 7.0%	97 9.1%	23 3.3%	141 7.7%	124 8.3%	155 10.7%	296 7.3%	148 9.6%	45 12.7%	165 8.8%	140 9.0%	95 8.5%	63 7.7%
76%-100%	594 11.0%	93 10.4%	222 11.3%	157 11.0%	117 10.8%	64 11.2%	186 10.0%	147 11.2%	159 13.1%	348 9.5%	192 14.8%	47 13.3%	187 10.9%	145 10.8%	107 10.0%	96 13.0%
None	2236 39.0%	442 47.8%	757 36.1%	568 37.3%	459 39.6%	369 57.6%	891 44.5%	493 34.8%	310 23.0%	1551 41.5%	509 32.7%	137 32.7%	714 37.2%	554 37.6%	402 36.2%	223 32.4%
Total having LED bulbs indoors	3710 61.0%	698 74.8%	1486 69.1%	1080 70.0%	805 71.0%	512 80.1%	1428 72.7%	952 67.7%	879 64.7%	2674 70.1%	1066 70.9%	291 73.9%	1295 68.9%	1032 70.7%	781 69.0%	500 67.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q33a. About how many light bulbs are used outside your home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	166 2.9%	58 6.1%	36 1.7%	39 2.7%	33 2.7%	68 10.1%	42 2.1%	13 0.8%	8 0.8%	114 2.9%	21 1.4%	9 3.8%	18 1.0%	31 2.0%	17 1.5%	15 2.3%
TOTAL ANSWER	**6100 100.0%**	**961 100.0%**	**2284 100.0%**	**1633 100.0%**	**1196 100.0%**	**664 100.0%**	**2102 100.0%**	**1469 100.0%**	**1374 100.0%**	**4060 100.0%**	**1561 100.0%**	**409 100.0%**	**1968 100.0%**	**1572 100.0%**	**1193 100.0%**	**768 100.0%**
Less than six	4543 79.5%	818 87.2%	1651 78.4%	1189 78.5%	867 76.4%	615 93.1%	1773 87.4%	1057 78.2%	758 60.7%	3120 82.1%	1083 73.1%	280 72.2%	1553 82.0%	1164 78.7%	740 68.1%	525 74.1%
6-10	1175 15.9%	118 10.7%	479 16.5%	325 16.4%	251 18.6%	41 5.8%	263 10.4%	340 18.2%	426 27.8%	712 14.0%	367 21.0%	90 19.3%	346 15.2%	323 17.3%	309 22.1%	165 18.1%
11-15	248 3.1%	11 1.0%	107 3.7%	81 3.5%	46 3.0%	1 0.2%	48 1.7%	45 2.3%	124 7.7%	147 2.6%	73 3.8%	25 5.6%	44 2.0%	59 2.6%	91 6.6%	50 4.8%
16 or more	134 1.5%	14 1.1%	47 1.4%	38 1.6%	32 2.0%	7 0.9%	18 0.5%	27 1.3%	66 3.8%	81 1.3%	38 2.1%	14 2.9%	25 0.8%	26 1.4%	53 3.2%	28 3.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q33b. How many of these are Compact Fluorescent Light (CFL) bulbs?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	412 6.4%	83 8.3%	139 5.6%	118 6.8%	71 5.5%	81 11.0%	128 5.9%	62 3.9%	53 3.6%	314 7.0%	58 4.2%	16 3.5%	99 4.5%	101 6.0%	60 5.0%	54 6.9%
TOTAL ANSWER	**5854 100.0%**	**936 100.0%**	**2181 100.0%**	**1554 100.0%**	**1158 100.0%**	**651 100.0%**	**2016 100.0%**	**1420 100.0%**	**1329 100.0%**	**3860 100.0%**	**1524 100.0%**	**402 100.0%**	**1887 100.0%**	**1502 100.0%**	**1150 100.0%**	**729 100.0%**
1%-25%	1135 18.1%	211 19.9%	406 17.7%	282 17.7%	231 18.2%	138 20.8%	383 17.1%	293 19.3%	218 15.9%	736 17.7%	312 19.8%	77 17.4%	421 21.3%	286 18.2%	218 18.5%	112 14.0%
26%-50%	422 6.7%	49 5.0%	184 7.8%	108 6.1%	80 6.5%	25 3.7%	104 4.5%	117 8.0%	146 10.8%	242 6.0%	140 8.1%	38 9.2%	152 8.0%	103 6.6%	97 7.3%	53 6.6%
51%-75%	279 4.9%	41 4.0%	91 4.2%	83 5.5%	63 6.2%	8 1.6%	86 5.0%	90 6.1%	84 6.0%	169 4.5%	86 6.1%	22 5.4%	94 4.9%	72 5.3%	56 5.0%	41 5.6%
76%-100%	894 16.5%	123 13.3%	373 18.6%	235 16.8%	158 14.8%	72 10.8%	301 15.7%	249 20.0%	233 19.1%	530 15.4%	274 19.2%	85 19.6%	268 15.4%	217 15.8%	184 17.1%	144 21.6%
None	3124 53.8%	512 57.8%	1127 51.7%	846 53.9%	626 54.3%	408 63.1%	1142 57.7%	671 46.6%	648 48.2%	2183 56.4%	712 46.8%	180 48.4%	952 50.4%	824 54.1%	595 52.1%	379 52.2%
Total having CFL bulbs outdoors	2730 46.2%	725 80.1%	1775 82.3%	1272 82.3%	927 81.8%	513 79.2%	1633 82.9%	1127 80.7%	1111 84.1%	3124 82.3%	1212 80.2%	325 82.6%	1466 78.7%	1216 81.8%	932 81.5%	617 86.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q33c. How many of these are Light Emitting Diode (LED) bulbs?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	483	99	173	121	88	101	167	59	64	349	86	22	123	121	74	51
	7.5%	9.3%	7.0%	7.2%	7.2%	13.4%	7.3%	4.3%	4.4%	8.1%	5.1%	4.7%	5.5%	6.9%	6.9%	6.7%
TOTAL ANSWER	**5783**	**920**	**2147**	**1551**	**1141**	**631**	**1977**	**1423**	**1318**	**3825**	**1496**	**396**	**1863**	**1482**	**1136**	**732**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
1%-25%	891	160	315	248	165	86	316	218	195	600	218	65	297	231	175	107
	14.3%	16.9%	13.8%	13.7%	13.7%	12.9%	14.5%	13.6%	14.2%	14.4%	13.8%	15.1%	15.1%	14.9%	14.7%	12.8%
26%-50%	330	51	134	84	60	16	71	98	125	187	112	29	119	70	88	42
	5.1%	5.0%	5.4%	5.0%	4.8%	2.2%	3.4%	6.3%	8.7%	4.6%	6.3%	7.1%	6.4%	4.1%	6.6%	5.4%
51%-75%	213	20	91	55	47	3	63	52	75	124	69	20	68	52	45	41
	3.4%	1.6%	4.0%	3.3%	4.1%	0.5%	3.1%	3.5%	5.4%	2.9%	4.7%	4.5%	3.6%	3.4%	3.7%	5.0%
76%-100%	750	93	275	211	165	47	214	190	241	452	239	52	234	190	150	139
	13.1%	10.8%	12.3%	14.1%	15.0%	8.4%	11.6%	13.4%	18.1%	11.5%	16.9%	15.5%	13.3%	13.0%	13.4%	17.9%
None	3599	596	1332	953	704	479	1313	865	682	2462	858	230	1145	939	678	403
	64.1%	65.7%	64.5%	63.9%	62.4%	76.0%	67.4%	63.2%	53.6%	66.6%	58.3%	57.8%	61.6%	64.6%	61.6%	58.9%
Total having LED bulbs outdoors	2184	760	1832	1303	976	545	1661	1205	1123	3225	1278	331	1566	1251	961	625
	35.9%	83.1%	86.2%	86.3%	86.3%	87.1%	85.5%	86.4%	85.8%	85.6%	86.2%	84.9%	84.9%	85.0%	85.3%	87.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

LIGHTING...Q34. How many electric post lanterns do you use?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	208 3.2%	47 4.4%	61 2.3%	61 3.6%	39 3.2%	42 6.0%	76 3.2%	25 1.6%	22 1.4%	143 3.2%	34 2.3%	9 2.4%	55 2.5%	56 3.3%	31 2.5%	21 2.7%
TOTAL ANSWER	**6058** **100.0%**	**972** **100.0%**	**2259** **100.0%**	**1611** **100.0%**	**1190** **100.0%**	**690** **100.0%**	**2068** **100.0%**	**1457** **100.0%**	**1360** **100.0%**	**4031** **100.0%**	**1548** **100.0%**	**409** **100.0%**	**1931** **100.0%**	**1547** **100.0%**	**1179** **100.0%**	**762** **100.0%**
One	636 9.2%	119 10.8%	223 8.1%	164 9.1%	124 10.2%	66 8.8%	212 8.6%	160 10.1%	149 9.8%	423 9.1%	161 9.6%	48 10.4%	243 10.9%	203 12.0%	109 9.0%	43 5.1%
Two	96 1.4%	14 1.1%	31 1.3%	29 1.7%	20 1.5%	15 2.0%	22 0.9%	24 1.4%	24 1.9%	62 1.4%	24 1.4%	8 2.0%	26 1.0%	27 1.5%	24 2.2%	10 1.4%
Three or more	63 0.9%	7 0.7%	23 0.9%	19 0.8%	13 0.9%	7 1.1%	11 0.3%	15 1.0%	26 1.6%	43 0.8%	16 1.1%	4 0.9%	15 0.5%	20 0.7%	15 1.2%	9 1.4%
None	5263 88.5%	832 87.4%	1982 89.7%	1399 88.4%	1033 87.4%	602 88.1%	1823 90.2%	1258 87.5%	1161 86.7%	3503 88.7%	1347 87.9%	349 86.7%	1647 87.6%	1297 85.8%	1031 87.6%	700 92.1%
Total having electric post lantern	795 11.5%	140 12.6%	277 10.3%	212 11.6%	157 12.6%	88 11.9%	245 9.8%	199 12.5%	199 13.3%	528 11.3%	201 12.1%	60 13.3%	284 12.4%	250 14.3%	148 12.4%	62 7.9%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

YOUR HOME...Q35a. Do you have a plug-in hybrid electric vehicle (PHEV) or an all-electric vehicle?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	154	52	39	35	28	38	59	14	6	105	24	8	44	32	18	16
	2.3%	4.7%	1.8%	1.7%	1.9%	4.9%	2.5%	1.0%	0.3%	2.3%	1.3%	2.2%	2.0%	1.8%	1.8%	1.8%
TOTAL ANSWER	**6112**	**967**	**2281**	**1637**	**1201**	**694**	**2085**	**1468**	**1376**	**4069**	**1558**	**410**	**1942**	**1571**	**1192**	**767**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Yes, PHEV	59	3	28	23	5	1	8	16	33	38	18	3	15	23	11	6
	1.0%	0.5%	1.3%	1.3%	0.4%	0.1%	0.5%	1.1%	2.9%	0.9%	1.5%	0.5%	1.1%	1.4%	0.9%	0.7%
Yes, all-electric	21	3	11	5	2	1	5	3	11	12	9	-	9	1	6	3
	0.4%	0.6%	0.4%	0.4%	0.1%	0.3%	0.3%	0.3%	0.8%	0.3%	0.7%	0.0%	0.6%	0.1%	0.5%	0.3%
No	6032	961	2242	1609	1194	692	2072	1449	1332	4019	1531	407	1918	1547	1175	758
	98.6%	98.9%	98.3%	98.3%	99.5%	99.6%	99.2%	98.6%	96.3%	98.8%	97.8%	99.5%	98.3%	98.5%	98.6%	99.0%
Total having PHEV or all-electric vehicle	80	6	39	28	7	2	13	19	44	50	27	3	24	24	17	9
	1.4%	1.1%	1.7%	1.8%	0.5%	0.4%	0.8%	1.4%	3.7%	1.2%	2.2%	0.5%	1.7%	1.5%	1.4%	1.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

YOUR HOME...Q35b. Do you charge your car at home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	6187 98.6%	1013 98.9%	2281 98.3%	1645 98.3%	1222 99.5%	730 99.6%	2132 99.3%	1463 98.6%	1338 96.3%	4125 98.8%	1555 97.8%	415 99.5%	1962 98.3%	1579 98.5%	1194 98.7%	774 99.0%
TOTAL ANSWER	**79 100.0%**	**6 100.0%**	**39 100.0%**	**27 100.0%**	**7 100.0%**	**2 100.0%**	**12 100.0%**	**19 100.0%**	**44 100.0%**	**49 100.0%**	**27 100.0%**	**3 100.0%**	**24 100.0%**	**24 100.0%**	**16 100.0%**	**9 100.0%**
Yes	57 64.1%	2 25.5%	32 79.2%	19 62.4%	4 40.4%	- 0.0%	6 41.6%	14 59.8%	36 79.5%	35 64.9%	19 60.9%	3 100.0%	15 53.5%	20 72.2%	14 89.9%	6 77.4%
No	22 35.9%	4 74.5%	7 20.8%	8 37.6%	3 59.6%	2 100.0%	6 58.4%	5 40.2%	8 20.5%	14 35.1%	8 39.1%	- 0.0%	9 46.5%	4 27.8%	2 10.1%	3 22.6%

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

YOUR HOME...Q35c. How many hours per day do you charge your car at home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	6209	1017	2288	1653	1225	732	2138	1468	1346	4139	1563	415	1971	1583	1196	777
	99.1%	99.7%	98.6%	99.0%	99.8%	100.0%	99.7%	99.2%	97.1%	99.2%	98.7%	99.5%	99.1%	98.9%	98.9%	99.3%
TOTAL ANSWER	**57**	**2**	**32**	**19**	**4**	**-**	**6**	**14**	**36**	**35**	**19**	**3**	**15**	**20**	**14**	**6**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**-**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
0 hours	1	-	1	-	-	-	-	-	1	-	-	1	-	-	1	-
	1.2%	0.0%	2.1%	0.0%	0.0%	-	0.0%	0.0%	1.9%	0.0%	0.0%	39.1%	0.0%	0.0%	5.3%	0.0%
1 hour	6	-	2	3	1	-	-	-	6	3	2	1	2	1	2	1
	10.9%	0.0%	5.8%	21.0%	18.1%	-	0.0%	0.0%	16.8%	11.8%	6.2%	48.0%	18.8%	4.8%	8.1%	14.7%
2 hours	4	-	2	1	1	-	1	1	2	4	-	-	1	2	-	-
	3.9%	0.0%	4.6%	1.5%	18.0%	-	11.7%	3.3%	2.6%	6.4%	0.0%	0.0%	1.5%	8.6%	0.0%	0.0%
3 hours	7	1	4	2	-	-	1	2	4	5	2	-	2	4	-	1
	17.9%	72.0%	13.7%	19.0%	0.0%	-	8.9%	27.4%	16.5%	19.8%	16.2%	0.0%	20.3%	24.2%	0.0%	37.6%
4 hours	12	1	7	3	1	-	2	4	5	8	4	-	3	3	5	1
	17.5%	28.0%	15.2%	15.0%	56.6%	-	30.4%	24.9%	12.0%	20.3%	14.2%	0.0%	15.1%	10.8%	37.5%	7.3%
5 hours	6	-	4	2	-	-	-	1	5	2	4	-	3	1	2	-
	13.8%	0.0%	16.6%	12.6%	0.0%	-	0.0%	13.3%	16.7%	8.0%	24.8%	0.0%	23.1%	3.6%	22.7%	0.0%
6 hours	8	-	5	3	-	-	-	3	5	6	1	1	-	6	1	-
	13.2%	0.0%	18.3%	7.8%	0.0%	-	0.0%	11.8%	16.3%	14.7%	10.6%	12.9%	0.0%	29.5%	4.9%	0.0%
7 hours	1	-	-	1	-	-	-	-	1	-	1	-	-	1	-	-
	1.8%	0.0%	0.0%	5.7%	0.0%	-	0.0%	0.0%	2.8%	0.0%	5.1%	0.0%	0.0%	5.9%	0.0%	0.0%
8 hours	5	-	2	3	-	-	1	1	3	3	2	-	3	-	2	-
	6.1%	0.0%	3.3%	12.8%	0.0%	-	11.9%	2.2%	6.3%	6.7%	5.5%	0.0%	7.0%	0.0%	16.7%	0.0%
9 hours	1	-	1	-	-	-	-	-	1	-	1	-	-	1	-	-
	2.4%	0.0%	4.1%	0.0%	0.0%	-	0.0%	0.0%	3.7%	0.0%	6.8%	0.0%	0.0%	7.8%	0.0%	0.0%
10 hours	2	-	2	-	-	-	1	1	-	1	1	-	1	1	-	-
	6.1%	0.0%	10.5%	0.0%	0.0%	-	37.1%	6.7%	0.0%	7.6%	4.2%	0.0%	14.2%	4.8%	0.0%	0.0%
11+ hours	4	-	2	1	1	-	-	1	3	3	1	-	-	-	1	3
	5.2%	0.0%	5.8%	4.6%	7.3%	-	0.0%	10.4%	4.4%	4.7%	6.4%	0.0%	0.0%	0.0%	4.8%	40.4%
Median:	4	3	5	4	4	-	4	4	5	4	5	1	4	5	4	3
Mean:	5.1	3.3	5.5	5.0	3.7	-	6.4	5.3	4.8	5.1	5.6	1.3	4.6	4.9	4.9	8.2
Std. Deviation:	3.84	0.71	3.03	5.04	4.99	-	3.13	2.82	4.38	4.29	2.91	3.21	2.71	2.33	3.15	8.57
Std. Error:	0.51	0.50	0.54	1.16	2.50	-	1.28	0.75	0.73	0.73	0.67	1.86	0.70	0.52	0.84	3.50

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

YOUR HOME...Q36. Do you generate any of your own electricity?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North- west	North- east	< $20K	$20K- $59K	$60K- $99K	$100K+	1-2	3-4	5+	< 1960	1960- 1979	1980- 1999	2000- present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	122 1.8%	34 3.0%	33 1.5%	27 1.2%	28 2.3%	29 3.8%	38 1.6%	16 0.9%	4 0.3%	72 1.6%	21 1.3%	6 1.8%	33 1.5%	23 1.3%	18 1.6%	9 1.0%
TOTAL ANSWER	**6144 100.0%**	**985 100.0%**	**2287 100.0%**	**1645 100.0%**	**1201 100.0%**	**703 100.0%**	**2106 100.0%**	**1466 100.0%**	**1378 100.0%**	**4102 100.0%**	**1561 100.0%**	**412 100.0%**	**1953 100.0%**	**1580 100.0%**	**1192 100.0%**	**774 100.0%**
Yes, solar	49 0.8%	2 0.1%	29 1.3%	13 0.7%	5 0.4%	2 0.5%	11 0.5%	13 0.7%	15 1.2%	31 0.7%	15 0.9%	3 0.8%	14 0.8%	16 1.1%	7 0.4%	10 1.2%
Yes, wind	3 /	1 0.1%	- 0.0%	2 0.1%	- 0.0%	- 0.0%	1 /	1 0.1%	1 0.1%	2 /	1 0.1%	- 0.0%	1 /	2 0.1%	- 0.0%	- 0.0%
Yes, fuel cell	9 0.1%	2 0.3%	3 0.1%	2 /	2 0.1%	2 0.3%	2 0.1%	2 /	2 0.1%	5 0.1%	3 0.2%	1 0.2%	4 0.2%	3 0.1%	1 /	- 0.0%
No	6083 99.1%	980 99.5%	2255 98.6%	1628 99.2%	1194 99.5%	699 99.2%	2092 99.4%	1450 99.2%	1360 98.6%	4064 99.2%	1542 98.8%	408 99.0%	1934 99.0%	1559 98.7%	1184 99.6%	764 98.8%
Total generating own electricity	61 0.9%	5 0.5%	32 1.4%	17 0.8%	7 0.5%	4 0.8%	14 0.6%	16 0.8%	18 1.4%	38 0.8%	19 1.2%	4 1.0%	19 1.0%	21 1.3%	8 0.4%	10 1.2%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

YOUR HOME...Q37. Do you plan to generate any of your own electricity in the next 5 years?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	163 2.3%	46 4.0%	48 1.9%	42 2.2%	27 2.1%	37 4.2%	51 2.0%	19 1.1%	14 1.1%	99 2.1%	29 1.9%	10 1.9%	52 2.4%	35 2.0%	18 1.3%	16 1.6%
TOTAL ANSWER	**6103 100.0%**	**973 100.0%**	**2272 100.0%**	**1630 100.0%**	**1202 100.0%**	**695 100.0%**	**2093 100.0%**	**1463 100.0%**	**1368 100.0%**	**4075 100.0%**	**1553 100.0%**	**408 100.0%**	**1934 100.0%**	**1568 100.0%**	**1192 100.0%**	**767 100.0%**
Yes, solar	469 8.8%	78 8.9%	203 10.3%	119 8.4%	64 6.0%	40 6.4%	127 7.2%	148 11.8%	128 10.5%	272 7.9%	155 11.0%	38 10.1%	176 10.9%	117 8.6%	81 7.5%	62 9.2%
Yes, wind	58 0.9%	7 0.7%	20 0.6%	13 1.0%	18 1.4%	3 0.4%	17 0.8%	25 1.6%	13 0.8%	31 0.7%	18 1.3%	8 1.5%	24 1.2%	13 0.8%	10 0.9%	9 0.9%
Yes, fuel cell	29 0.4%	4 0.5%	9 0.3%	11 0.5%	5 0.4%	- 0.0%	15 0.7%	5 0.2%	9 0.6%	17 0.3%	8 0.7%	4 0.8%	6 0.3%	9 0.5%	7 0.5%	5 0.5%
No	5547 89.9%	884 89.9%	2040 88.8%	1487 90.1%	1115 92.2%	652 93.2%	1934 91.3%	1285 86.4%	1218 88.1%	3755 91.1%	1372 87.0%	358 87.6%	1728 87.6%	1429 90.1%	1094 91.1%	691 89.4%
Total planning to generate own electricity	556 10.1%	89 10.1%	232 11.2%	143 9.9%	87 7.8%	43 6.7%	159 8.7%	178 13.6%	150 11.9%	320 8.9%	181 13.0%	50 12.4%	206 12.4%	139 9.9%	98 8.9%	76 10.6%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

YOUR HOME...Q38. What type of structure is this home?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	65	14	21	16	14	17	16	5	4	34	13	2	13	11	6	6
	0.9%	1.2%	0.9%	0.7%	1.0%	2.1%	0.5%	0.4%	0.2%	0.6%	1.1%	0.3%	0.6%	0.5%	0.5%	0.8%
TOTAL ANSWER	**6201**	**1005**	**2299**	**1656**	**1215**	**715**	**2128**	**1477**	**1378**	**4140**	**1569**	**416**	**1973**	**1592**	**1204**	**777**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Single family home (ranch)	2194	279	745	612	549	197	851	607	348	1509	550	112	907	692	303	173
	33.2%	27.0%	30.1%	36.0%	41.4%	25.4%	36.3%	38.6%	23.9%	34.0%	33.2%	24.6%	46.4%	40.3%	22.1%	19.9%
Single family home (2 or more stories)	2514	484	945	674	401	191	629	592	878	1415	820	258	927	582	541	332
	36.0%	43.4%	35.3%	35.2%	31.7%	23.3%	26.5%	35.5%	60.7%	29.7%	49.3%	60.0%	44.4%	33.0%	39.9%	38.0%
Mobile home	149	3	63	31	52	39	84	18	3	102	34	12	2	17	83	37
	2.2%	0.4%	2.6%	1.6%	3.9%	4.5%	3.2%	1.2%	0.3%	2.2%	2.0%	3.1%	0.1%	1.2%	6.7%	4.2%
Apartment	549	109	227	139	73	173	241	85	27	461	64	12	41	116	71	49
	13.5%	14.1%	15.6%	13.3%	8.8%	29.1%	16.6%	10.7%	3.3%	16.4%	6.7%	4.3%	3.0%	11.3%	9.9%	9.6%
Townhouse (attached)	136	26	61	36	10	32	47	31	19	94	32	7	13	51	19	23
	2.9%	3.4%	3.4%	3.1%	1.1%	5.5%	2.6%	3.0%	2.2%	2.8%	3.1%	3.3%	1.0%	4.0%	2.3%	4.5%
Two family duplex or flat	99	56	22	9	11	25	44	17	10	72	15	6	37	10	7	6
	1.9%	6.3%	1.1%	0.6%	1.4%	3.5%	2.6%	1.2%	0.9%	2.1%	1.0%	2.1%	2.4%	0.7%	0.7%	0.6%
Condominium	481	29	208	144	98	40	194	116	88	428	42	6	18	113	171	150
	8.9%	3.2%	10.6%	9.4%	9.9%	6.0%	10.3%	9.0%	8.2%	11.2%	3.9%	1.6%	1.1%	8.8%	17.6%	22.1%
Cottage or cabin	11	-	4	2	5	-	8	1	2	11	-	-	4	1	1	-
	0.2%	0.0%	0.2%	0.2%	0.4%	0.0%	0.4%	/	0.2%	0.3%	0.0%	0.0%	0.2%	0.1%	0.1%	0.0%
Other	68	19	24	9	16	18	30	10	3	48	12	3	24	10	8	7
	1.2%	2.2%	1.1%	0.6%	1.4%	2.7%	1.5%	0.8%	0.3%	1.3%	0.8%	1.0%	1.4%	0.6%	0.7%	1.1%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Source: 2016 Residential Customer Appliance Saturation Study

Ipsos RDA

YOUR HOME...Q39. What year was your residence built?

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	93	36	21	22	14	35	21	3	3	57	10	5	-	-	-	-
	1.4%	3.1%	0.9%	1.2%	1.2%	4.5%	0.9%	0.2%	0.2%	1.3%	0.5%	1.5%	0.0%	0.0%	0.0%	0.0%
TOTAL ANSWER	**6173**	**983**	**2299**	**1650**	**1215**	**697**	**2123**	**1479**	**1379**	**4117**	**1572**	**413**	**1986**	**1603**	**1210**	**783**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2010-present	175	18	80	46	29	15	34	35	78	103	56	16	-	-	-	175
	3.2%	2.5%	3.5%	3.2%	2.8%	2.6%	1.7%	2.8%	6.5%	2.7%	4.4%	4.8%	0.0%	0.0%	0.0%	26.2%
2000-2009	608	27	315	123	140	38	140	152	235	361	172	66	-	-	-	608
	8.9%	2.8%	12.2%	6.5%	11.2%	4.6%	6.1%	9.6%	16.5%	7.9%	10.6%	13.6%	0.0%	0.0%	0.0%	73.8%
1990-1999	684	21	315	164	184	47	176	168	235	431	197	50	-	-	684	-
	9.7%	2.1%	12.1%	8.4%	13.7%	5.9%	7.8%	9.5%	15.5%	9.1%	11.1%	12.0%	0.0%	0.0%	55.0%	0.0%
1980-1989	526	25	203	167	128	35	156	150	141	380	108	35	-	-	526	-
	7.9%	2.2%	8.4%	9.6%	9.6%	5.5%	7.2%	9.1%	9.2%	8.4%	6.6%	8.4%	0.0%	0.0%	45.0%	0.0%
1970-1979	871	42	379	280	165	76	297	224	186	594	217	52	-	871	-	-
	13.7%	4.4%	15.9%	16.1%	13.7%	11.3%	13.6%	14.8%	13.0%	13.8%	13.6%	12.9%	0.0%	53.9%	0.0%	0.0%
1960-1969	732	70	266	268	121	64	275	183	138	504	178	38	-	732	-	-
	11.7%	6.4%	11.8%	15.8%	9.9%	9.1%	12.6%	12.2%	10.4%	11.9%	11.6%	8.8%	0.0%	46.1%	0.0%	0.0%
1950-1959	1008	231	321	267	187	101	398	253	182	682	262	56	1008	-	-	-
	15.9%	21.9%	13.8%	16.0%	15.2%	13.6%	17.1%	16.6%	14.3%	16.5%	15.3%	13.1%	49.6%	0.0%	0.0%	0.0%
1940-1949	409	167	88	93	61	62	166	108	51	290	100	15	409	-	-	-
	6.8%	17.0%	3.9%	5.9%	5.0%	8.5%	7.6%	7.9%	3.8%	7.3%	6.3%	2.8%	21.2%	0.0%	0.0%	0.0%
1930-1939	154	63	43	27	20	16	57	42	27	102	39	12	154	-	-	-
	2.3%	5.8%	1.6%	1.6%	1.5%	1.9%	2.3%	2.7%	1.8%	2.3%	2.1%	2.5%	7.1%	0.0%	0.0%	0.0%
1920-1929	227	87	48	61	31	32	79	39	49	136	64	24	227	-	-	-
	3.9%	8.5%	2.4%	4.0%	2.9%	4.1%	3.7%	3.4%	4.0%	3.5%	4.5%	6.3%	12.2%	0.0%	0.0%	0.0%
Before 1920	188	46	65	27	49	29	66	44	40	116	55	14	188	-	-	-
	3.2%	5.5%	2.9%	1.6%	4.2%	4.1%	3.4%	3.0%	2.7%	3.0%	3.7%	3.4%	9.9%	0.0%	0.0%	0.0%
Don't know	591	186	176	127	100	182	279	81	17	418	124	35	-	-	-	-
	12.8%	20.9%	11.5%	11.3%	10.3%	28.8%	16.9%	8.4%	2.3%	13.6%	10.2%	11.4%	0.0%	0.0%	0.0%	0.0%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Source: 2016 Residential Customer Appliance Saturation Study

Ipsos RDA

YOUR HOME...Q40. About how many square feet of living space does this residence contain?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample	Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	123	45	36	26	16	31	43	5	5	84	13	4	38	15	9	10
	1.8%	4.1%	1.5%	1.3%	1.4%	4.3%	1.8%	0.2%	0.4%	1.9%	0.6%	0.9%	1.9%	0.8%	0.7%	1.2%
TOTAL ANSWER	**6143**	**974**	**2284**	**1646**	**1213**	**701**	**2101**	**1477**	**1377**	**4090**	**1569**	**414**	**1948**	**1588**	**1201**	**773**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Under 1,000 sq. ft.	900	179	328	230	162	212	445	161	43	739	133	21	347	225	94	33
	19.2%	20.1%	20.0%	18.9%	17.4%	32.2%	25.8%	16.3%	5.2%	23.5%	10.1%	6.0%	20.5%	19.5%	12.2%	6.6%
1,000 - 1,499 sq. ft.	1912	330	635	501	439	198	824	519	233	1348	440	100	834	512	267	159
	33.4%	34.5%	30.4%	34.2%	37.7%	27.6%	39.1%	39.1%	21.2%	35.2%	30.1%	24.7%	44.3%	34.2%	27.3%	26.5%
1,500 - 1,999 sq. ft.	1251	138	500	329	275	73	403	363	306	810	350	81	363	399	286	169
	17.9%	11.8%	19.0%	18.2%	20.1%	8.5%	15.9%	21.3%	21.9%	16.9%	20.9%	17.8%	17.0%	22.6%	20.8%	20.8%
2,000 - 2,499 sq. ft.	827	66	360	247	153	29	135	254	322	478	274	70	164	234	248	167
	10.9%	5.7%	12.6%	12.3%	10.2%	3.3%	4.8%	13.8%	21.8%	9.2%	15.0%	16.0%	6.7%	12.0%	18.5%	19.2%
2,500 - 2,999 sq. ft.	458	34	209	141	73	16	55	105	238	245	164	48	72	114	157	110
	5.9%	3.5%	7.5%	6.0%	4.8%	1.8%	2.1%	5.4%	15.7%	4.2%	9.8%	11.9%	3.3%	5.5%	10.8%	12.5%
3,000 or more sq. ft.	359	41	142	127	44	8	34	54	228	194	104	58	62	52	127	114
	4.3%	3.8%	4.5%	5.1%	3.0%	1.1%	1.4%	2.4%	13.6%	3.2%	5.5%	13.6%	2.7%	2.3%	8.3%	11.3%
Don't know	436	186	110	71	67	165	205	21	7	276	104	36	106	52	22	21
	8.4%	20.6%	6.0%	5.3%	6.8%	25.5%	10.9%	1.7%	0.6%	7.8%	8.6%	10.0%	5.5%	3.9%	2.1%	3.1%
Median (Interpolated):	1397	1283	1443	1416	1386	1092	1240	1419	2031	1320	1630	1901	1301	1417	1727	1870

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

YOUR HOME...Q41. How many people presently live in this household?

	Total Sample	Region				Income				Persons in Household			Year Residence was Built			
		Detroit	West	North-west	North-east	< $20K	$20K-$59K	$60K-$99K	$100K+	1-2	3-4	5+	< 1960	1960-1979	1980-1999	2000-present
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	92	32	24	24	12	20	12	3	3	-	-	-	19	20	9	9
	1.3%	2.8%	1.0%	1.1%	1.0%	2.7%	0.6%	0.3%	0.2%	0.0%	0.0%	0.0%	1.0%	1.1%	0.7%	1.2%
TOTAL ANSWER	**6174**	**987**	**2296**	**1648**	**1217**	**712**	**2132**	**1479**	**1379**	**4174**	**1582**	**418**	**1967**	**1583**	**1201**	**774**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
One	1592	318	564	416	290	360	744	286	92	1592	-	-	512	409	268	124
	31.7%	37.8%	30.6%	31.1%	29.7%	54.1%	41.0%	25.8%	8.2%	44.9%	0.0%	0.0%	31.7%	31.8%	28.2%	20.2%
Two	2582	332	995	721	524	184	861	680	604	2582	-	-	814	689	543	340
	38.9%	30.8%	40.2%	40.7%	40.9%	23.1%	36.6%	43.1%	44.6%	55.1%	0.0%	0.0%	39.8%	39.7%	41.5%	41.5%
Three	908	171	318	233	181	83	272	238	255	-	908	-	324	223	162	110
	13.6%	15.6%	12.7%	13.7%	13.0%	10.8%	11.9%	14.7%	17.9%	0.0%	57.5%	0.0%	14.2%	13.3%	12.8%	15.0%
Four	674	90	260	184	137	45	139	166	290	-	674	-	196	172	143	118
	10.0%	9.1%	10.6%	9.6%	10.2%	6.8%	6.0%	10.4%	20.1%	0.0%	42.5%	0.0%	9.3%	10.3%	10.8%	14.5%
Five	279	43	114	68	52	28	69	68	101	-	-	279	78	59	63	57
	3.9%	4.0%	4.2%	3.4%	3.8%	3.7%	2.7%	3.7%	6.8%	0.0%	0.0%	66.9%	3.1%	3.3%	4.9%	6.4%
Six	92	21	34	11	24	9	28	27	26	-	-	92	29	22	12	20
	1.3%	1.7%	1.3%	0.7%	1.8%	0.9%	1.1%	1.7%	1.7%	0.0%	0.0%	22.3%	1.4%	1.1%	1.1%	2.0%
Seven or more	47	12	11	15	9	3	19	14	11	-	-	47	14	9	10	5
	0.6%	1.0%	0.4%	0.8%	0.6%	0.6%	0.7%	0.6%	0.7%	0.0%	0.0%	10.8%	0.5%	0.5%	0.7%	0.4%

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Source: 2016 Residential Customer Appliance Saturation Study

Ipsos RDA

YOUR HOME...Q42. What age is the head of the household?

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266	1019	2320	1672	1229	732	2144	1482	1382	4174	1582	418	1986	1603	1210	783
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DON'T KNOW/NO ANSWER	199	47	66	55	31	26	33	13	7	120	21	3	42	53	31	21
	2.1%	3.0%	1.9%	2.2%	1.8%	2.1%	1.0%	0.6%	0.4%	1.8%	1.0%	0.6%	1.4%	2.3%	1.9%	1.9%
TOTAL ANSWER	**6067**	**972**	**2254**	**1617**	**1198**	**706**	**2111**	**1469**	**1375**	**4054**	**1561**	**415**	**1944**	**1550**	**1179**	**762**
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
34 or younger	646	81	274	186	100	61	225	215	137	386	205	51	186	138	95	87
	19.6%	14.9%	21.9%	22.9%	14.3%	15.3%	19.6%	26.8%	18.4%	18.5%	23.6%	17.2%	17.1%	16.6%	15.1%	20.2%
35 - 44	749	121	283	213	127	66	195	207	260	258	362	127	240	181	114	127
	15.1%	15.2%	15.3%	15.8%	13.2%	10.9%	11.6%	17.2%	23.8%	9.2%	27.2%	36.4%	14.9%	15.6%	12.1%	19.1%
45 - 54	1121	188	423	286	220	105	275	285	394	526	452	136	371	247	230	170
	17.9%	19.4%	17.8%	16.7%	18.7%	14.7%	14.0%	18.3%	26.8%	14.4%	25.7%	29.4%	19.2%	15.5%	20.3%	19.4%
55 - 64	1532	268	551	384	321	209	484	379	368	1136	332	57	554	380	312	164
	19.4%	22.5%	18.4%	17.5%	21.4%	24.6%	18.1%	19.0%	19.0%	22.0%	14.4%	9.5%	22.3%	19.6%	20.9%	16.1%
65 or older	2019	314	723	548	430	265	932	383	216	1748	210	44	593	604	428	214
	28.0%	28.0%	26.6%	27.1%	32.4%	34.5%	36.7%	18.7%	12.0%	35.9%	9.1%	7.5%	26.5%	32.7%	31.6%	25.2%
Median:	53	55	52	52	57	58	58	48	47	59	44	43	54	56	56	50
Mean:	52.8	54.1	51.7	51.7	55.5	56.7	55.2	48.5	47.9	55.8	45.6	45.2	53.3	54.5	54.9	51.4

NOTE: Data is weighted by kilowatt hour usage and age.
NOTE: / represents percent less than .05

YOUR HOME...Q43. Please indicate your total household income, including Social Security, pensions, wages and salaries.

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	526 6.9%	66 5.5%	204 7.2%	148 6.6%	107 8.0%	- 0.0%	- 0.0%	- 0.0%	- 0.0%	363 7.1%	94 4.9%	15 3.3%	145 6.6%	160 8.1%	102 7.1%	56 6.1%
TOTAL ANSWER	**5740 100.0%**	**953 100.0%**	**2116 100.0%**	**1524 100.0%**	**1122 100.0%**	**732 100.0%**	**2144 100.0%**	**1482 100.0%**	**1382 100.0%**	**3811 100.0%**	**1488 100.0%**	**403 100.0%**	**1841 100.0%**	**1443 100.0%**	**1108 100.0%**	**727 100.0%**
Under $19,999	732 14.0%	270 30.6%	179 9.5%	137 9.3%	140 14.4%	732 100.0%	- 0.0%	- 0.0%	- 0.0%	544 15.1%	128 10.1%	40 11.9%	240 13.5%	140 11.0%	82 8.8%	53 8.0%
$20,000 - $39,999	1128 21.0%	246 27.2%	328 17.1%	274 18.7%	279 26.8%	- 0.0%	1128 53.2%	- 0.0%	- 0.0%	857 23.5%	199 14.2%	62 17.3%	402 22.1%	295 21.9%	147 14.6%	80 11.4%
$40,000 - $59,999	1016 18.4%	155 16.6%	363 18.6%	253 17.6%	242 21.1%	- 0.0%	1016 46.8%	- 0.0%	- 0.0%	748 20.2%	212 15.3%	54 12.4%	364 19.7%	277 19.3%	185 19.2%	94 14.0%
$60,000 - $79,999	848 15.1%	107 10.3%	318 15.7%	241 16.7%	178 15.9%	- 0.0%	- 0.0%	848 58.7%	- 0.0%	572 15.7%	210 13.7%	64 13.8%	283 16.3%	234 16.3%	181 15.8%	93 13.1%
$80,000 - $99,999	634 10.6%	50 4.6%	279 12.6%	190 12.7%	114 9.2%	- 0.0%	- 0.0%	634 41.3%	- 0.0%	394 9.7%	194 13.3%	45 12.3%	203 10.8%	173 11.7%	137 11.8%	94 13.4%
$100,000 - $149,999	839 13.0%	81 6.9%	388 16.6%	248 14.8%	120 8.9%	- 0.0%	- 0.0%	- 0.0%	839 62.3%	443 10.6%	318 19.3%	77 18.4%	238 12.3%	199 12.8%	220 17.6%	164 20.6%
$150,000 - $249,999	420 6.2%	31 2.6%	204 7.8%	138 8.1%	42 3.2%	- 0.0%	- 0.0%	- 0.0%	420 29.7%	196 4.1%	178 11.5%	45 9.7%	92 4.5%	106 6.1%	118 9.1%	102 13.9%
$250,000 or over	123 1.7%	13 1.2%	57 2.1%	43 2.1%	7 0.5%	- 0.0%	- 0.0%	- 0.0%	123 8.0%	57 1.1%	49 2.6%	16 4.2%	19 0.8%	19 0.9%	38 3.1%	47 5.6%
Median (Interpolated):	56340	34248	66121	65151	48330	10000	38787	77032	140103	51310	75155	72208	54526	57669	69346	85204

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

DTE Energy

Ipsos RDA

Customer Annual KWH

		Region				Income				Persons in Household			Year Residence was Built			
	Total Sample A	Detroit B	West C	North-west D	North-east E	< $20K F	$20K-$59K G	$60K-$99K H	$100K+ I	1-2 J	3-4 K	5+ L	< 1960 M	1960-1979 N	1980-1999 O	2000-present P
SAMPLE SIZE	6266 100.0%	1019 100.0%	2320 100.0%	1672 100.0%	1229 100.0%	732 100.0%	2144 100.0%	1482 100.0%	1382 100.0%	4174 100.0%	1582 100.0%	418 100.0%	1986 100.0%	1603 100.0%	1210 100.0%	783 100.0%
DON'T KNOW/NO ANSWER	2 /	- 0.0%	- 0.0%	- 0.0%	1 0.1%	1 0.1%	1 /	- 0.0%	- 0.0%	2 /	- 0.0%	- 0.0%	- 0.0%	1 /	- 0.0%	1 0.1%
TOTAL ANSWER	**6264 100.0%**	**1019 100.0%**	**2320 100.0%**	**1672 100.0%**	**1228 100.0%**	**731 100.0%**	**2143 100.0%**	**1482 100.0%**	**1382 100.0%**	**4172 100.0%**	**1582 100.0%**	**418 100.0%**	**1986 100.0%**	**1602 100.0%**	**1210 100.0%**	**782 100.0%**
Under 6,000	2407 58.7%	468 65.5%	873 57.8%	635 59.8%	406 52.3%	427 74.6%	1035 68.5%	490 55.8%	261 35.6%	2007 68.7%	293 36.9%	49 23.0%	776 59.4%	621 58.8%	371 50.3%	228 47.0%
6,000 - 7,499	984 15.7%	169 15.0%	355 15.5%	270 15.9%	190 16.5%	98 11.1%	350 14.7%	246 17.3%	208 18.4%	710 15.3%	239 18.8%	27 9.1%	323 15.8%	254 16.3%	187 16.7%	135 18.6%
7,500 - 8,499	619 4.9%	98 4.9%	232 4.9%	163 4.7%	126 5.5%	55 3.5%	195 4.1%	163 5.6%	144 6.1%	392 4.2%	174 6.6%	47 7.8%	202 5.2%	148 4.5%	132 6.0%	87 6.1%
8,500 - 9,999	758 2.6%	113 2.2%	261 2.5%	215 2.6%	169 3.1%	51 1.3%	226 1.9%	210 3.0%	209 3.6%	438 2.0%	259 4.0%	53 3.5%	236 2.5%	198 2.6%	170 3.2%	97 3.0%
10,000 or more	1496 18.1%	171 12.4%	599 19.3%	389 17.0%	337 22.6%	100 9.5%	337 10.8%	373 18.3%	560 36.3%	625 9.8%	617 33.7%	242 56.6%	449 17.1%	381 17.8%	350 23.8%	235 25.3%
Mean (Thousands):	6534	5889	6641	6495	7071	5076	5720	6590	8721	5571	8493	10485	6524	6486	7308	7524

NOTE: Data is weighted by kilowatt hour usage and age.

NOTE: / represents percent less than .05

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DTE Energy Residential Baseline Study: First Quarter 2013

Prepared for:
DTE Energy

DTE Energy

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September 2, 2013

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E. Executive Summary

E1. Study Objectives

The objective of this baseline study is to characterize existing residential building and equipment stocks that use electricity and natural gas within DTE Energy's (DTE's) service territory as well as current residential customer equipment purchase patterns and preferences. To that end, Navigant conducted market research to collect information regarding:

- The saturation, penetration and characteristics of residential end use energy technologies (e.g., lighting; heating, ventilation and air conditioning (HVAC); and appliances) and technologies or systems which influence energy use (e.g., building envelope and control systems).
- The saturation levels and characteristics of energy efficient equipment and building and other systems which improve efficiency (e.g., insulation and setback thermostats).
- Document operating practices with respect to the energy-consuming equipment (e.g., information such as operating hours, temperature settings, etc.).
- Current market shares of key energy efficient products.

E2. Study Methods

In consultation with DTE, Navigant developed a series of research questions to address the research objectives listed above. Two approaches were taken to collect data for the study. The main work stream involved an assessment of existing stock of buildings and equipment served by DTE Energy. As part of this stream, Navigant identified a representative sample of DTE customers and inventoried the energy-consuming equipment and systems which affect key energy uses, with a focus on those measures and building types which have the greatest relevance to energy efficiency.

Navigant's second work-stream involved trade ally interviews to assess current market conditions and related matters. Navigant's objective was to maximize benefits to DTE by ensuring baseline data can immediately be incorporated into program planning, marketing and delivery services as well as provide an update to the baselines developed by Opinion Dynamics in their 2009 report. The Navigant team worked with DTE to determine the applicable measures, building types, and market information that would provide the most relevant and meaningful data for DTE and for any future potential study.

The on-site survey sample was designed to provide a representative sample of DTE Energy residential customers and to achieve a 90% confidence interval +/- 10% precision at the sector level and 90% confidence +/- 20% precision within each of the sampling segments. Customer data for all residential customers was collected from DTE Energy's billing and Customer Information System.

Navigant developed its final sampling plan to provide a segmentation reflecting characteristics identified as being of value to DTE. Table ES-1 shows the characteristics selected for segmentation.

Table ES-1: Segmentation/Stratification

Segment	Residential
Building Type	Single Family Multi-Family
Geographic	Urban/Rural
Size	Large/Small

In addition, information obtained from DTE allowed the identification of service type for each customer (i.e., customers who only receive gas service only from DTE Energy, those who only receive electric service and those who receive both electric and gas service – referred to as combo customers). The actual sample matrix showing the number of customers per segment is shown in Table 4 of the main report. The segments used in the study are defined more fully in section 2.3.1 of the report.

Navigant surveyed and interviewed residential customers as part of the on-site visits and conducted trade ally and retailer interviews in order collect baseline data. The on-site survey instrument is presented in Appendix B.

On-site surveys were completed to collect information from a sample of 133 residential customers. The focus of the on-site data collection was on structure and equipment characteristics as well as some information on operating practices. Information relating to 'captive electric'[1] equipment was not collected in homes where DTE did not supply electricity (i.e. homes where DTE Energy only provided gas service). Information was collected in "gas only" homes on equipment which can use multiple energy sources, such as stoves and clothes dryers.

Information from each site surveyed as part of the baseline was assigned a weight based on the characteristics of each site relative to the population of DTE's customers as a whole. This allows the results for the sites surveyed to be extended to represent the entire customer base within the error limits discussed above. The results of the survey presented in the following section are presented on a "weighted" basis unless otherwise noted.

[1] Captive electric loads are those end uses which are only supplied by electricity, such as lighting, home electronics, etc.; where the use of natural gas is not normally a choice.

To gain a more comprehensive understanding of the market for high-efficiency equipment as it is unfolding through current transactions in the marketplace and to gain insight into market trends, Navigant also conducted in-depth interviews with market actors, including:

- Ten participating residential HVAC and water heating system contractors
- Representatives from four companies participating in the residential lighting component of the ENERGY STAR® Products program:[2]
    - 3 manufacturers working with national retail chains
    - 2 regional retailers
    - 1 national retail chain
- Representatives from three retailers participating in the non-lighting component of the ENERGY STAR® Products program (2 national, 1 regional)

Navigant asked interviewees across all technologies to estimate what percentage of their total sales comprise high-efficiency units, moderately-efficient units, and minimally code-compliant units. They were also asked questions about what level of efficiency they consider to be current industry standard practice when new equipment is specified for installation, and what changes are likely to unfold in the marketplace during the next few years.

Detailed data on market share for consumer electronics (through April 2012) are presented in a white paper on DTE Energy's pilot ENERGY STAR® Consumer Electronics program completed in June, 2012. Data presented for consumer electronics in this report are excerpted from that paper.

Market share data are presented as "likely ranges," reflecting the limited precision in the data collected.[3]

[2] Only 4 of the 6 lighting trade ally respondents provided market share data.
[3] The upper and lower bounds of the ranges reflect: 1) averages weighted by level of program participation and 2) un-weighted averages. This reflects that some respondents' perspectives may warrant greater weight based on their level of involvement in the program, but recognizes that program participation is an imperfect predictor of knowledge of the market. All HVAC contractors indicated that they hold a high level of expertise in the market.

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E3. Key Findings

Key findings of the report are listed below.

- Natural gas dominates most heating applications within DTE's service territory, including space heating (>90%), water heating (over 80%) and to a lesser extent cooking (50-60%) and clothes drying (56%). The table below summarizes the market share (percent of homes) for natural gas in various residential heating applications found in the prior and current baseline studies.

Table ES-2: Market Share of Heating Applications for Natural Gas

Application	2009 Baseline	2013 Baseline
Space Heating	94%	93%*
Water Heating	89%	82%
Oven	48%	60%
Range/Stove	45%	50%
Clothes Dryer (heat source)	62%	56%

**includes both primary and secondary heating systems.*

- Energy efficient equipment penetrations and saturations have increased since the last (2009) baseline:
  - The penetration of high efficiency furnaces has grown from about 12% to 31%; primarily in the replacement market.
  - CFL lights are now present in 85% of homes (up from 68% in 2009) and the average number per home has increased from 6.6 reported in the last baseline to over 13 CFLs in the average home.
  - Front-loading clothes washers have increased their share of in-home laundry equipment from 14% of homes in 2009 to 22% in 2013.
- While not as easy to quantify, the number and diversity of home electronics also appears to have increased. The type of equipment found in homes has changed (fewer VCR's for example) but the variety has increased overall. The number of desktop computer systems appears to have decreased while the penetration of laptop computers has increased.

- Information collected on equipment operation also indicates some interesting trends:
  - As CFLs are installed, it appears that they are preferentially used in high lighting hour applications. Navigant's estimate of lighting hours indicates that CFLs represent a disproportionate share of lighting hours compared to their share of household lamps. CFLs account for about 25.7% of the bulbs in an average home, but 33.4% of lighting hours.
  - It appears that messages to conserve energy by using cold or warm water wash have been successful. Customers report that they use cold or warm water wash for 79% of their laundry.
  - By contrast, the survey found that while 65% of homes with natural gas heating surveyed had a programmable thermostat, just 13% used daytime temperature setback and 24% set temperatures back at night.
  - Questions regarding cooking behaviors found that 37% of households cook 50% or more of their meals in their microwaves.
  - While the number of LED fixtures has increased since the last baseline study, the majority (67%) of LEDs found were used at nightlights.

Market Activity and Trends

Highlights in residential HVAC market activity include the following:

- Installation of high-efficiency (over 90% AFUE) equipment is most common in the market for natural gas furnaces (70% - 86% market share). The majority of natural gas boilers installed are also high-efficiency units (54% - 58% market share). In the market for central air conditioners, sales of high-efficiency units only account for 33% to 45% of the market.
- Installation of moderately-efficient units is uncommon across all three technologies. This may reflect that the program plays an important role in driving efficiency improvements and defining what the market deems to be "efficient;" it appears that if there is an interest in pursuing higher-efficiency equipment, most will choose a rating that is eligible to receive program incentives.
- Though installation of program-eligible natural gas furnaces is already the industry standard, most trade allies expect to see further growth in this market. It appears that increased installation of furnaces with ECMs will account for some of this growth.
- Growth in the market for high-efficiency air conditioning systems is limited by low run-times; current paybacks do not appear to justify installation of equipment that exceeds 13 to 15 SEER.
- A majority of trade allies believe that 90-95% AFUE natural gas boilers are becoming the industry standard. However, the market for natural gas boilers appears to be relatively small, consisting mostly of those with existing systems and those in the new

construction market who wish to use radiant heat. It appears that the upfront cost of installing high-efficiency boilers is still prohibitively high for many, even after accounting for the program rebate.

- Most (8 out of 10) trade allies believe that distributors have increased the quantity of higher efficiency HVAC equipment they stock during the last few years.

Water heating market highlights include the following:

- Among tank water heater systems, minimally-compliant systems account for nearly all installations; seven out of ten trade allies believe that this is industry standard practice. High-efficiency, program-eligible systems account for 0% to 3% of new tank system installations.
- Tankless water heating systems are installed in about 5 to 10% of cases. Those choosing tankless water heating systems are more likely to choose higher-efficiency equipment; high-efficiency systems account for nearly all new *tankless* systems installed, or 1% to 5% of all water heater installations. This may reflect the fact that tankless water heaters are, by definition, more energy-efficient than tank systems, and therefore, those installing these systems are more likely to prioritize energy-efficiency in their decision-making.
- Trade allies find it difficult to convince customers to install higher-efficiency tanked water heater systems based on project economics, even after accounting for the program rebate.
- Only a few trade allies anticipate growth in the high-efficiency water heater system market during the next few years. Two of these trade allies expect more customers to gravitate towards the highest efficiency tankless water heater systems. Other trade allies indicate that growth would be contingent on: 1) improved cost-effectiveness (either lower prices or increases in savings), or 2) changes in federal water heater standards.

Lighting market highlights are summarized below:

- The majority of medium screw-based bulb sales are still incandescent (44% – 46% market share), but standard CFL sales represent the next greatest percentage of market share (30% – 32%).
- Halogen incandescent (or “EISA-compliant halogens” or “energy-efficient halogens”) represent approximately 6% - 10% of the market for medium-screw base lamps. All trade allies report that halogens are playing a bigger role in the market now that the phase-in of the efficiency standard (EISA 2007) is underway. Based on trade ally input, it appears that without continued incentives for CFLs, energy-efficient halogens will likely become the leader in the market for incandescent replacements.
- Trade ally responses indicate that LEDs make up 8% - 10% of medium screw-based bulb sales. Only one of the four respondents reported that LED sales exceed 1% of total

medium screw-based bulb sales. However, that respondent represented a high volume of sales relative to the other respondents.

- Most respondents report that substantial growth in LED sales will not occur until price points fall due to manufacturing and market advancements, or due to utility incentives. However, one manufacturer reports that consumers so significantly favor the features of LEDs over those of CFLs (e.g., ability to dim, light quality, lack of mercury content and size options) that the market shares of CFLs and LEDs are likely to "flip flop" during the next year.
- One retailer and one manufacturer commented that, due to the superior features of LEDs, specialty CFLs are unlikely to see significant growth during the next several years as LEDs gain a more solid foothold in the market.
- National chains don't track changes in sales in specific utility territories, but representatives report that sales of CFLs are significantly higher in general in stores that participate in utility programs.

ENERGY STAR® appliances market highlights include the following:

- Nearly all dehumidifiers (98%) sold in DTE Energy's service territory by the three retailers interviewed are ENERGY STAR®. ENERGY STAR® market share in DTE's service territory was 63% - 68% for room air conditioners and 59% - 62% for clothes washers.
- Market share of DTE-supported ENERGY STAR® appliances appears to be in line with national levels for both clothes washers and dehumidifiers. For room air conditioners, market share in DTE Energy's territory is estimated to be moderately higher than the national average (63% - 68% compared to the national average of 62%).
- The ENERGY STAR® label has become almost universal among some products, like dehumidifiers. In such cases, the label has become significantly less meaningful as a tool for differentiating among product options.
- According to one retailer, appliance incentives are bigger on the east and west coasts than in Michigan, and DTE Energy's incentives are not big enough to drive changes in purchase behavior.
- Consumers have become more internet savvy. As a result, store staff are presented with more complex questions and required to be more knowledgeable about product options and market developments. This, combined with a changing market landscape (i.e., changes in efficiency standards and initiatives to highlight the most efficient products), calls for increased efforts to educate store staff and consumers through staff trainings and carefully designed signage and point-of-purchase (POP) materials.
- According to one retailer, initiatives to highlight top-saving products (e.g., Top Ten USA and ENERGY STAR® Most Efficient) will gain some traction in the coming years because some customers are motivated to buy the *most* efficient products.

Highlights of the ENERGY STAR® consumer electronics markets are summarized below:[4]

- As of April 2012, nearly 70% of all TVs sold in DTE's service territory through the pilot program were program-qualifying models. This exceeded the sales of stores participating in other utility mid-stream incentive programs (approximately 68% market share), and stores across the remainder of the U.S. that do not participate in any utility incentive programs (approximately 67% market share).
- Starting March, 2011, sales of qualifying TVs, which typically lagged in stores participating in the program, surpassed sales in stores across the nation; reflecting a change in stocking patterns and sales in mid-stream program-participating locations, such as DTE's program.

Personal computers and monitors highlights:[5]

- As of April 2012, approximately 21% of all PCs sold in DTE's service territory through the pilot program were program-qualifying models. The market share observed through DTE's pilot program is lower than the market share of qualifying PCs in stores that participate in other mid-stream incentive programs and in non-participating stores nationally. However, the white paper highlights that additional models have become available and qualifying product sales are growing in general.
- As of April 2012, approximately 70% of all monitors sold in DTE's service territory through the pilot program were program-qualifying models. This exceeds sales of qualifying monitors sold through other utilities' mid-stream incentive programs (approximately 67% market share), and through non-participating stores nationally (approximately 68% market share).
- According to findings presented in the white paper, nationally, sales of monitors have been less affected by mid-stream programs than has the market for TVs.

[4] Source: Consumer Electronics Pilot Program White Paper, June 2012
[5] Source: Consumer Electronics Pilot Program White Paper, June 2012

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3.3.2.2 *Heating System Type*

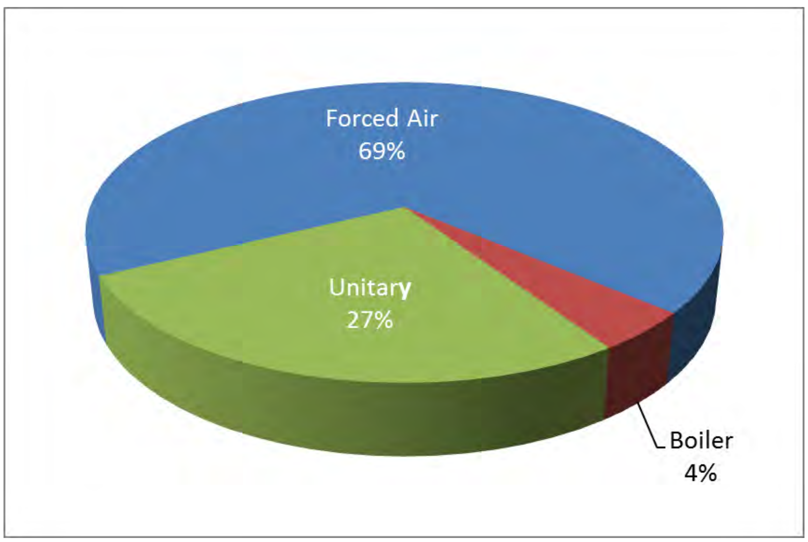
- Overall, just over three quarters of all natural gas heating systems are forced air systems and just under one in five systems were recorded as unitary (e.g., fireplaces).
- In contrast, almost three quarters of homes using electric heating rely on unitary systems[14] (such as baseboard heating).

Table 51: Primary Heating System Type by Energy Source (n=111)

	Heating System Type (as % of systems using energy source)		
Energy Source	Forced Air	Boilers	Unitary
Natural Gas	77.6%	5.3%	17.1%
Electricity	22.1%	3.3%	74.6%
Propane/Bottled Gas	100.0%	0.0%	0.0%
Fuel Oil*	0.0%	0.0%	100.0%
Wood/Other	0.0%	0.0%	100.0%

**includes kerosene.*

Figure 10: Primary Heating System Type (n=111)



[14] Unitary systems are those with no distribution system, such as electric baseboard heaters or fireplaces.

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- Table 52 shows the breakdown of all heating system types by housing type. As the table shows, boilers are more commonly found in multi-family homes.

Table 52: Heating System Type by Structure Type (n=111)

	Single Family	Multi-Family
Forced Air	68.4%	59.6%
Boiler	4.3%	11.4%
Unitary	27.2%	29.0%

- Natural gas systems clearly dominate the residential market. Information on heating system AFUE was only obtained for 41 homes with gas space heating. Using the manufacturer and model information collected as part of the on-site, Navigant was able to identify the AFUE for an additional 19 sites. Table 53 shows the average efficiency (AFUE) for different system types for natural gas systems.

Table 53: Average Heating System Efficiency (for Natural Gas only) (n=60)

	Forced Air	Boiler
Average	83%	75%

- 31% of natural gas furnaces surveyed were identified as high efficiency (>90%). The prior (2009) baseline reported that 11% of all heating systems were condensing/high efficiency (or 12% of natural gas systems).
- The table below shows the number of high efficiency furnaces found in homes of different vintages; where high efficiency is defined as an AFUE of 90% or over. High efficiency furnaces were not identified in any homes built after 2000, however, a number of older homes were found to have installed a high efficiency furnace as a replacement.

Table 54: Penetration of High Efficiency Gas Furnaces (n=41)

Vintage	% of Gas Heated SF Homes in Age Category with High Efficiency Furnace (> 90% AFUE)
<1950	0.0%
1950-1970	24.2%
1970-1990	14.3%
1980-2000	7.6%
2000-present	0.0%

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **DTE ELECTRIC COMPANY** for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority.	U-20836

PROOF OF SERVICE

On the date below, an electronic copy of **Direct Testimony of Chris Neme and Exhibits MEC-74 to MEC-77 on behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and Citizens Utility Board of Michigan** was served on the following:

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The statements above are true to the best of my knowledge, information and belief.

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