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Seventhwave

New Homes Baseline and Market Characterization Study

October 5, 2017

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EXECUTIVE SUMMARY

This report summarizes a study seeking to better understand the characteristics of—and market for—new single-family homes in Wisconsin. The study involved site visits in the first half of 2017 to a geographically-representative sample of 50 homes built in 2015 and 2016. The purpose of the site visits was to collect detailed data about the energy-related construction characteristics of the homes and appliances in the home.

To establish baseline construction practices for the state, the site visits excluded homes certified under the Focus on Energy New Homes program. However, some builders of homes in the study have certified homes under the program—and in general, the baseline established by the study cannot be taken to be free of past influence by the program.

The results show that non-program homes in the state are generally well-insulated, tightly-constructed and have efficient appliances. Nonetheless, Home Energy Rating System (HERS) scores for the non-program homes in the sample average about six points higher than program homes from the first half of 2017 (higher scores mean worse energy performance in this system), indicating that the program is achieving some level of differentiation with respect to baseline practices.

Lighting perhaps remains the least energy-efficient aspect of the characteristics examined by the study: while some homes are entirely lit by LED lighting, others are almost entirely incandescent-based. Overall, a third of the lighting in the study homes still used incandescent bulbs at the time of the study.

In addition, secondary data and interviews were used to characterize the Wisconsin single-family new home construction market. Results from a review of housing permit trends show that the market for single-family new homes is rebounding from a decline that began in 2004. Aside from a slight decline in 2014, the number of permits issued has been increasing between 8 and 20 percent a year beginning in 2011. In the first three months of 2017, the number of permits issued increased 13 percent compared to the first three months of 2016.

Most new homes are being built in Dane and Waukesha counties followed by significant activity in Brown, St. Croix, Washington and Outagamie counties. Limiting factors on home building in Wisconsin are a shortage of construction workers and rising costs of framing lumber. These factors have pushed the market toward more expensive homes. Regional data shows that new home prices have increased since 2010 (41 percent over the median sale price in 2010) and the average size of new homes has increased somewhat (12 percent).

BASELINE CONSTRUCTION PRACTICES IN SINGLE-FAMILY HOMES IN WISCONSIN

The Focus on Energy Program Administrator contracted with Seventhwave to conduct a baseline study of residential, single-family construction practices in Wisconsin using data collected from a sample of recently-constructed homes in the state. The purpose of this study was to characterize the efficiency of new homes not part of the Focus on Energy New Homes program.

It is important to note that while this effort helps establish current baseline construction practices, it is not necessarily free of past influences from the program. Although none of the homes in the study are certified under the New Homes program, some builders of these homes are active participants in the program, or have been active in the past (we distinguish among these groups for most results in this report). Even if the sample was entirely free of program builders, it is possible that subcontractors involved in the study homes may have worked on a mix of program and non-program homes and had their practices influenced by the program. It is also possible that the program has had a general indirect influence on construction practices due to its significant market share in Wisconsin.

METHODOLOGY

Seventhwave collected data on 50 non-program homes built in 2015 or 2016. These site visits involved a home performance technician spending three to four hours in each home collecting information on the home's construction, conducting blower door and (in some cases) duct leakage tests, and then modeling each home in the REM/Rate software used by the New Homes program.

Sampling Plan

Participants for the site visits were drawn from lists of new residential service connections in 2015 and 2016 that were provided to us by the following utilities:

- WE Energies
- Alliant
- Wisconsin Public Service
- Xcel Energy
- Madison Gas and Electric
- WPPI Energy

After removing premise addresses with apartment or unit numbers indicative of multifamily properties, and consolidating properties that appeared on two utility lists due to having different electric and gas service providers, the study sample frame was approximately 16,700 service addresses.

To ensure appropriate geographic distribution and representation, we stratified the on-site sample across five regions established by the Wisconsin Department of Natural Resources (Figure 1).

Figure 1. Geographic regions for the study.

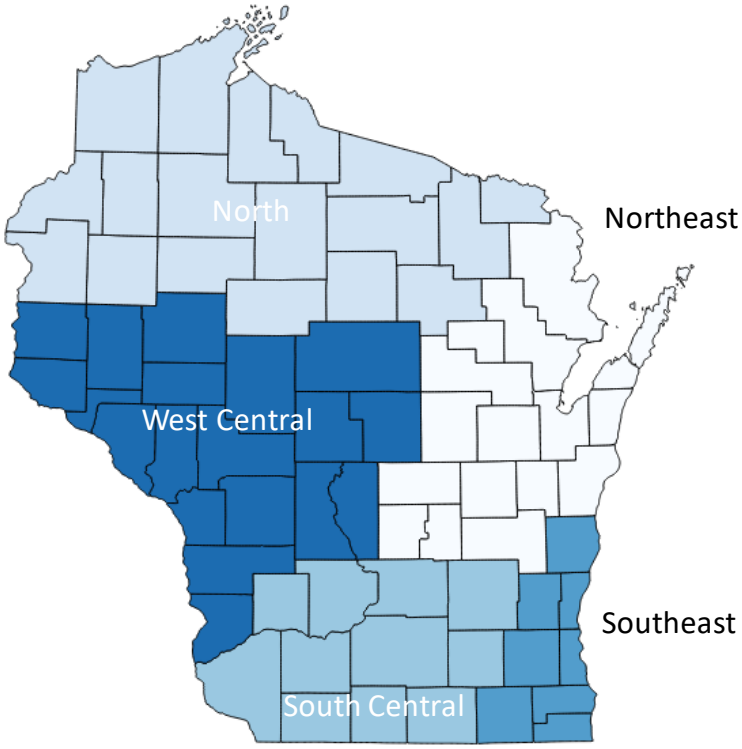


Table 1. Regional proportions for new homes.

	New Homes Program (2011-2016)	Construction Permits (2011-2016)	New utility service connections (2015-2016)
North	1%	15%	8%
West Central	11%	20%	21%
Northeast	19%	20%	24%
South Central	29%	22%	25%
Southeast	40%	24%	20%

Notes:

(1) New Homes Program data (n=9,723) provided by WECC

(2) Construction permit data (n=38,943) are from the Wisconsin Builders Association, and include two-family homes for 2011 and 2012. Also contains missing data for some counties in some months.

(3) New utility service connections data (n=16,595) are for WE Energies, Alliant, Wisconsin Public Service, Xcel Energy, Madison Gas & Electric and WPPI Energy, and exclude approximately 200 premise addresses that could not be successfully geocoded.

In addition to the utility lists of new homes, we examined the regional distribution of new homes for the Focus on Energy New Homes program itself over the last five years and a five-year history of construction permits (Table 1). The permit data and utility data are reasonably consistent in terms of the regional distribution of new homes—even though the latter does not include all utility service providers in the state. Program participation, however, has been more heavily skewed to the south. Therefore, we

allocated the sample regionally per the utility sample frame, which appears to reasonably represent the broader distribution of construction permits across the state.

One complication was that neither the permit data nor the utility data made an explicit distinction between vacation homes and homes that are occupied year-round. We limited the study to homes that are occupied year-round, which affected the proportion of homes we sampled in the Northern region. To do this, we examined the incidence of properties where the billing address did not match the service address for the property in the data provided by the utilities. While these could have been homes that were still under construction, it provided an upper boundary on the incidence of vacation homes in each geographic area. The incidence of properties with different premise and billing addresses was significantly higher in the Northern region (67%) than for the rest of the state (26%), suggesting that a healthy percentage of new homes in the Northern region are indeed vacation homes.

We established the following regional quotas for recruiting homes for site visits.

Table 2. Regional quotas for site visits.

Region	Number of site visits	% of site visits
Northern	4	4%
West Central	11	24%
Northeast	11	24%
South Central	12	24%
Southeast	12	24%
Total	50	100%

Recruiting

Participants for the site visits were recruited by telephone following a script that was designed to ensure that the on-site sample only included owner-occupied, single-family site-built homes that were not associated with the Focus on Energy New Homes program. The recruiting script further restricted the on-site sample to homes heated with natural gas or propane, which constitute about 80 percent of all new homes in the state. Recruiting focused on homes that received a utility service connection in 2016, but allowed for homes with 2015 connections to meet the geographic quotas. We were able to meet the above regional quotas with a total of 30 homes built in 2016 and 20 homes built in 2015. Figure 2 shows the location of the 50 homes in the sample.

Participant responses to a recruiting question about involvement in the design and construction of their home indicate that a majority are custom-built homes (Table 3).

Table 3. Responses to recruiting question on design and construction of home

Which of the following statements best describes your involvement in the design and construction of your home?	N	%
I worked with my builder to customize the floor plan of my home to my needs.	35	70%
I selected my floor plan from among choices that my builder offered.	7	14%
I purchased a home that was already built.	8	16%

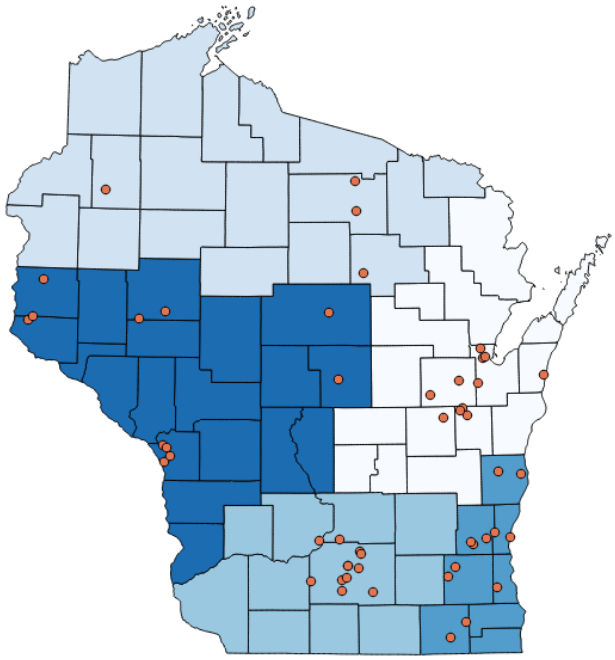
We do not have a direct point of comparison for the statewide population of new homes in this regard, but would note that Census data for the region (WI, IL, MI, IN and OH) indicate that about half of new homes are “built for sale” a quarter are “contractor-built,” and 15 percent are “owner-built.” (See Page 35.)

Demographically, the sample appears to somewhat over-represent non-senior, adult-only households and households with children, and under represent senior households (Table 4).

Table 4. Demographic representation of study sample

	Study Sample		State
	n	%	(Census data)
Families with children	18	36%	47%
Non-senior, adults only	30	60%	41%
Senior, adults only	2	4%	12%

Figure 2. Locations of recruited homes.



Site Visit Protocol and Instruments

The site visit called for a home performance technician to:

- Conduct a brief homeowner interview
- Characterize the square footages and insulation levels of various building components (walls, ceilings, foundation spaces, windows and doors)
- Collect detailed information on the characteristics of heating, cooling, water heating and whole-house ventilation equipment.
- Do a walk-through of the home to gather information about lights, appliances and spot ventilation equipment
- Conduct a blower-door test of air leakage
- Conduct a duct pressurization test for total leakage and leakage to outside for homes with ducts in unconditioned space (performed for homes with ductwork outside conditioned space and some homes with all interior ducts)
- Do an infrared scan of the home (if conditions were amenable) to look for noteworthy areas of missing or defective insulation

- Measure whole-house ventilation rates, and (where readily obtained) spot ventilation rates.

Data was collected using a slightly-modified paper version of a form used by the program (Appendix B: Site Visit Data Collection -- Paper Form) as well as a tablet-based form for additional information (Appendix C: Site Visit Data Collection – Tablet Form). The former was used to capture the information needed to develop a REM/Rate (Version 15.3) model of each home; the latter captured the data from the homeowner interview, lighting and appliance details, photos taken during the site visit, and notes from the site visit and REM/Rate modeling.

Air leakage and duct leakage was measured using standard home and duct-pressurization equipment with digital manometers, and air leakage was measured with multi-point testing with baseline measurements before and after each test.

ANALYSIS

In addition to summarizing the collected data, we used the REM/Rate software (Version 15.3) to assess the extent to which the modeled energy performance of the sample homes meets or exceeds federal ENERGY STAR and Department of Energy (DOE) Net-Zero Homes standards. Finally, we developed a set of reference-home characteristics for use in the REM/Rate software.

RESULTS

We first summarize key characteristics of the sample of non-program homes. For some items, we can compare the baseline sample against data tracked by the New Homes program, making use of a tracking-system extract of about 1,200 program homes certified in the first six months of 2017 that was made available to us by the program administrator.

In addition to providing distributions and overall averages for selected characteristics, we also summarize selected characteristics by builder category (as explained below) and by geographic region. The number of homes in these subcategories is small, and the sample was not designed to yield statistically meaningful results at this level: we provide these results mainly to look for signs of substantial differences across the sample in these dimensions—generally, there are none.

We define three categories of builders of the homes in the sample. These categories represent different levels of builder engagement with the New Homes program. Although none of the homes in the sample were certified under the New Homes program, some builders represented in the sample are either currently participating in the program or have participated in the past.[1] Table 5 shows the three categories.

[1] There are 47 builders among the 50 homes in the sample: three builders have two homes in the sample each. Note also that: (a) for four homes, the homeowner acted as the general contractor; and, (b) the builder for one home is unknown—this home is assumed to be associated with a non-participating builder.

One additional note: statistical confidence intervals expressed throughout this section are at a 95 percent confidence level.[2]

Table 5. Builder program-participation categories for the study sample.

Builder program-participation category	Definition	Number of sample homes	Years between most recent certified home and construction of sample home
Never participated	No certified homes back to 1999	34	(not applicable)
Inactive participant	Most recent certified home is 6+ years prior to construction of sample home	7	9 (2 homes) 10 (2 homes) 11 (1 home) 12 (1 home) 15 (1 home)
Active participant	Most recent certified home is within five years of construction of sample home	9	0 (4 homes) 2 (2 homes) 3 (1 home) 4 (1 home) 5 (1 home)

In the second section, we examine the modeled energy performance of the sample, including modeled performance against several federal benchmarks.

Finally, we discuss the development of a reference-home profile intended to represent current baseline construction practices.

CHARACTERISTICS OF NON-PROGRAM HOMES

Home Size

Table 6 compares various size statistics for the study sample and 2017 data for the New Homes program, and Figure 3 shows the distribution of conditioned floor area for the study sample. Compared to program homes, the study sample of non-program homes is somewhat larger and has a notably higher proportion of one-story homes.

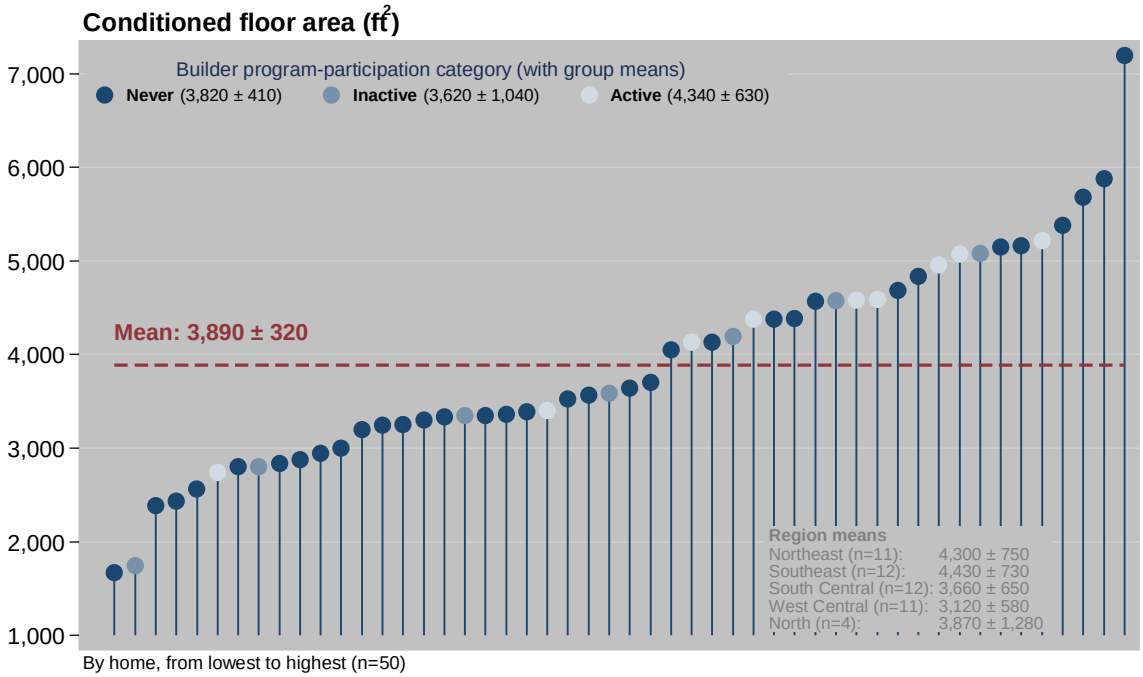
[2] This means that, in theory, if we were to repeat the study 100 times with a different random sample of 50 homes each time, 95 of the 100 sets of confidence intervals will contain the result that we would get if we could somehow obtain the same information for all non-program homes in the state. Of course, studies such as this can be subject to errors from non-response and other non-random factors that can affect accuracy in ways that are difficult to quantify.

Table 6. Home-size statistics for the study sample and for the New Homes Program.

		Study sample	New Homes Program (Jan-June 2017)
Number of bedrooms	1	0%	<1%
	2	12%	5%
	3	48%	53%
	4	36%	38%
	5+	4%	4%
Stories	1	72%	51%
	2	28%	49%
Mean conditioned floor area* (ft^2)		3,890	3,750
Mean finished living area** (ft^2)		2,890	2,390
Mean building volume* (ft^3)		35,600	32,900
Mean building shell area*** (ft^2)		7,820	7,410

*Includes basements
**Includes finished areas of basements
***Includes all ceilings, above-grade walls, frame floors above unconditioned space, foundation walls and slabs

Figure 3. Distribution of conditioned floor area for the study sample.

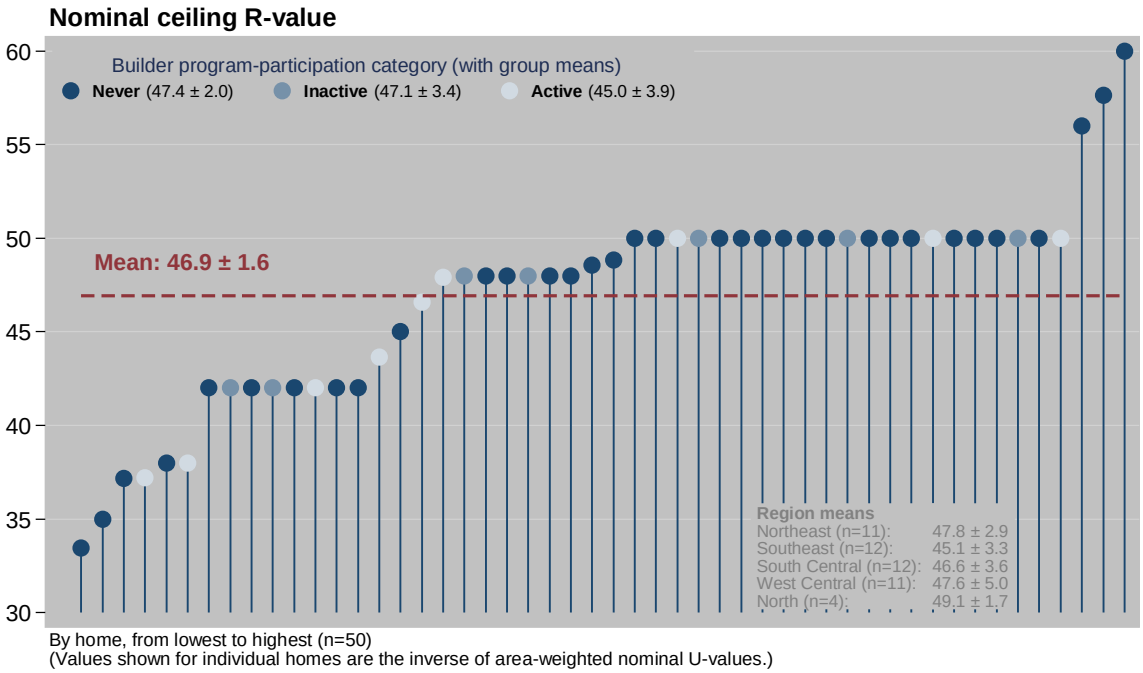


Ceiling insulation

Nearly all (93%) of the aggregate ceiling area for the 50 homes is attic space (vs. vaulted ceiling). Nominal R-values range from less than R-35 to R-60, with an average of about R-46 (Figure 4). Visual and infrared scans of ceilings revealed only a few instances of ceiling-insulation defects. In one case, a

joist cavity was uninsulated; in another instance, a 100-square-foot section of ceiling was lacking insulation.

Figure 4. Distribution of ceiling insulation levels.



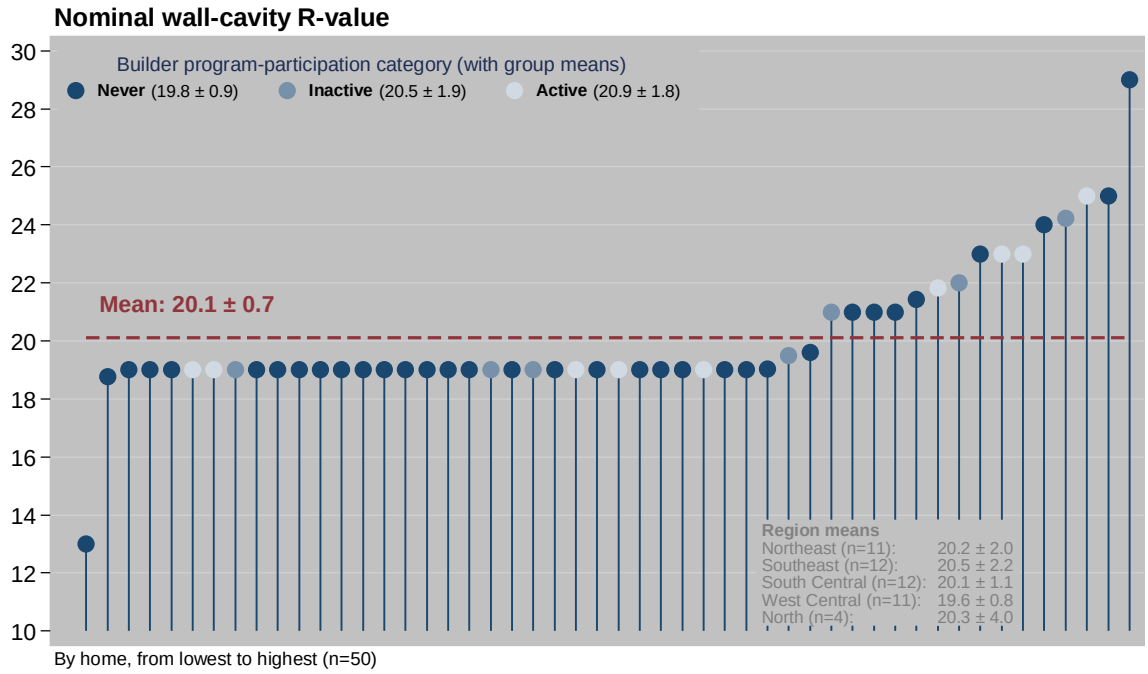
Above-grade wall insulation

All but one home is constructed of 2x6 wood framing; the exception is one home built with 2x4 framing. Cavity insulation is about R-19 for most homes (Figure 5).

The home with the highest (R-29) cavity insulation has 3 inches of closed-cell spray foam and 2.5 inches of blown-in blanket fiberglass cavity insulation. The home with the lowest (R-13) cavity insulation is the home with 2x4 construction: that home also has R-6 continuous exterior insulation.

Overall, 42 homes (84%) have no above-grade exterior continuous insulation, six homes (12%) have R-3 to R-6 continuous insulation, and two homes (4%) have R-10 continuous insulation.

Figure 5. Distribution of above-grade wall cavity-insulation level.



Foundation types and insulation levels

One home in the sample is constructed entirely slab on grade: the remainder have basements, some of which have walk-out sections. The proportion of home with slab-on-grade construction in the baseline sample (2%) is very close to that of the New Homes program (1.6%).

About half of homes with foundation walls (n=49) had some interior foundation-wall insulation at the time of the site visit (Table 7). This excludes one case where the foundation walls were insulated by the homeowner after occupancy. In most cases, interior foundation-wall insulation takes the form of 2x4 or 2x6 wood framing with cavity insulation, but in a few cases rigid-board insulation was used—and one home has both.

Table 7. Interior foundation insulation.

Presence/level of interior foundation-wall insulation	N	%
No interior foundation insulation	24	49%
Mix of insulated and uninsulated foundation walls	4	8%
Insulated to R-11 to R-13 (2x4 studs)	17	35%
Insulated to R-19 to R-21 (2x6 studs)	1	2%
Insulated with R-10 rigid-board	2	4%
Insulated with 2x4 cavity insulation + R-5 rigid-board	1	2%

All of the homes have insulation in the rim-joist area, the majority of which (72%) is spray foam application.

More than half of the homes have some level of exterior foundation insulation (Table 8). Twenty-one of the 29 homes with exterior foundation insulation (72%) have no interior foundation-wall insulation.

Table 8. Exterior foundation insulation.

Presence/level of Exterior foundation-wall insulation	n	%
None	20	41%
R-5 to R-7.5	22	45%
R-10	7	14%

The single home in the sample with slab-on-grade construction has R-7.5 perimeter insulation, and R-10 under the slab. Of the 49 homes with basements, 41 (84%) have no under-slab insulation, 7 (14%) have R-10 under-slab insulation, and one (2%) has R-15 under-slab insulation. Note that slab insulation values—and in some cases, exterior foundation-wall insulation—presented here are generally derived from building plans, and not from direct field observation.

Windows

We could reliably ascertain window U-values and solar heat-gain coefficient (SHGC) values for 39 of the 50 homes.[3] Window U-values range from about 0.27 to 0.35, with an average of 0.30 (Figure 6). Similarly, window SHGC values averaged about 0.30 (Figure 7).

[3] Assessment of window characteristics was based on a combination of information stamped in the corners of window glass and scanning windows with a special tool to detect low-e coatings and surfaces. Not all homes had such stamps, and the tool was not available for all site visits.

Figure 6. Distribution of window U-value.

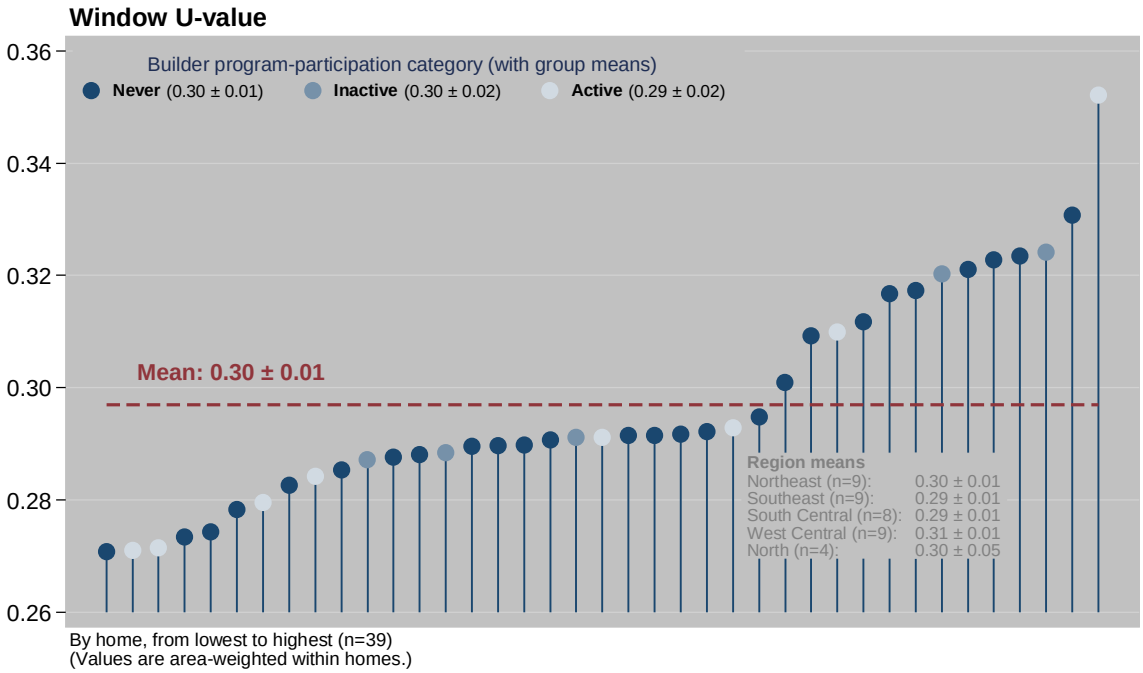
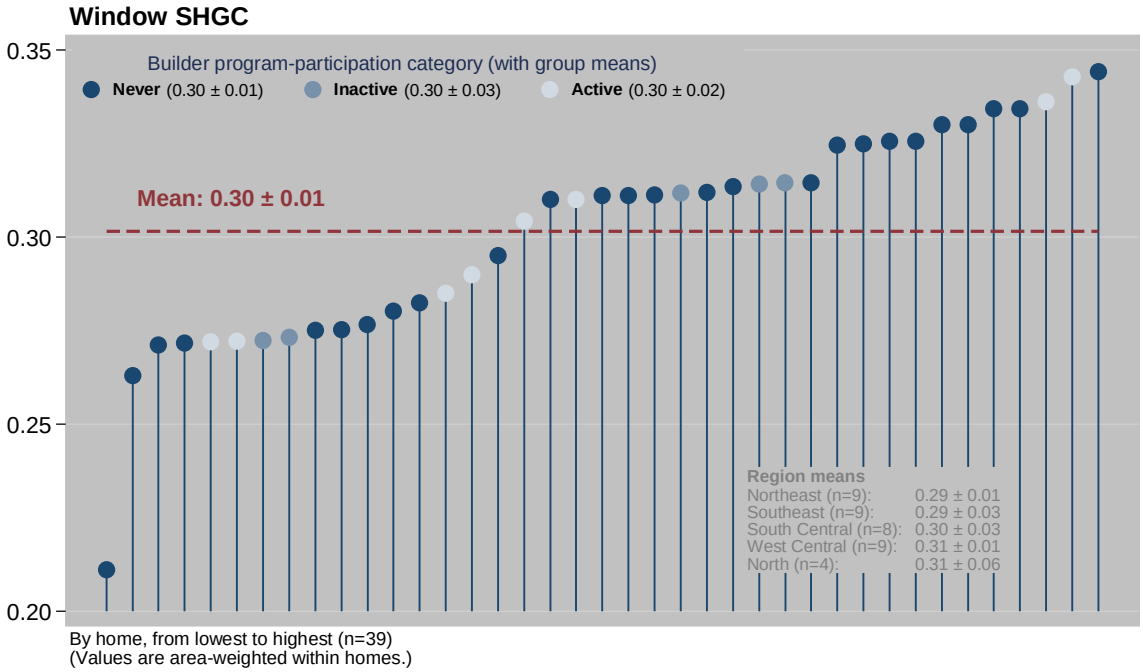


Figure 7. Distribution of window solar heat-gain coefficient (SHGC).



Air leakage

The New Homes program has a program requirement that air leakage not exceed 0.20 cubic feet per minute at 50 pascals of pressure (CFM50) per square foot of building shell area, and program data show that program homes range from about 0.06 CFM50/ft^2 to the cut-off value, with an average of about 0.14 CFM50/ft^2.

Air leakage for the baseline sample of homes was measured with a multi-point blower door test for each home. The baseline sample has a distribution of CFM50/ft^2 that is like that of the program, though six homes (12%) slightly exceed the program threshold. Figure 9 shows an alternative measure of air-leakage, expressed in terms of air changes per hour at the normalized test pressure of 50 pascals. As a point of comparison, current state code requires homes to have air leakage of less than 7 air changes per hour—though also allows for compliance without testing, through visual inspection of potential leakage sites.

Figure 8. Distribution of air leakage per square foot of shell area.

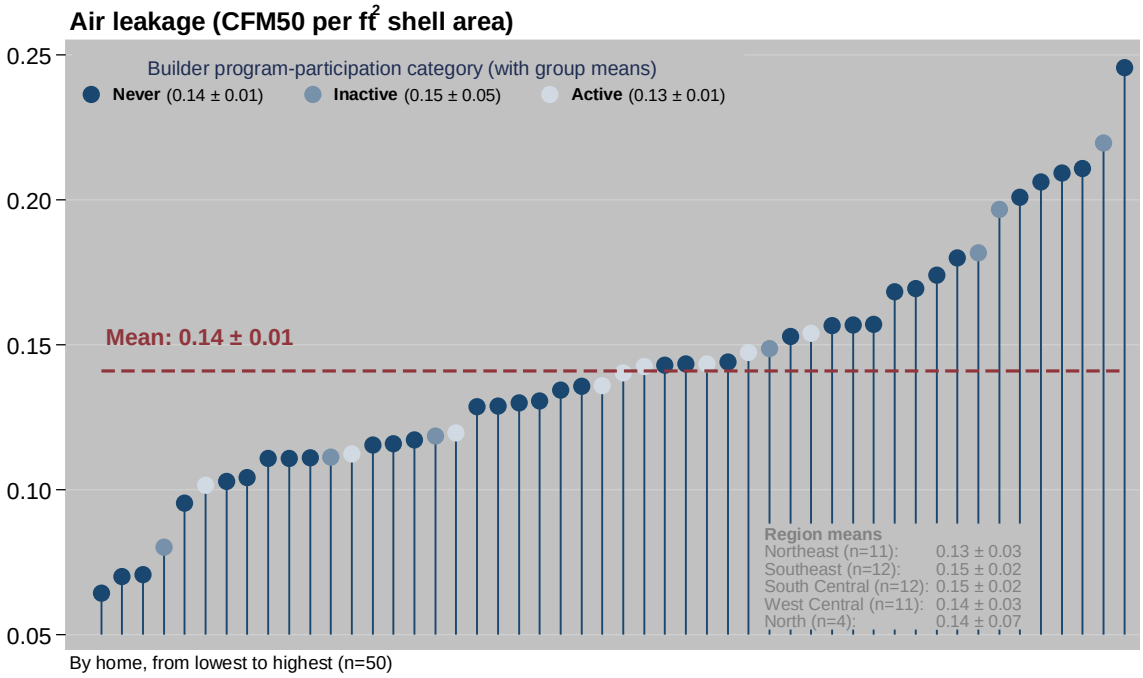
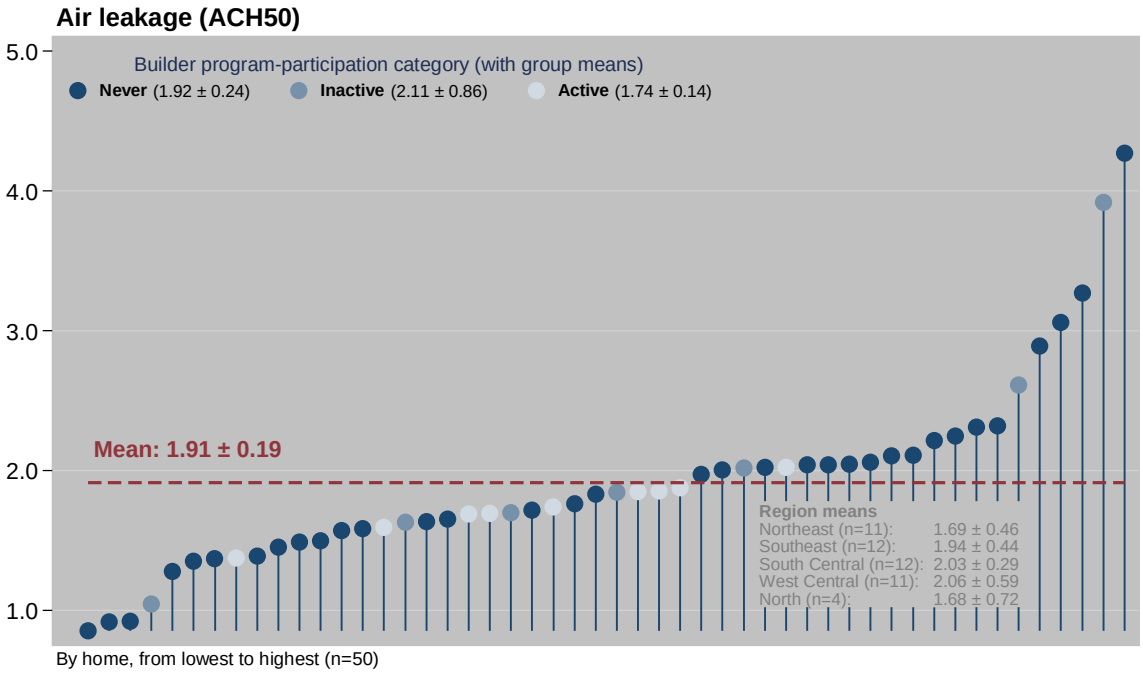


Figure 9. Distribution of air leakage, expressed as air-changes per hour at 50 pascals of house pressure.

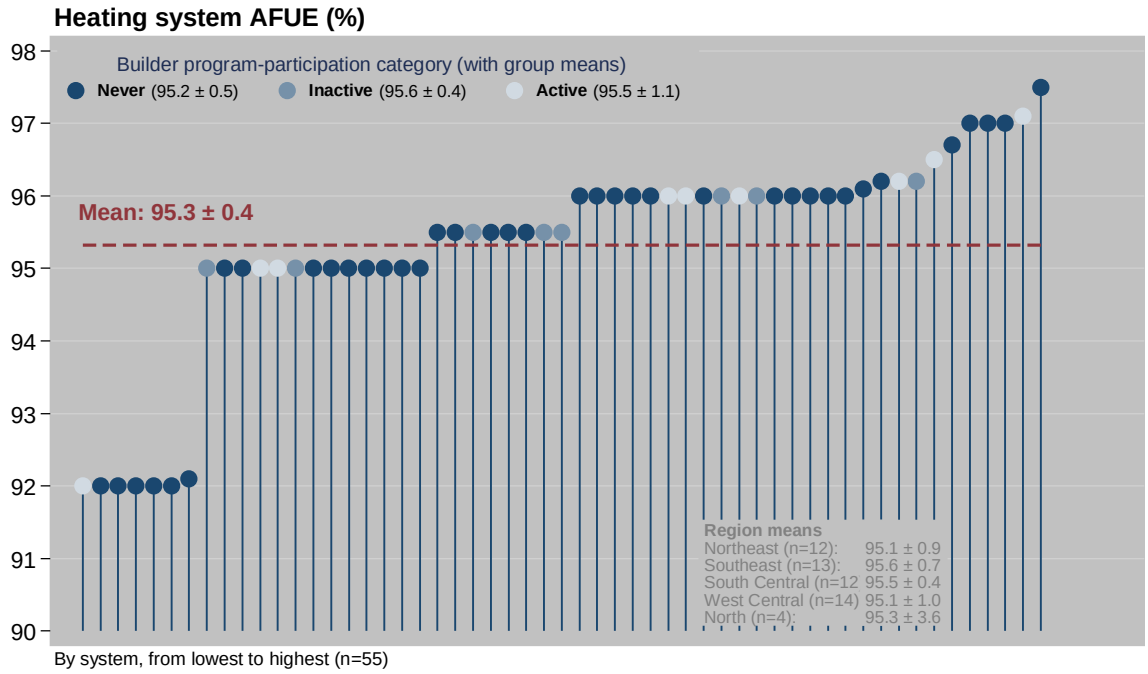


Primary heating systems

All homes in the sample have natural-gas, forced-air furnaces, though one home relies extensively on a water-source heat pump, and three homes also have hydronic boilers that provide heat for part of the home (two of these boilers also provide heat for domestic hot water). Two homes each have two furnaces, making for 55 natural-gas heating systems altogether (52 furnaces and 3 boilers). The furnaces range in output capacity from 42 to 117 kBtuh, with an average of about 75 kBtuh.

The rated annual fuel utilization efficiency (AFUE) for these systems ranges from 92 to more than 97 percent (Figure 10), with an average of about 95 percent.

Figure 10. Distribution of heating system rated annual fuel utilization efficiency.



Secondary heating systems

Most households in the sample (80%) have some form of supplemental heating system, and a few (10%) have more than one such system. Most of these are gas fireplaces that are sometimes used frequently and other times rarely used (Table 9).

Table 9. Incidence and frequency of use of supplemental heating systems.

Type of supplemental heating system	Incidence (% of homes with system)	Reported frequency of use			
		Daily	A few times a week	A few times a month	Rarely or never
Gas fireplace	62%	13%	42%	19%	26%
Wood fireplace	12%	33%	33%	33%	0%
Wood stove	8%	50%	25%	25%	0%
Gas garage heater	4%	0%	50%	0%	50%
Electric heater	4%	0%	0%	50%	50%
Any	80%				

Cooling systems

Forty-six of the 50 homes had a central cooling system at the time of the site visit, and the four homes that lacked it already had indoor coils in place in preparation for installation during the warmer months. As noted above, one home is cooled via a water-source heat pump: the others use conventional central air

conditioners that ranged in output capacity from 1.5 to 5 tons, with an average of about 2.5 tons. Two homes have two central air conditioning units each, making for 47 central air conditioners in all.

Residential central air conditioners are rated in terms of seasonal energy efficiency rating (SEER), which can be based on the SEER-class of just the outdoor unit, the combination of outdoor unit and indoor unit, or even the combination of the outdoor unit, indoor unit and furnace or air handler. However, indoor coils are sometimes hidden inside ductwork, and many combinations of air conditioner and furnace do not have listed SEER ratings. Of the 46 central air conditioners for which we obtained nameplate data, SEER values for 12 (26%) are based on the outdoor unit alone, 27 (59%) are based on the combination of outdoor and indoor units, and seven (15%) are combined ratings that include the furnace's air handler.[4]

For the 46 central air conditioners with SEER determinations, 38 (83%) are SEER 13 or 13.5, 7 (15%) are SEER 14 and one system (2%) is SEER 19, giving an average SEER rating of 13.3.

Duct Leakage

Our original protocol called for duct-leakage testing using duct-pressurization equipment in all homes. However, this proved too time intensive given other data collection needs, so after testing five homes that had no ductwork outside the thermal envelope, we switched to only testing homes with exterior ductwork. These were mainly homes with ducts in ceilings above attached garages.

In all, useable test results were obtained for 12 homes, of which seven had duct runs outside conditioned space, and five had all interior ductwork (Figure 11). Most of the tested homes had measured duct leakage to outside of 40 to 60 cubic feet per minute at 25 pascals (CFM25), which likely represents leakage through code-required makeup-air venting that is commonly connected to the return side of the duct system. Two homes had very low measured duct leakage, and the single home in the study with most of its ductwork outside conditioned space had considerably higher leakage. This last home is unusual in that it is mostly constructed over a large tuck-under garage (Figure 12).

For modeling purposes and establishment of overall standard baseline settings, we set the total leakage to outside for all untested homes in the sample to 50 CFM25. By default, REM/Rate assigns 40 percent of this leakage to supply ducts and 60 percent to return ducts.

[4] We were unable to capture cooling-system information for one site.

Figure 11. Duct location proportions and tested leakage to outside, by home.

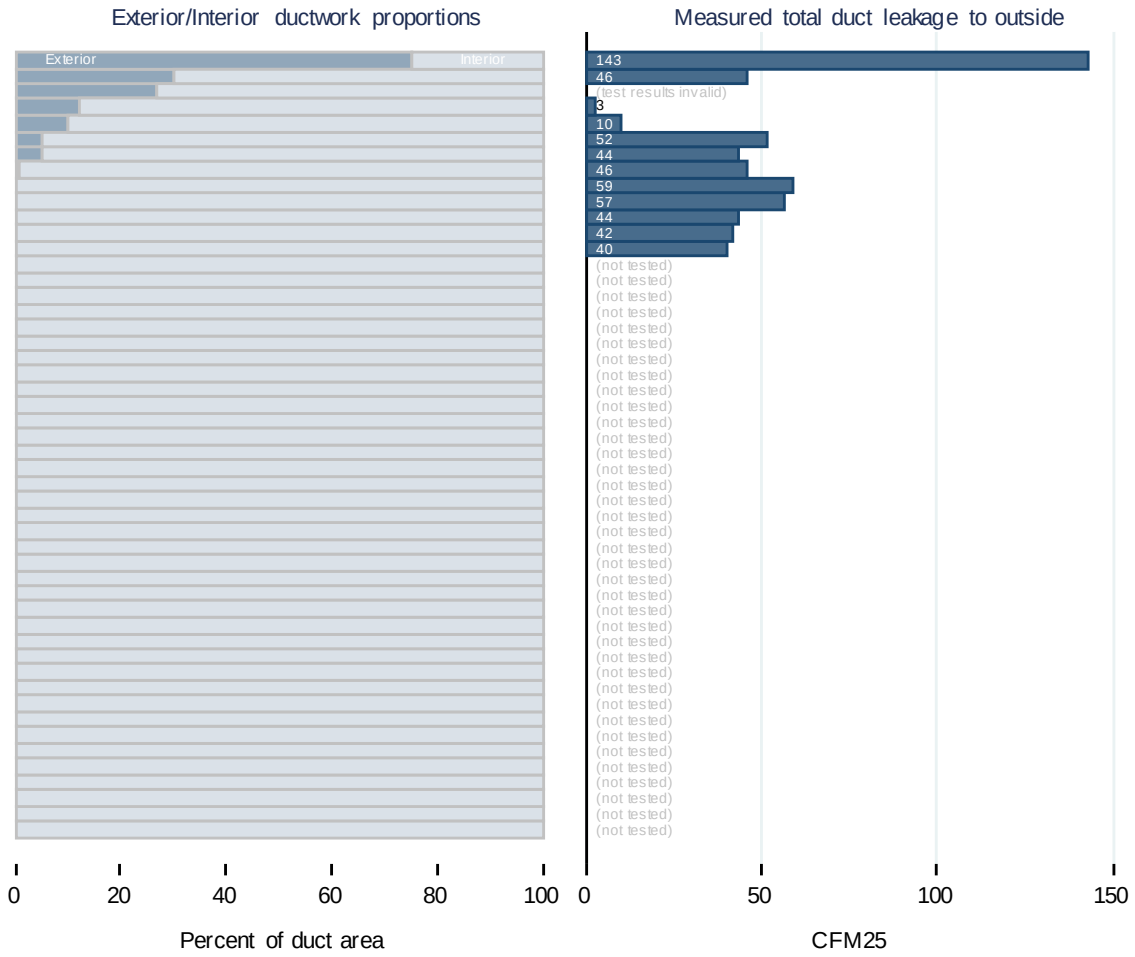


Figure 12. The single home with significant ductwork outside conditioned space.

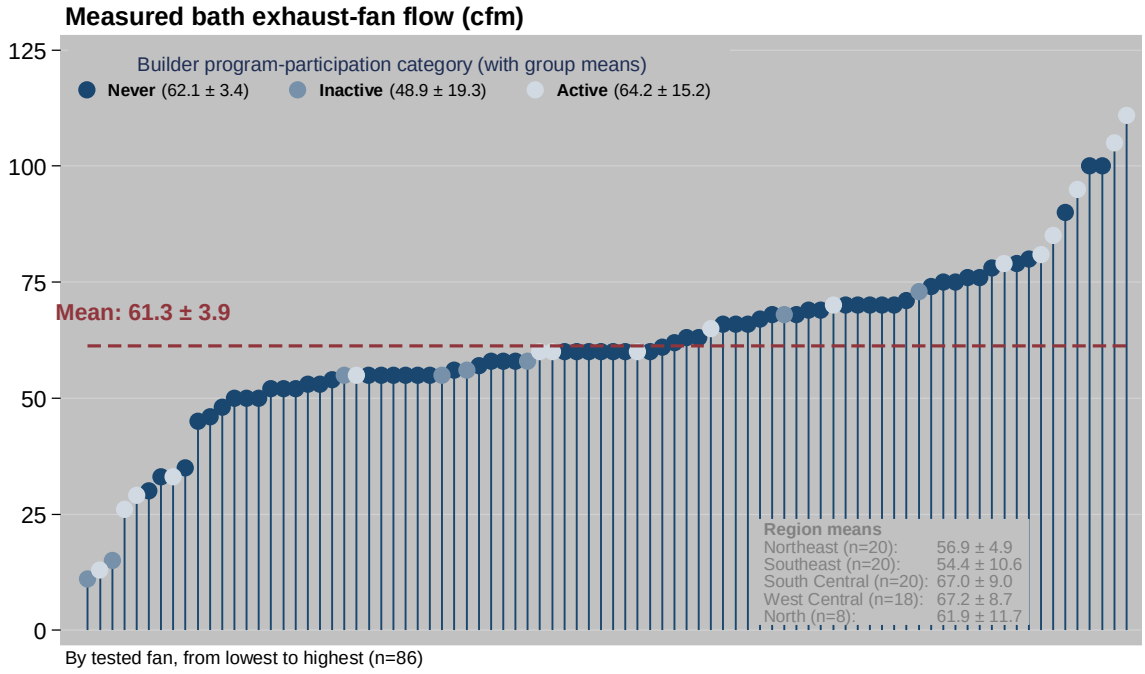
Mechanical Ventilation

Nine homes in the sample (18%) have some form of mechanical ventilation beyond switch-operated exhaust fans in bathrooms and kitchens. One of these homes has a humidistat-controlled bath fan for exhaust-only ventilation; the other eight have heat-recovery ventilators (n=5) or energy-recovery ventilators (n=3). In contrast, all program homes have continuous mechanical ventilation for ensuring proper indoor air quality, typically in the form of an exhaust-only bath fan that operates throughout the day. All else being equal, this imposes an energy penalty on program homes.

The rated sensible heat recovery (at 32F) for the eight HRV/ERVs in the study sample ranges from 64 to 78 percent, with an average of 62 percent. Five of the systems are set to run 20 minutes of each hour, one runs 30 minutes per hour, one runs continuously, and one is used only for intermittent ventilation. For modeling purposes, all nine systems were modeled to conform to required ASHRAE 62.2 flow rates, regardless of actual as-found operating condition.

Spot exhaust fans in bathrooms and kitchens are not critical to the energy performance of homes, because these are not typically operated for substantial periods of time. Nevertheless, we tested flow rates for bath exhaust fans in most of the sample homes (two fans per home were tested). Most fans moved at least 50 cfm of air when operated (Figure 13).

Figure 13. Distribution of measured bath exhaust-fan flow.



Water heaters

Most of the homes in the study have conventional, tank-type water heaters, and most of these are natural-gas models (Table 10).

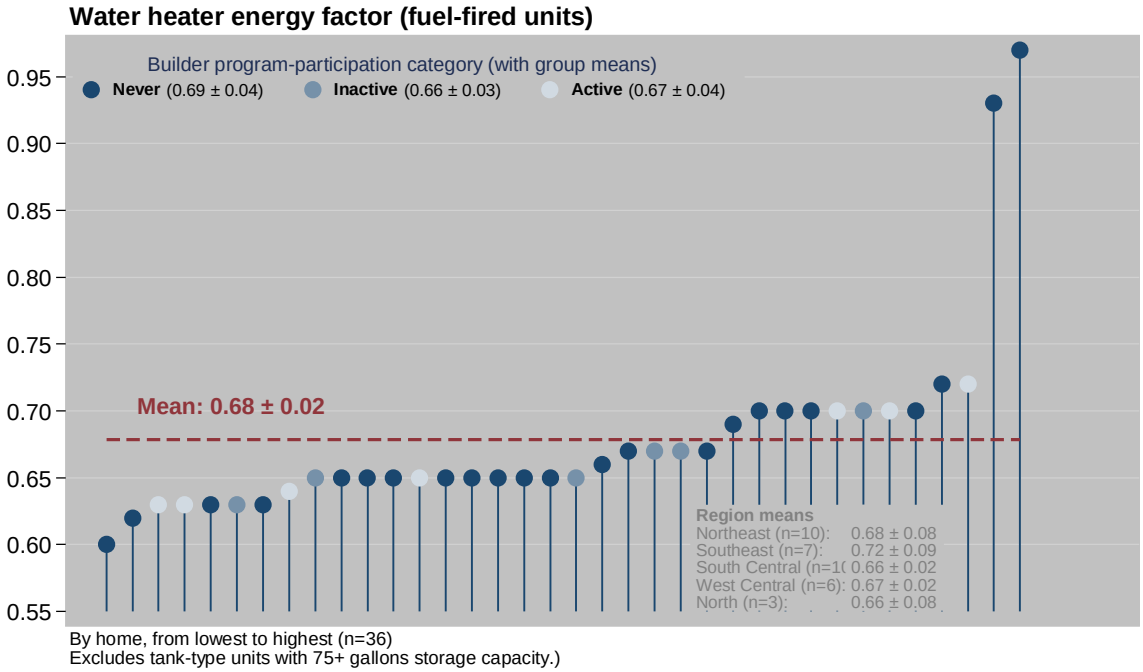
Table 10. Water heater types.

Water heater type	Fuel	n	%
Conventional tank-type	Natural gas	39	78
	Electricity	6	12
Tankless	Natural gas	2	4
Indirect-fired from boiler that also provides space heat	Natural gas	2	4
Heat pump (hybrid model)	Electricity	1	2

Tank volumes for the conventional water heaters in the study range from 40 to 85 gallons, with a mean of 53 gallons. Five of these water heaters have tank volumes that are 75 gallons or more, and are thus considered light commercial-class water heaters: until very recently, such water heaters were not rated for efficiency in the same way as smaller residential water heaters.

Rated energy factors for the 36 homes with fuel-fired, residential-class water heaters ranged from 0.60 to 0.72 for the conventional tank-type models, and more than 0.90 for the two tankless systems on the right side of Figure 14.

Figure 14. Distribution of water heater energy factor for fuel-fired, residential-class water heaters.



Lighting

The field protocol called for tallying socket counts by bulb type for each home. This information was obtained for 44 of the 50 homes. For individual homes in the sample, lighting ranged from nearly entirely incandescent to entirely LED, with incandescent lighting making up about a third of the aggregate sockets in the sample homes (Figure 15, Table 11). The overall fraction of lighting that was efficient (CFL or LED) by space type was 65.3% for interior lighting, 73.9% for exterior lighting and 60.5% for garage lighting. (Note that the lighting data reported here includes plug-in luminaires as well as hard-wired fixtures—and that homeowners may have replaced some bulbs after occupancy.)

Figure 15. Lighting composition, by home and overall.

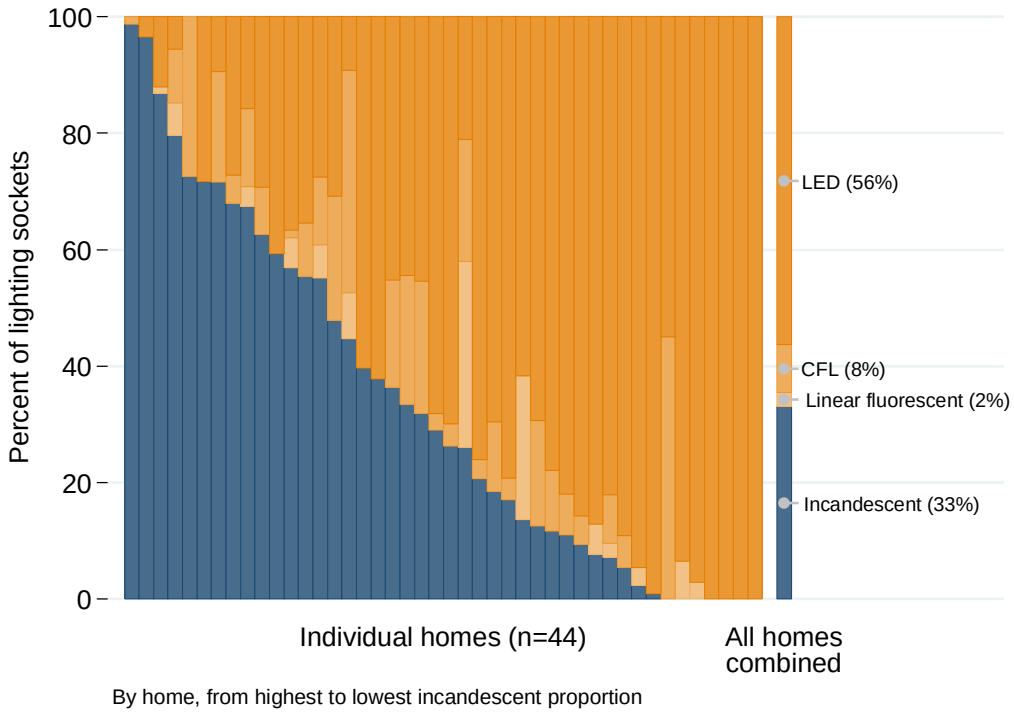


Table 11. Lighting composition, by builder program-participation category and overall.

Builder program-participation category	Lighting type				Total
	Incandescent	Linear Fluorescent	CFL	LED	
Never (n=31)	28%	2%	7%	63%	100%
Inactive (n=7)	53%	7%	11%	29%	100%
Active (n=6)	33%	1%	12%	54%	100%
All (n=44)	33%	2%	8%	56%	100%

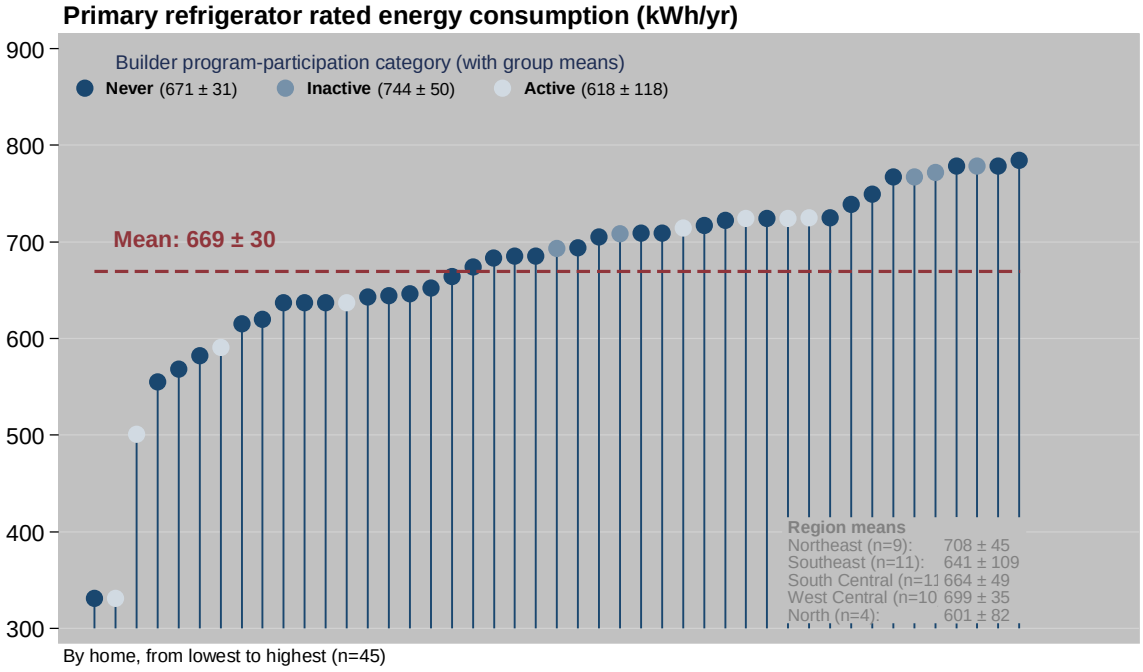
Appliances

Table 12 provides summary statistics for appliances in the study-sample homes, and Figure 16 shows the distribution of primary refrigerator energy consumption for the 45 cases where this could be determined. The two sites with very low refrigerator consumption have single-door refrigerators.

Table 12. Selected appliance characteristics.

Primary refrigerator type	French door	70%
	Side-by-side	14%
	Top-freezer	4%
	Bottom-freezer	6%
	Single-door	6%
Primary refrigerator ENERGY STAR qualified?		64%
Number of refrigerators in home	1	72%
	2	22%
	3	6%
Percent of homes with stand-alone freezer		42%
Clothes washer	mean capacity (ft^3)	4.3
	mean efficiency (MEF)	2.37
	ENERGY STAR?	86%
Clothes dryer fuel	natural gas	58%
	electricity	42%
Range/oven fuel	natural gas	78%
	electricity	22%
Number of dehumidifiers used	0	44%
	1	52%
	2+	4%
Mean number of ceiling fans		3.3

Figure 16. Primary refrigerator energy consumption.



Thermostats

All but three of the homes in the sample have programmable thermostats, and most households reported setting back the temperature at night during the winter and setting up (increasing) the setting during the day and when away from home during the summer. Some households also reported running the furnace fan continuously in the winter and/or summer.

Table 13. Thermostat type and reported settings.

Thermostat type		Non-programmable	6%
		Standard programmable	78%
		Connected/smart	16%
Run a thermostat program?	Winter	Yes	70%
		No	30%
	Summer	Yes	59%
		No	41%
Mean temperature setting (F)	Winter	Day	68.3
		Night	65.6
		Away	63.6
	Summer	Day	73.3
		Night	72.4
		Away	73.3
Thermostat setback/set-up	Winter (night setback vs. day)	<0 F	6%
		0 F	33%
		1-5 F	45%
		6+ F	16%
	Summer (away set-up vs. night)	<0 F	3%
		0 F	42%
		1-5 F	29%
		6+ F	26%
Furnace-fan setting	Winter	Always “Auto”	72%
		Sometimes “On”	12%
		Always “On”	16%
	Summer	Always “Auto”	70%
		Sometimes “On”	15%
		Always “On”	15%

Note: Summer-season results (except furnace-fan settings) do not include 12 households without central cooling or that had not yet been through a summer in their new home.

MODELED ENERGY PERFORMANCE

Heating and Cooling Energy Consumption

Figure 17 through Figure 20 show the distribution of modeled space-heating and space-cooling energy consumption among the sample homes. These estimates use occupant-reported thermostat settings, and incorporate differences in climate across the state, as well as home-to-home differences in square footage insulation levels and other differences.

We also calculate normalized heating and cooling *intensity* scores that attempt to remove differences due to home size and location—though not differences in thermostat settings. Note that the confidence intervals for the intensity scores indicate that there is five (heating) to eight (cooling) percent statistical-

sampling uncertainty in the heating and cooling performance of non-program homes from our sample of 50 homes.

Figure 17. Distribution of modeled heating energy consumption.

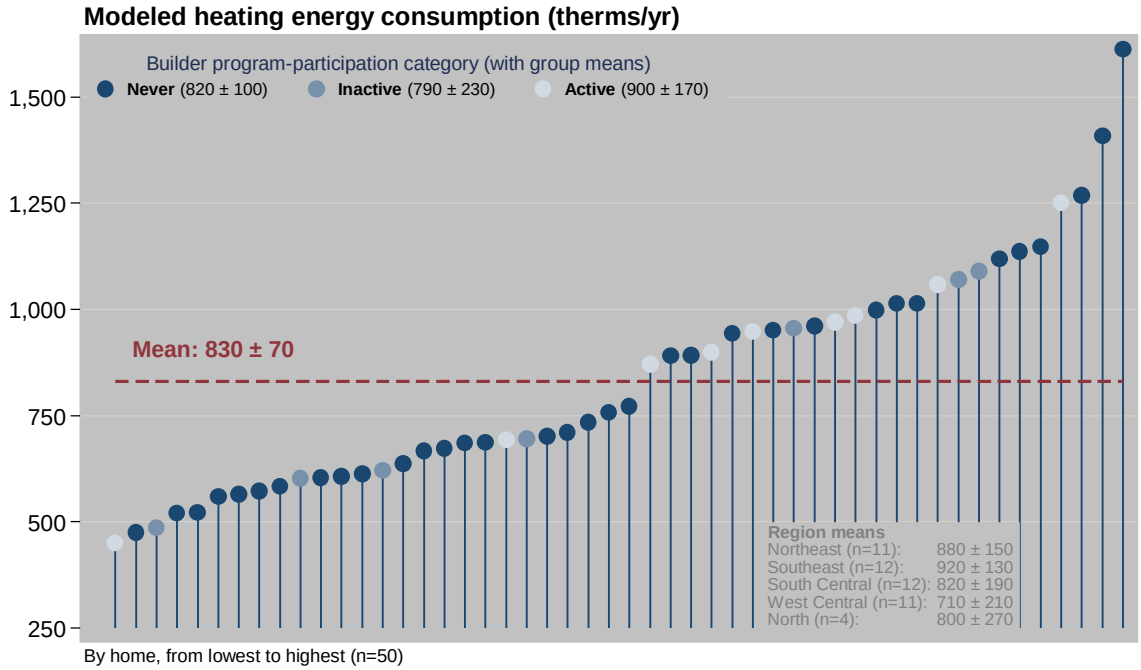


Figure 18. Distribution of modeled heating energy intensity.

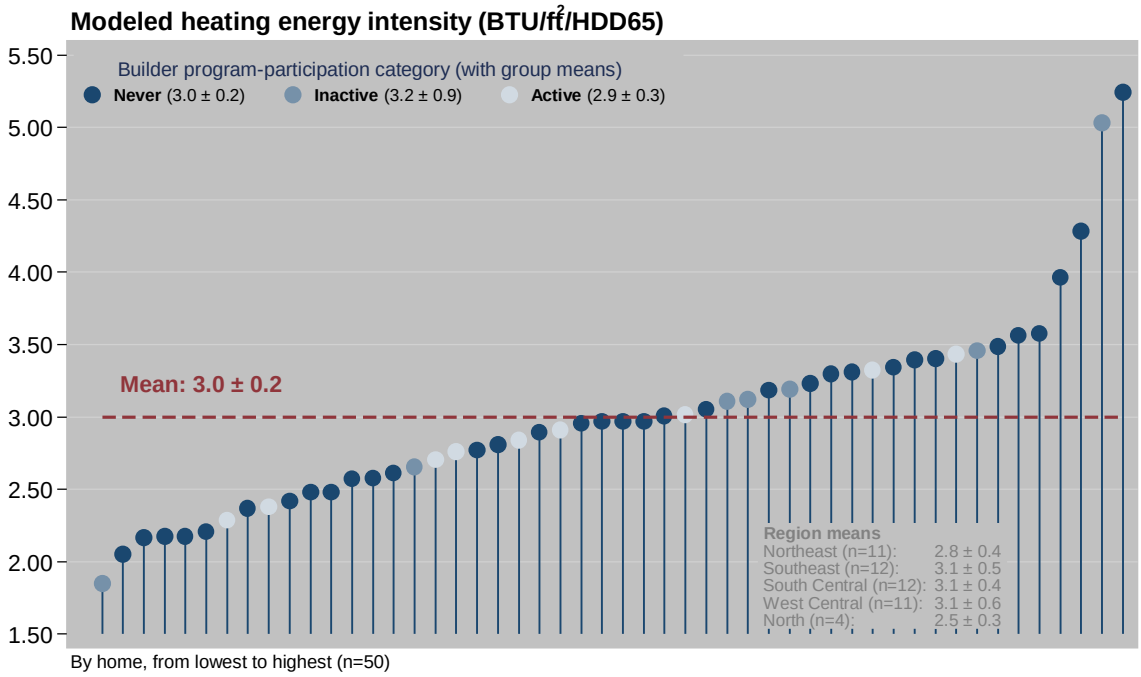


Figure 19. Distribution of modeled cooling energy consumption.

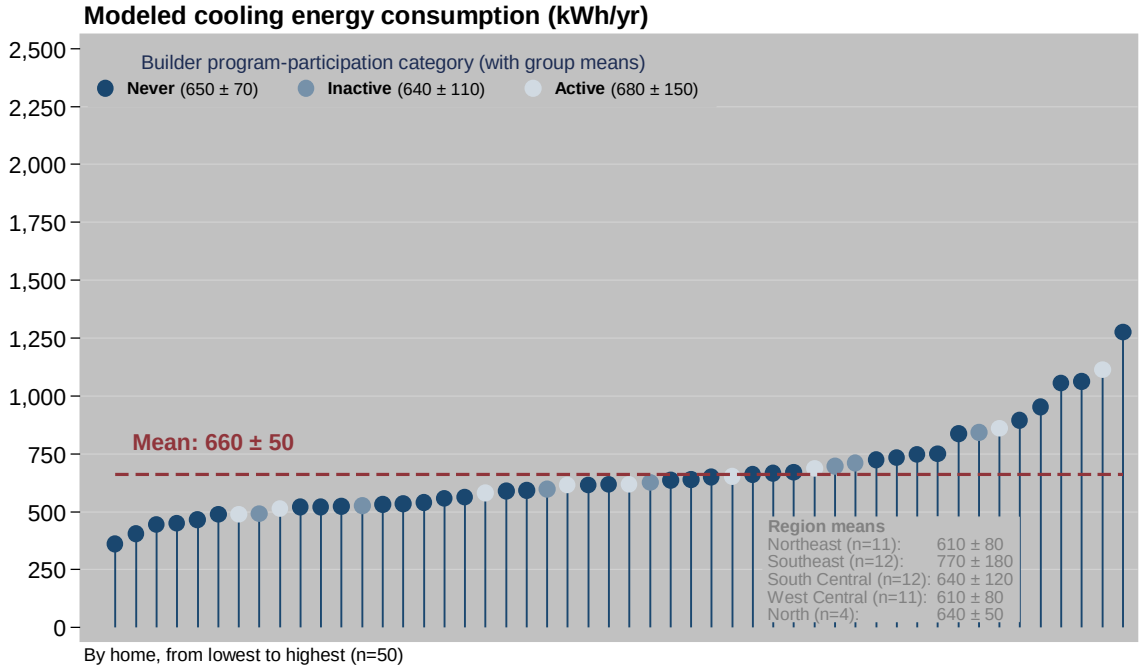
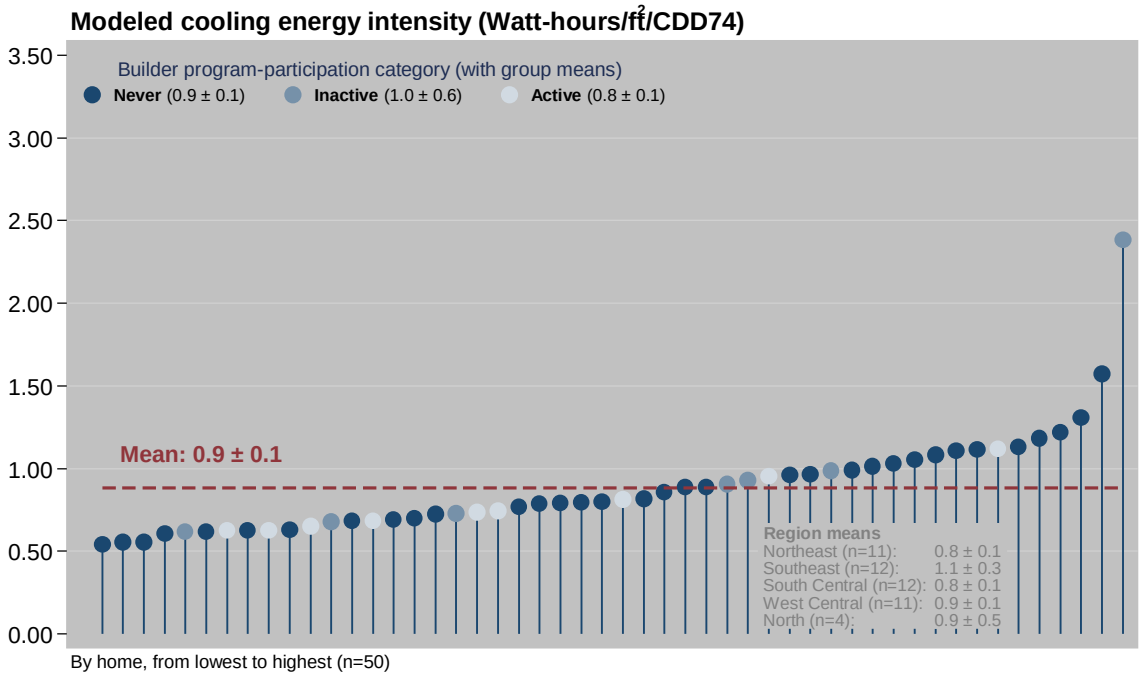


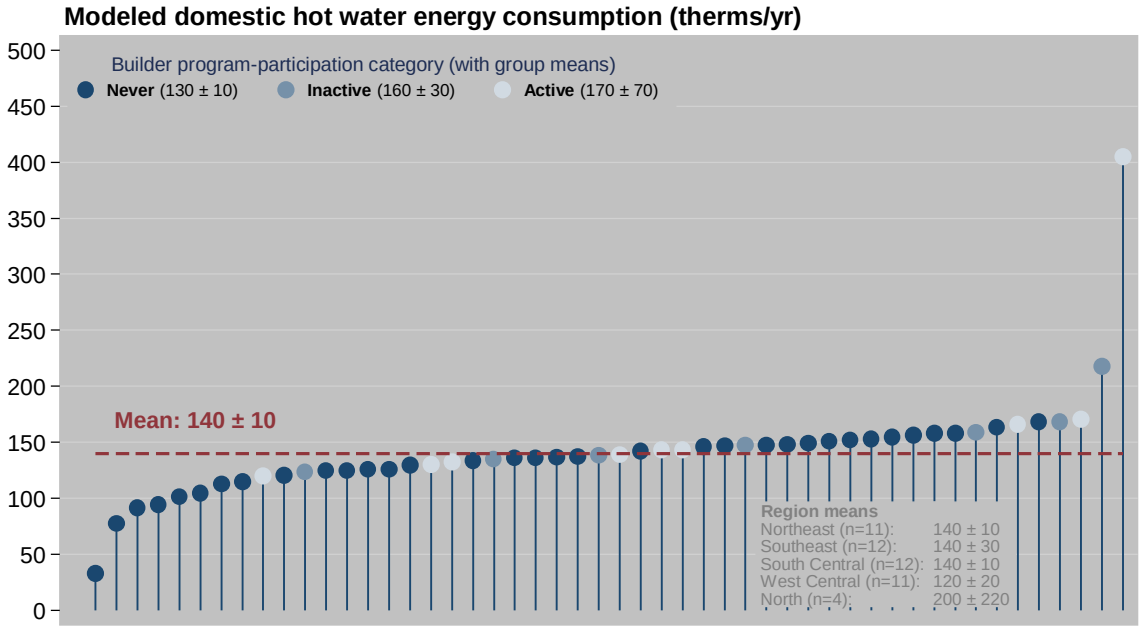
Figure 20. Distribution of modeled cooling energy intensity.



Domestic Hot Water

Energy consumption for domestic hot water is modeled at less than 50 therms to more than 400 therms per year across the study sample, though the former is the therm equivalent of the sole electric heat pump water heater in the sample. The two homes with the highest estimated DHW consumption are the homes with recirculation systems, and the higher of these has a recirculation system with uninsulated pipes, which results in substantial heat loss.

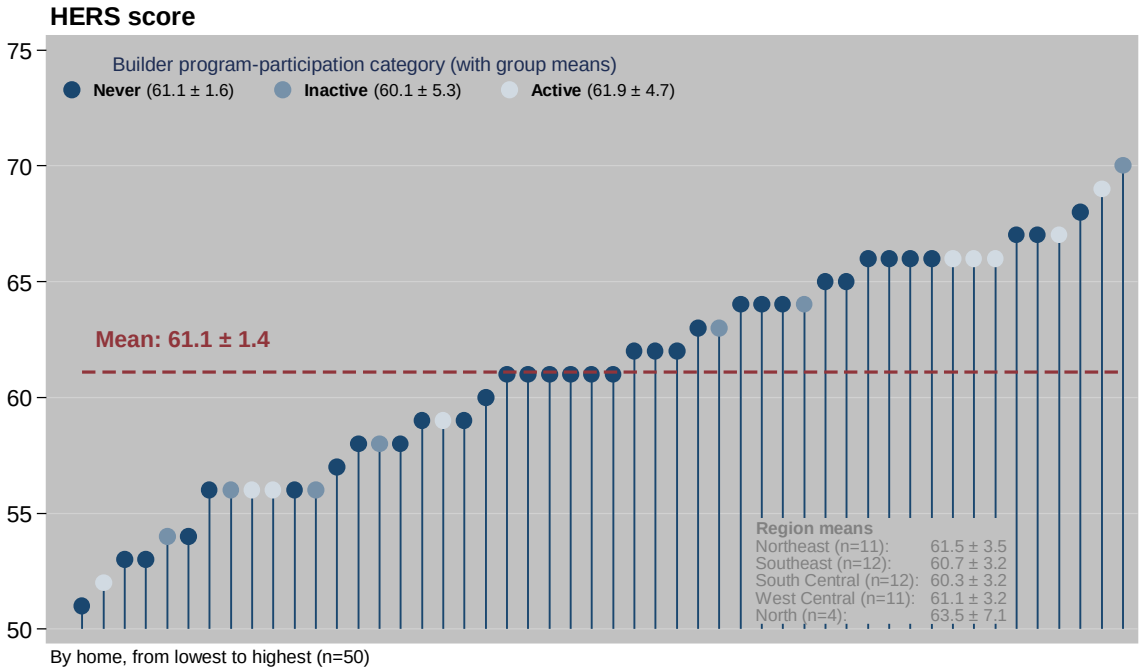
Figure 21. Distribution of modeled domestic hot water energy consumption.



HERS Scores

Figure 22 shows the distribution of Home Energy Rating System index scores for the 50 homes in the sample. In this system, smaller numbers indicate better energy performance. The average non-program home in the sample has a score of about 61. As a point of comparison, HERS scores for program homes in the first half of 2017 ranged from 21 to 67, with an average of about 56.

Figure 22. Distribution of HERS scores for sample homes.



Several federal program standards establish benchmark HERS scores for energy performance. To qualify for these programs, homes must achieve HERS scores at or below a benchmark score, in addition to meeting many other requirements (which are not assessed here). The REM/Rate software calculates these benchmarks, and thus provides a ready means to assess whether homes meet the performance requirements of the programs. Table 14 shows results for three federal programs: ENERGY STAR (3.0 and 3.1) and the Department of Energy's (DOE) Zero Energy Ready program. A minority of non-program homes pass the performance thresholds for these programs.

All three programs have a size-adjustment mechanism that requires better performance for larger homes. To help gauge the extent to which home size is a factor in meeting the program performance benchmarks, the right-most column of Table 14 shows how many homes meet the target if the size-adjustment is removed. This significantly increases the fraction of homes that would meet the ENERGY STAR 3.0 performance metric were it not for the size of the home—but has little impact for the other programs.

Table 14. Percent of sample homes meeting federal-program energy-performance benchmarks.

Program	% meeting HERS score benchmark	…excluding size-adjustment factor
ENERGY STAR 3.0	38%	76%
ENERGY STAR 3.1	14%	20%
DOE Zero Energy Ready	2%	8%

PROPOSED REFERENCE-HOME SETTINGS FOR REM/RATE

We used the data from the site-visit sample to develop a proposed set of reference-home values for use in the REM/Rate software. A reference home is meant to serve as a baseline against which modeled energy consumption and savings are calculated. If the study sample is meant to serve as such a baseline, then our goal was to develop reference-home specifications such that when the sample itself is evaluated against these reference conditions, average energy savings should be close to zero.

Our approach was to use REM/Rate's user-defined-reference-home (UDRH) feature to seed key baseline characteristics with average values from the study sample, then implement an iterative procedure to adjust these values between iterations based on average differences between as-built and reference-home loads and consumption. Specifically, we adjusted the reference-home inputs until mean component loads per square foot of conditioned floor area closely matched for the reference-home and as-built conditions across the 50-home study sample.

Fifteen iterations were sufficient to reach a set of reference-home values (Table 15) that closely matched average loads and consumption in the study sample in most respects (Table 16).[5] On average, the study sample shows heating and cooling consumption that is within a quarter of a percent of the reference home, and domestic hot water consumption that is within 1.25 percent. Modeled heating and cooling loads for individual components are generally within a percent or two as well. There is little point in further tightening these values given that there is five to eight percentage points of sampling uncertainty regarding the overall heating and cooling energy performance of non-program homes. In other words, there is more uncertainty associated with how well the study sample of 50 homes represents the larger population of non-program homes than there is in how well the proposed baseline settings match the study sample.

For calculating ex ante savings for program homes in the future, one option would be to use a UDRH script file to model the energy difference between each program home's design characteristics and a standard baseline version of the home. However, the UDRH script syntax is somewhat limited in this regard. In particular, the UDRH syntax cannot readily deal with the fact that some program homes are tested for duct leakage while others are exempt from testing. This could lead to false comparisons if, say, the baseline condition assumed some level of duct leakage, while exempt homes were calculated as having no leakage. Because a single UDRH script cannot accommodate both tested and untested homes, work-arounds would be needed.

Alternatively, the program has traditionally worked with the software manufacturer (Noresco) to customize the REM/Rate software to reflect code-based standard reference-home settings for Wisconsin, thus removing the limitations of the UDRH syntax. The current Wisconsin version of the software adheres to standard reference home requirements of the Wisconsin Uniform Dwelling Code's Energy Conservation Chapter (SPS 322) for both assessing code compliance and calculating savings relative to code-minimum energy performance. The standard reference-home settings in the software follow insulation levels and other specifications set forth in Table 322.53-1 of the UDC.[6]

While these code-minimum performance settings will need to be maintained in the software to continue to validate code compliance under a performance path, the software could be further customized in the same way to also provide modeled energy savings relative to baseline conditions determined from this (or a future) study of non-program homes. Appendix E provides an adapted and expanded version of Table 322.53-1 that reflects proposed reference-home settings for the software.

[5] Appendix D provides the full REM/Rate syntax for the final user-defined reference home configuration for this analysis.
[6] See https://docs.legis.wisconsin.gov/code/admin_code/sps/safety_and_buildings_and_environment/320_325/322.pdf#page=12

Table 15. Proposed key reference-home settings for use in REM/Rate.

Parameter	Value
Ceiling Uo, attic or sealed attic	0.02163
Ceiling Uo, vaulted ceiling	0.04751
Above-grade wall Uo	0.0690
Foundation wall Uo	0.1650
Joist Uo	0.0788
Frame floor Uo	0.04671
Window Uo	0.3039
Window SHGC	0.3145
Door Uo	0.2163
Infiltration, ACH50	1.878
Duct leakage CFM25 (supply/return)	23.9/35.9
Mechanical ventilation* CFM	20.2
Heating system AFUE	95.24
Central air conditioner SEER	13.29
Gas/propane water heater EF	0.661
Electric water heater EF	0.901

*Modeled as a balanced, heat-recovery ventilation system with 65% sensible heat recovery and 15% total heat recovery operating 24 hours per day.

Table 16. Percentage difference in average modeled load and consumption per square foot of conditioned floor area between proposed reference-home and "as-built" conditions for the study sample.

		Space heating	Space cooling	Domestic hot water
Loads	Ceilings	+0.00%	+0.42%	
	Above-grade walls	-0.01%	-13.36%	
	Foundation walls	+0.00%	-1.06%	
	Joists	+0.00%	-0.08%	
	Frame floors	+0.01%	-1.30%	
	Slabs	-1.78%	+0.04%	
	Windows	+0.01%	-0.02%	
	Doors	+0.02%	-0.55%	
	Infiltration	+0.01%	+1.67%	
	Ducts	+0.00%	+6.48%	
	Mechanical ventilation	+0.90%	+1.70%	
	Internal gains	+0.45%	+0.50%	
	Total	-0.24%	+0.05%	+0.05%
Consumption		-0.14%	-0.08%	+1.24%

Notes: Space heating and cooling load comparisons are based on mean reference-home and as-built loads per square foot across the 50-home sample. Space heating and cooling consumption excludes one home with a water-source heat pump. Domestic hot water consumption combines electric and gas water heaters, but excludes one home with a hybrid heat pump water heater. One slab-on-grade, and two homes with in-floor radiant heating are excluded from slab load calculations.

SINGLE-FAMILY NEW HOME MARKET IN WISCONSIN

Seventhwave staff reviewed market data from several sources, including data on single-family housing permits issued in Wisconsin,[7] residential construction employment data,[8] framing lumber costs,[9] and data on new home characteristics[10] to paint a picture of the new home market in Wisconsin. Additionally, we spoke with staff of the Wisconsin Home Builders Association and code officials from the Wisconsin Department of Safety and Professional Services for their insights on the state of the new home building market in Wisconsin, industry trends and potential changes/updates to Wisconsin's Uniform Dwelling Code, particularly the Energy Conservation Code.

This characterization of the single-family new home market in Wisconsin involved identifying the market size, determining the geographic market share, and if possible, builder's market share, reviewing the potential for changes to the building code or to appliance standards, and identifying trends in construction practices.

MARKET SIZE

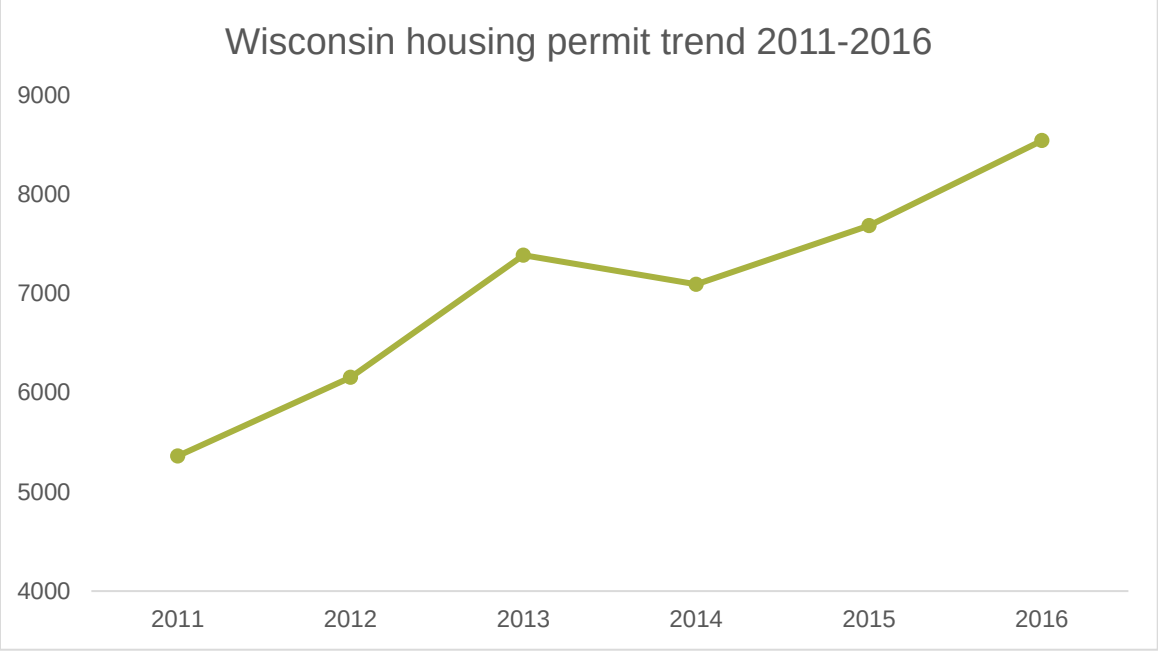
For a historical perspective of Wisconsin's new home market, we looked at housing permit trends[11] from a high in 2003 of more than 30,000 permits through the steady decline from 2004 through 2011 and the current rebound through 2016. It should be noted, however, that housing permit data for the years 2003 through 2012 include two-family as well as single-family homes.

Figure 23. Housing permit trends in Wisconsin

[7] Source: Wisconsin Builders Association
[8] Source: Wisconsin WorkNet and Bureau of Labor Standards
[9] Source: National Association of Home Builders, framing lumber prices. http://www.nahb.org/en/research/housing-economics/construction-statistics/national/framing-lumber-prices.aspx
[10] Source: Characteristics of New Housing from the Survey of Construction. U.S. Census Bureau. https://www.census.gov/construction/chars/
[11] Housing permit data is collected monthly from sites across Wisconsin. These sites do not include all municipalities so the data represents trends in new home construction; not total number of homes built.

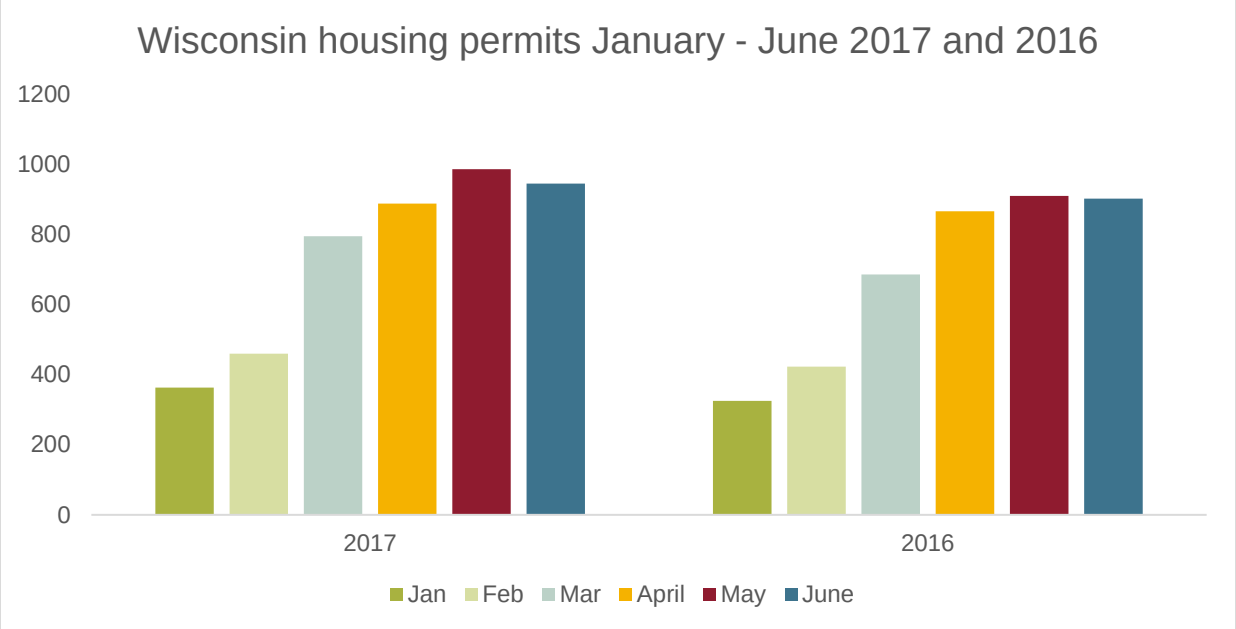
The single-family new home construction market in Wisconsin (as measured by number of permits issued) increased by 15 percent from 2011 to 2012 and by 20 percent from 2012 to 2013 before declining slightly in 2014. In 2015, the number of permits issued increased by 8 percent and then by 11 percent in 2016.

Figure 24. Housing permit trends in Wisconsin over the past five years



The new home construction market is continuing its upward trend in 2017. Housing permits issued are up eight percent for the first six months of 2017 compared to those months in 2016.

Figure 25. Comparison of housing permits issued, 2017 and 2016.

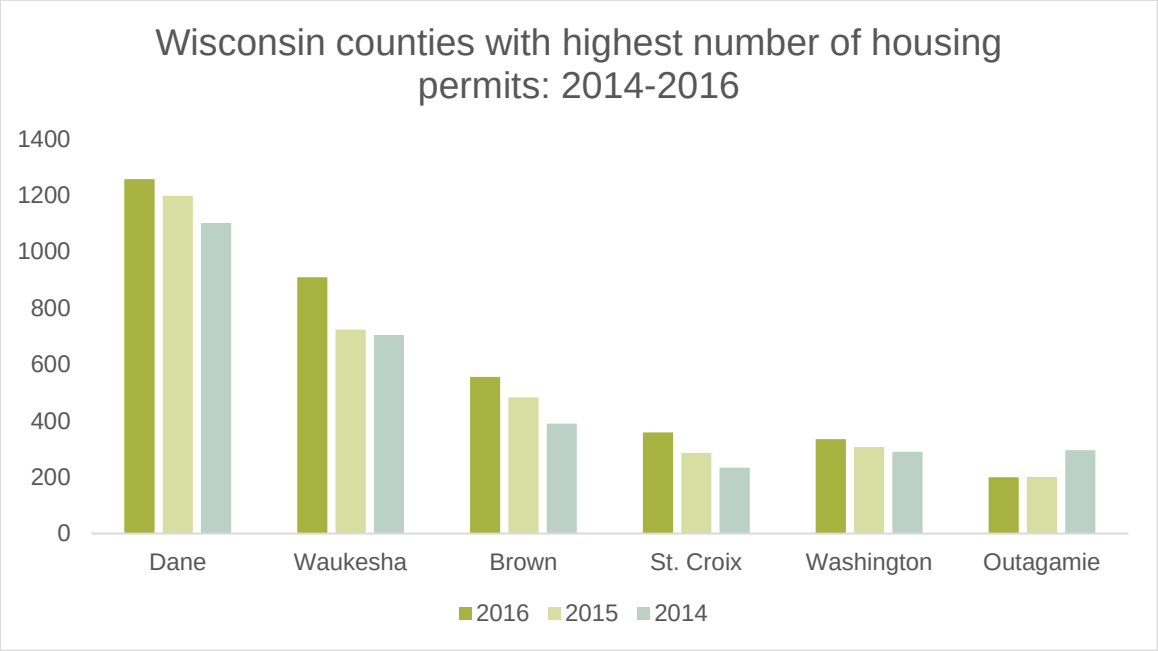


All signs point to continued growth in the new home construction market in Wisconsin, though labor shortages are a factor in limiting that growth. While the demand for housing (both new and existing) is rising (fueled by people who postponed buying a house after the economic downturn and millennials who are now marrying and having families), new home construction is not keeping up. The market (labor shortages, higher land and material costs) push the home building trend toward high end homes rather than homes for entry-level buyers.

GEOGRAPHIC MARKET SHARE

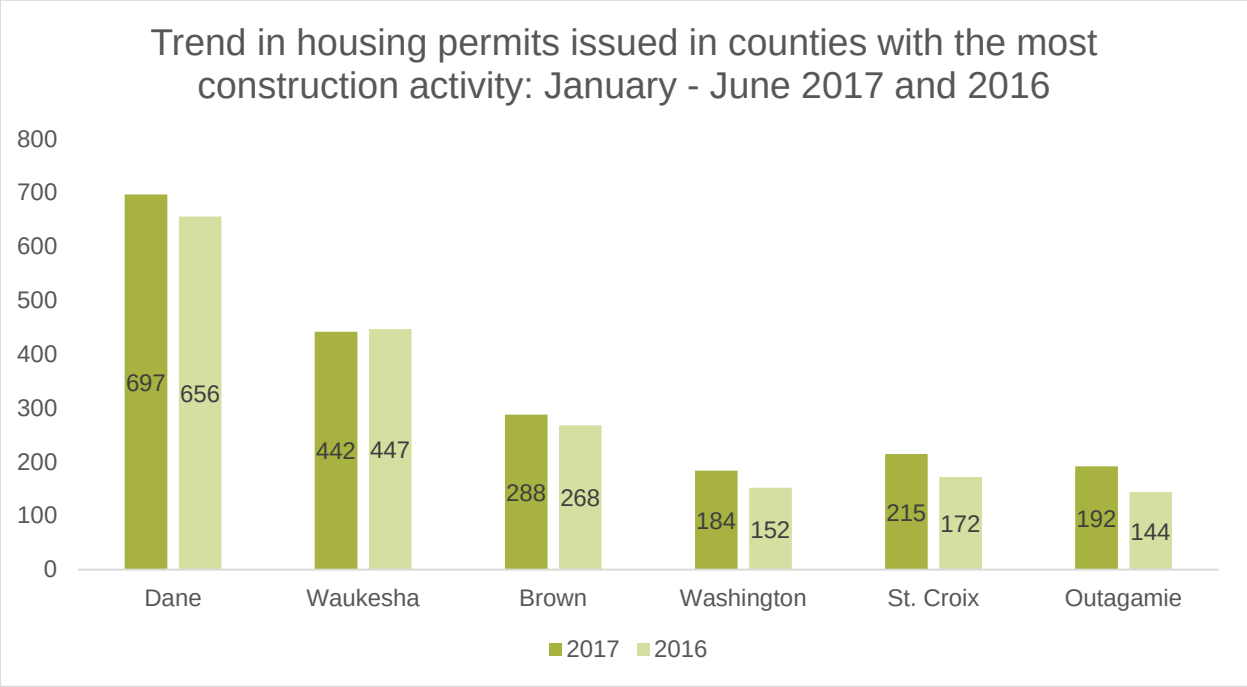
The greatest amount of single-family new home construction activity is occurring in Dane and Waukesha counties. The number of housing permits issued annually drops dramatically in the counties that round out the top five, with a sixth, Outagamie County jockeying for fifth place over the years.

Figure 26. Wisconsin counties with highest annual housing permits issued



This lineup hasn't changed in the first six months of 2017. Dane and Waukesha counties continue to have the most construction activity with lesser amounts in the other four. However, Outagamie, Washington and St. Croix counties had significant upticks in permits issued in the first six months of 2017 compared to those same months in 2016 (33%, 21% and 25% higher respectively).

Figure 27. Trend in housing permits issued in Wisconsin counties with the most construction activity: 2016 and 2017



DEMOGRAPHICS OF WISCONSIN HOUSEHOLDS IN SINGLE-FAMILY NEW HOMES

The Census Bureau's American Community Survey is an annual survey of the characteristics of U.S. households and homes.[12] We used public microdata from this survey to assess key demographic (and other) characteristics of households living in new homes in Wisconsin. In order to have a useable number of homes to analyze, we used survey responses from the period 2011 through 2015, and included homes that had been built within three years of the survey year: this provided information for 976 households.

In terms of demographics, households living in new, single-family homes in Wisconsin can be placed into three categories:

- Non-senior households with no children
- Households with children
- Senior households with no children

Families with children make up the largest category of households over the state as a whole, followed closely by non-senior households without children (Table 17). Senior households—meaning households with no children and at least one household member who is age 65 or more—constitute only about one in eight new-home households in the state. Regionally, the Northern region stands out as having fewer families with children and more non-senior households.

[12] https://www.census.gov/programs-surveys/acs/

Table 17. Demographic composition of households in new Wisconsin homes, by region within the state.

Region	Families with children	Non-senior (no children)	Senior (no children)	Total
Northeast	42%	45%	12%	100%
Northern	26%	58%	17%	100%
South Central	49%	36%	14%	100%
Southeast	52%	42%	6%	100%
West Central	54%	32%	13%	100%
Total	47%	41%	12%	100%

The median annual income for owners of new homes is $96,000, with a significant proportion earning upwards of $150,000 (Table 18). Not surprisingly, median income for owners of new homes is considerably higher than that of the Wisconsin general population ($51,500) or even that of all households residing in owner-occupied, single-family homes ($69,000).

Table 18. Annual income for households living in new Wisconsin homes.

Annual income	Percent of households
<$50,000	19%
$50,000-74,999	18%
$75,000-99,000	16%
$100,000-149,999	23%
$150,000+	24%

In addition to demographics, the ACS data also provide information on heating fuel. Statewide, natural gas is the dominant heating fuel, followed by propane (Table 19). Together, these two fuels heat 80 percent of new Wisconsin homes. Electricity heats only about one in ten new homes across the state. More than a quarter of homes in the Northern region are heated with "other" fuels, mostly wood and other biomass sources.

Table 19. Heating fuel, by region.

Region	Natural gas	Propane	Electricity	Other	Total
Northeast	67%	22%	6%	5%	100%
Northern	29%	37%	5%	28%	100%
South Central	60%	11%	20%	9%	100%
Southeast	80%	6%	10%	3%	100%
West Central	47%	31%	7%	15%	100%
Total	61%	19%	10%	10%	100%

NEW UTILITY SERVICE CONNECTIONS

In order to develop a sample frame for recruiting households for the baseline study, we requested information on all new residential service connections from January 2015 through October 2016 made by the major Wisconsin utilities, as well as for the WPPI umbrella of municipal utilities. We attempted to match instances where a home was served by separate electric and natural gas utilities, though some cases undoubtedly escaped our address-matching algorithms. We also eliminated accounts with apartment or unit numbers that would indicate a residence that was something other than a single-family home.

Altogether, this effort yielded a total of about 16,000 new accounts, with WE Energies accounting for the largest share of both electric and gas new connections. Regionally, new service connections are relatively evenly divided among the Northeast, Southeast, South Central and West Central regions, with the Northern region accounting for substantially fewer new connections.

Table 20. New utility service connections, by region.

Region	Percent of new service connections
Northeast	25%
Northern	9%
South Central	25%
Southeast	20%
West Central	22%

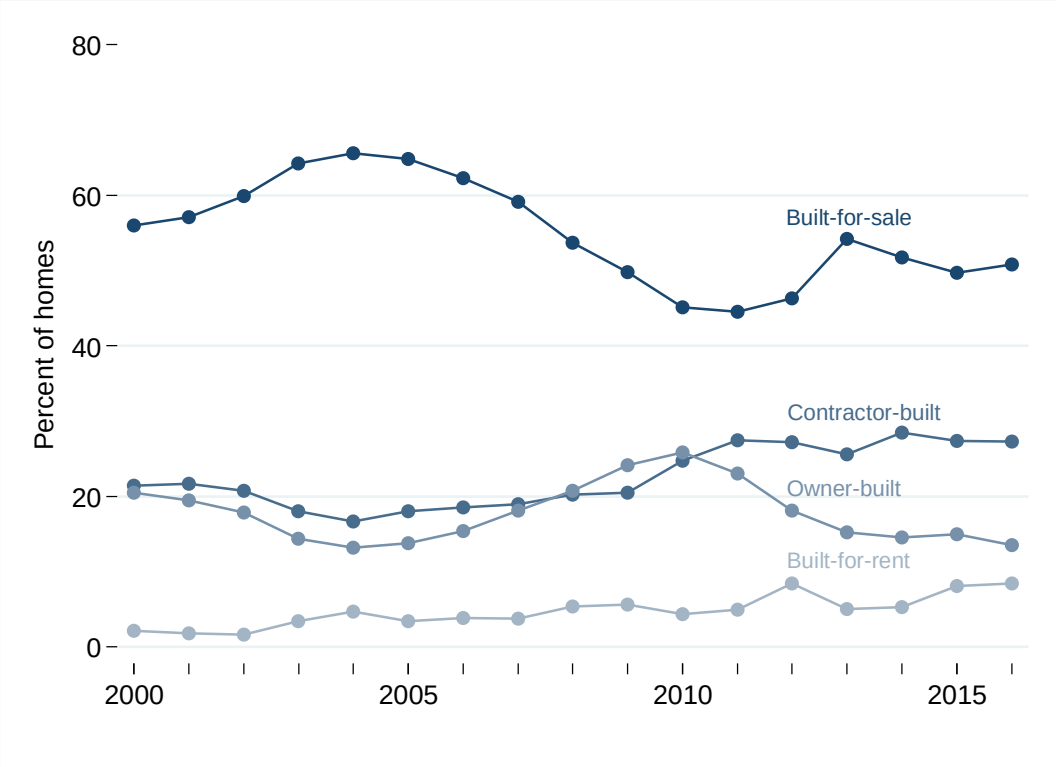
REGIONAL TRENDS IN HOUSING CHARACTERISTICS

The U.S. Census Bureau data on new housing characteristics is current through 2016 and is available by region. To shed light on regional trends over time, we looked at a number of characteristics for homes built between 2000 and 2016 in the East North Central Census Division (which includes Wisconsin, Illinois, Michigan, Indiana and Ohio).

Category
The Census data distinguishes among "built-for-sale" homes where the house and home are sold as a package, "contractor-built" homes where the owner of the land hires a general contractor to build the home, "owner-built" homes where the owner of the land acts as his/her general contractor and homes built for rent.

Regionally, most homes fall in the built-for-sale category, though the proportion has risen and fallen somewhat over the last 16 years (Figure 28). Since the recent recession, the proportion of owner-built homes has declined, and the proportion of contractor-built homes has risen somewhat.

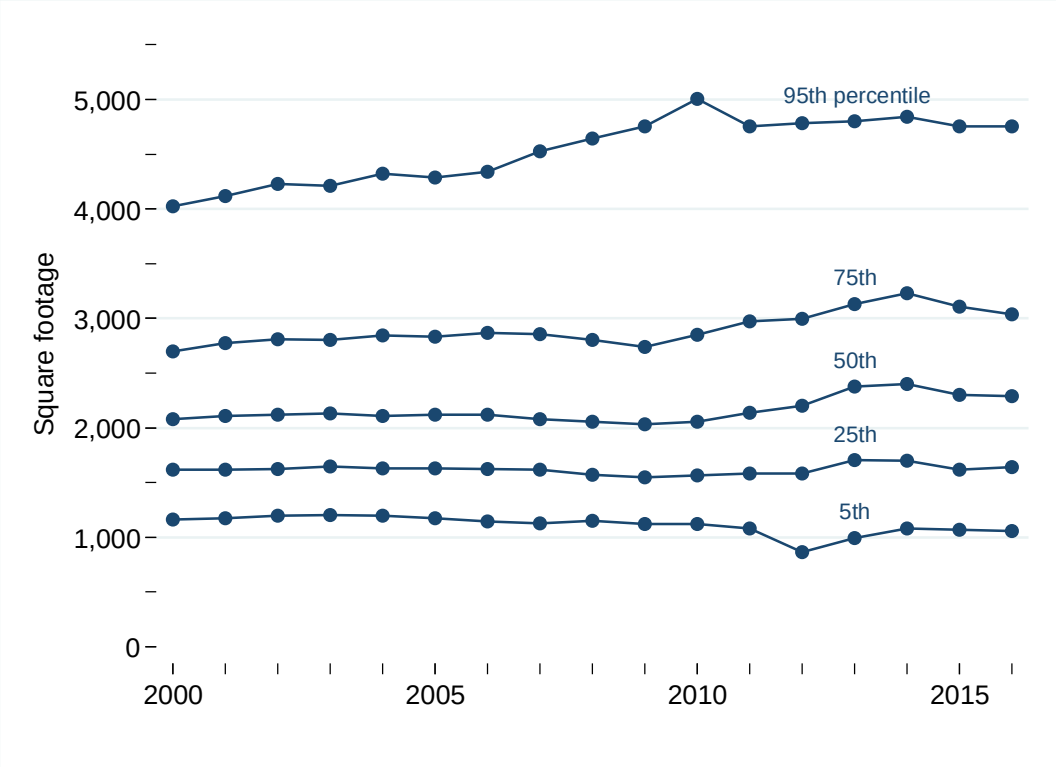
Figure 28. Home category proportions, 2000-2016 (East North Central Census Division).



Home size

Regionally, the distribution of home size (finished square footage) remained relatively unchanged from 2000 up through the recent recession (Figure 29). Since about 2010, average home sizes have increased somewhat: the median home in 2016 had 2,300 square feet of floor area, an increase of about 12 percent from the 2010 value of 2,057 square feet. Very large homes have also grown even larger over the years: the 95th percentile of home size has grown from about 4,000 square feet in 2,000 to 4,750 square feet in 2016.

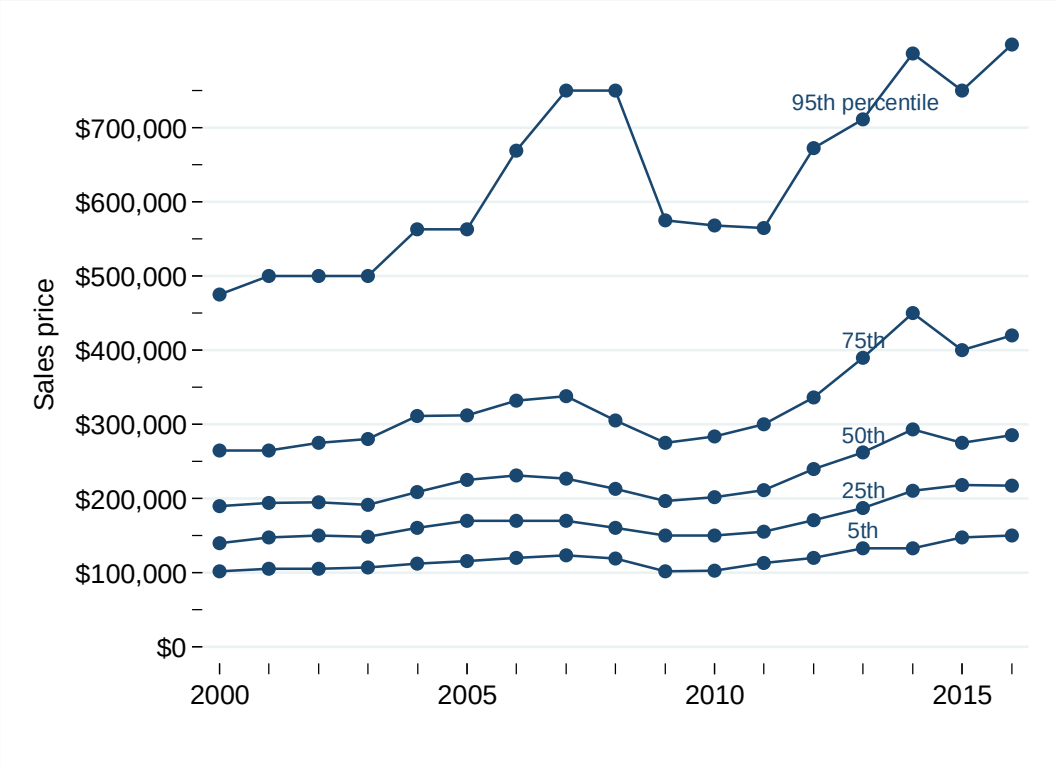
Figure 29. Percentiles of home square footage, 2000-2016 (East North Central Census Division).



Sales price

As one might expect, sales prices took a hit during the recent recession, especially among high-end homes (Figure 30). Since 2010, prices have recovered, with the median home selling for $285,000 in 2016, a 41 percent increase over the median sales price of $201,900 in 2010. Prices for high-end homes have increased even more dramatically since the recession.

Figure 30. Percentiles of sales price, 2000-2016 (East North Central Census Division).

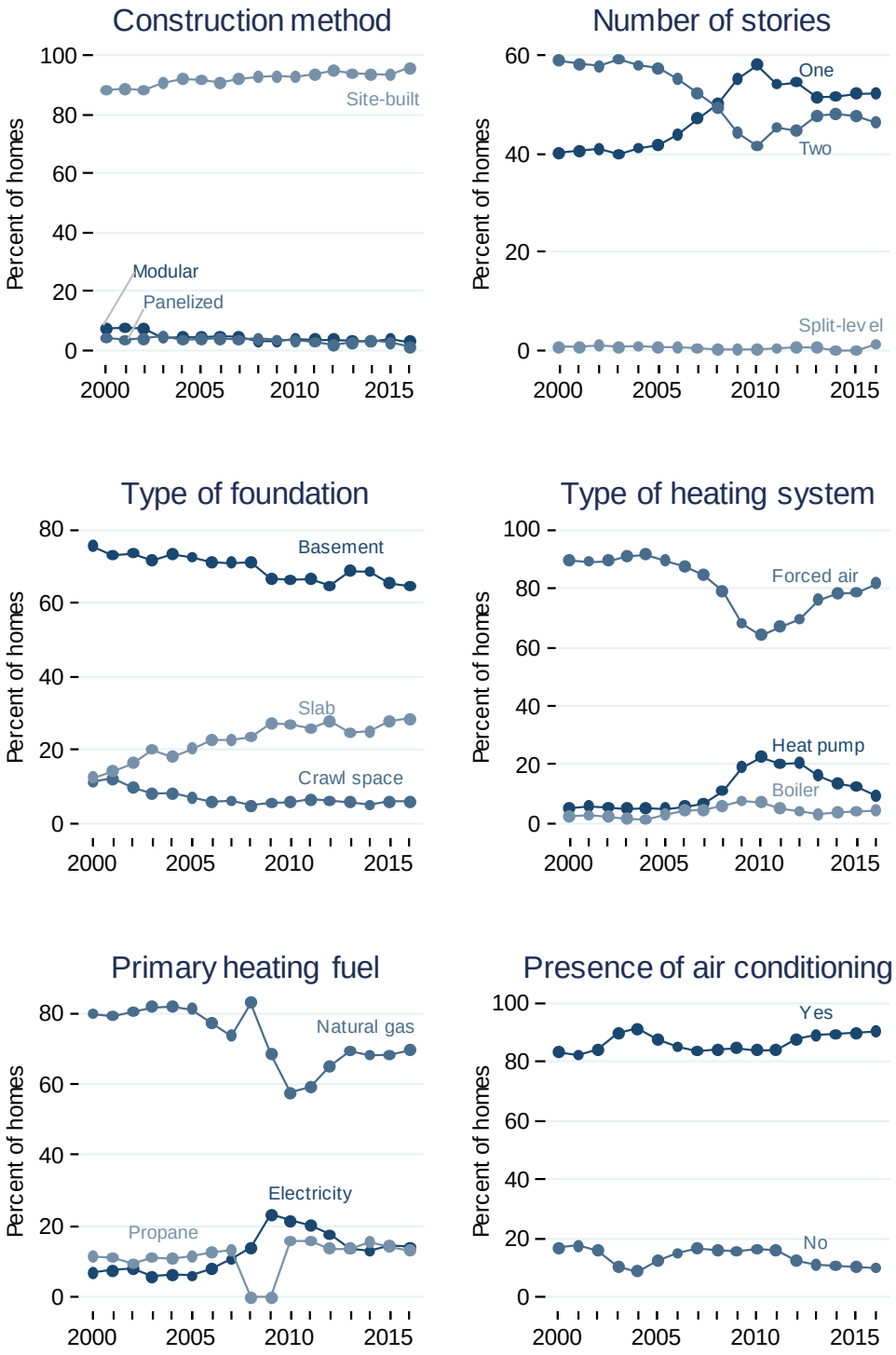


Other characteristics

The Census data provide information about regional trends in a number of other home characteristics, which we summarize graphically in (Figure 31). Notably:

- Single-story homes have become slightly more common than two-story homes in recent years;
- The proportion of slab-on-grade homes has been rising since 2000; and,
- The proportion of homes with heat pumps increased the mid-2000s (probably in response to high natural gas prices at the time), but has since fallen.

Figure 31. Selected characteristics of new homes, 2000-2016 (East North Central Census Division).



OTHER FACTORS AFFECTING NEW HOME BUILDING IN WISCONSIN

We interviewed Brad Boycks, executive director of the Wisconsin Builders Association, for his insights on the new home market in Wisconsin. This interview covered the following topics:

- Major challenges facing Wisconsin home builders
- Changes in the market over the past several years
- Effects of the changes to the energy code for 2016
- Sense of the extent to which builders exceed the code
- Considerations other than code requirements that motivate builders to construct more energy efficient homes
- Trends in new homes
- Market share for custom versus production builders

Mr. Boyck's insights included:

- The major challenge facing Wisconsin home builders is a shortage of construction workers. This labor shortage has been reported in the press[13] and, in conjunction with rising costs of framing[14] has pushed home building toward more expensive homes. Residential building construction employment is projected to increase by a little more than seven percent from 2014 to 2024.[15] In the near term (second quarter of 2015 to second quarter of 2017), though, it was projected to increase by a little over four percent (4.36 percent).

- One way the market has changed over the past several years is an increase in development closer in to urban areas.

- WBA thought that the Code council and Safety and Buildings went a bit farther than they wanted in order to use ResCheck but otherwise they have no real complaints with the Energy Code. They hear more complaints from builders with the code changes that affect wall bracing.

- WBA doesn't expect any changes to the code in the near future (not for six years).

- WBA is aware that a number of builders participate in the Focus on Energy New Homes program (particularly among those builders with the greatest market share of new homes in the state) and expects there is some influence on non-program builders given the emphasis on energy efficiency (conveyed through programs like B4) and customer requests for energy efficiency (consumers are more energy savvy now than in the past).

- One trend in new homes that WBA identified is smaller home size but with higher end features; walk-out basements; HVAC components all located in one area.

- Determining the market share for custom versus production builders is difficult in Wisconsin because Wisconsin doesn't typically have large volume production builders. Tim O'Brien homes and Veridian were identified as being larger volume builders in the state. Some (very) preliminary data from a market research company indicated that the following builders had the

[13] Gores, Paul. Economists: Wisconsin housing market needs more homes for sale. Milwaukee Journal Sentinel, Feb. 2, 2017.
[14] NAHB framing lumber prices. http://www.nahb.org/en/research/housing-economics/construction-statistics/national/framing-lumber-prices.aspx
[15] Source: Wisconsin's Worknet industry projections.

most detached home starts through August 2016: Tim O'Brien Homes, Kaerek Homes, Bielinski Homes, Korndoerfer Homes and Mastercraft Builders.

We also contacted Uniform Dwelling Code consultants at the Wisconsin Department of Safety and Professional Services for their insights on any issues builders had with the 2016 energy code changes, future changes to the code, and propensity for builders to exceed the code. Their responses included:

- The main issue they had with the change to the 2016 energy code was a hiccup with ResCheck. Recent version doesn't calculate building heat loss load so they had to do a work around. They posted a heat loss calculator on the website. They also received complaints about foundation insulation and duct testing.

- Code changes are instigated by DOE so are continually changing based on what comes out of Washington.

- Code officials estimate that 90 percent of home builders in Wisconsin build to code and 10 percent build above code.

CONCLUSIONS AND RECOMMENDATIONS

In general, the results of the baseline assessment show that non-program homes in the state are generally well-insulated, tightly-constructed and have efficient mechanical systems. The field findings from this study are generally consistent with the prior analysis of utility billing data showing small differences in energy consumption between program and non-program new homes.[16] However, it must be noted that budget constraints limited the current study to 50 non-program homes, and the results carry a five to eight percentage points of sampling uncertainty in terms of estimated space heating and cooling performance for non-program homes. Replicating the baseline study on an on-going or periodic basis would help increase confidence in the results.

Further, while the study provides for the first time a statistical picture of construction practices in Wisconsin outside the New Homes program, it cannot be assumed that these practices are free of past or current influence from the program itself. This study demonstrates that some builders of non-program homes also participate in the program—as is likely the case for subcontractors as well. The program may also have influenced construction practices in more indirect ways. Such program "spillover" effects into the non-program new-construction market could be substantial, but quantifying these was beyond the means of this study. It would be a mistake, however, to ignore these potential effects and conclude that the impacts of the program are limited to the energy-performance of program homes relative to that of non-program homes. Additional investigation of the spillover effects of the program is thus needed.

At the same time, the study does provide a useful baseline for assessing ways in which the program can continue to push the envelope in terms of energy performance for single-family homes. For example, the study shows that windows in non-program homes overwhelmingly use coatings that limit solar heat gain. This is good for reducing summer cooling loads, but also reduces beneficial solar gain during the heating season. One potential avenue for the program could be to promote the judicious use of high solar-gain glazing in south-facing windows that are exposed in the winter but shaded by overhangs in the summer.

[16] See "Focus on Energy Calendar Year 2015 Evaluation Report, Volume II," May 20, 2016, prepared by Cadmus.

It is beyond the scope of this study to fully explicate these possibilities—the ultimate success of which likely depends more on the willingness of builders to embrace proposed new approaches as they do on technical calculations of energy savings—but the study provides a basis for exploring the energy-savings potential for new approaches. Toward that end, working with the REM/Rate software vendor to incorporate a custom set of standard reference-home attributes is our recommended approach to calculating the energy-performance difference between a given proposed design and the average attributes from this study's baseline sample.

In summary, we recommend the following:

1. Conduct periodic field baseline studies like this one to build a body of knowledge about non-program practices and increase statistical confidence regarding these practices beyond what a single field study can provide.

2. Implement an effort to quantify potential spillover effects from the program into the population of non-program homes, and use the results of that study as part of the cost-effectiveness assessment of the program.

3. Use the baseline study findings to explore new avenues to increase the energy performance of program homes.

4. Codify the current baseline study's results in a set of customized standard reference home design parameters in the REM/Rate software using values provided in Appendix E.

APPENDIX A: PARTICIPANT RECRUITMENT SCRIPT

Recruitment Script

Hello, my name is _____ and I'm calling on behalf of Focus on Energy, your statewide energy efficiency program. This isn't a sales call: I'm actually calling about a research project.

(Q1) **First, can you confirm that you're 18 years or older?**

1 *Yes*
2 *No* → [ask to speak with an adult member of the household, and start script from beginning]

(Q1a) **Now I need some information about your household. Is anyone in your household under the age of 18?**

1. *Yes*
2. *No*

(Q1b) **Is anyone in your household 65 years of age or older?**

1. *Yes*
2. *No*

We're recruiting a random sample of new home owners in Wisconsin to participate in a research study about the construction of new homes. Participants get a $100 Visa gift card and a free thermal scan and air-leakage test.

(Q2) **Is that something you might be interested in?**

1 *Yes* → CONTINUE TO Q2a
2 *No* → SKIP TO Q2b
3 *Not sure* → SKIP TO Q2c

(Q2a) [Q2= "Yes"] **OK, great! I have a few questions to make sure that you qualify for the study. This will just take a couple of minutes.** [skip to Q3]

(Q2b) [Q2= "No"] **OK, that's fine. To help us with our research study, would you answer a few quick questions about your home before we hang up?**

1 *Yes* → SKIP TO Q3
2 *No* → **OK, thank you for your time.** [terminate]

(Q2c) [Q2= "Not sure"] **I can give you some more details about the study to help you decide, but first I have a few questions to make sure that you qualify for the study.**

(Q3) **Do you currently live in a single-family home that was built in the last two years?**

1 Yes
2 *No* → **We're interested only in new single-family homes. Thank you for your time.** [terminate]
3 *Not sure* → [continue]

(Q4) **Just to be clear, it is a NEW home, right—first occupied by you in 2015 or 2016?**

1 *Yes*
2 *No* → **We're interested only in new single-family homes. Thank you for your time.** [terminate]
3 *Not sure* → **OK thank you for your time.** [terminate]

(Q5) **…and your home is a single-family home, not a condo or apartment, right?**

1 *Yes (single-family)*
2 *No* (multifamily) → **We're interested only in new single-family homes. Thank you for your time.** [terminate]
3 *Not sure* → [clarify that single-family homes are not attached to any other home or structure]

(Q6) **Is your home a mobile home?**

4 *Yes* → **We're interested only in new single-family homes and not mobile homes. Thank you for your time.** [terminate]
1 *No*
2 *Not sure* → [clarify that mobile homes (also called manufactured homes) are built in a factory on a permanent steel chassis, and towed to their location. This is different than a modular or "prefab" home, which is also built in a factory, but assembled at the site and does not have a permanent steel chassis. Modular homes DO qualify for the study; mobile homes do not.]

(Q7) **Do you own or rent your home?**

1 *Own*
2 *Rent* → **We're interested is speaking with homeowners only. Thank you for your time.** [terminate]

(Q8) **Which of the following statements best describes your involvement in the design and construction of your home?**

1 *I worked with my builder to customize the floor plan of my home to my needs.*
2 *I selected my floor plan from among choices that my builder offered.*
3 *I purchased a home that was already built.*
4 *[not sure]*

(Q9) **What is the main fuel that you use to heat your house? Is it.. [read]**

1 *Natural gas*
2 *Propane or LP*
3 *Electricity, such as for geothermal heating, a heat pump, or baseboard electricity*
4 *Wood or pellets*
5 *Something else*
6 *[not sure]*

[if Q2= "Yes" AND Q9 <> natural gas or propane] **Our study is just for homes that heat with natural gas or propane. But thank you for your time.** [terminate]

(Q10) **Is your home certified under the Focus on Energy New Homes Program?**

1 *Yes*
[if Q2= "Yes"] → **Our study is just for homes that aren't part of that program. But thank you for your time.** [terminate]
2 *No*
3 *Not sure* → [if needed, explain that the New Homes program pairs prospective homeowners with builders and energy experts to construct new homes that exceed code.

(Q10a) **Could you tell me the name of the company or person who built your house?**

1 Record builder's name and contact information, if available
Builder's name

Builder's contact information (phone?, address?) ➔ thank you, I just need a moment to see if your builder is on the Focus on Energy New Homes Program list.
[Crosscheck builder name against list of participating builders.]

2 *Don't know*

If builder appears on the program list: **Thank you for your time but your builder participates in the Focus on Energy New Homes Program so your home does not qualify for our study**. [terminate]

[Q10 = No or not sure AND Q10a builder **does not** appear on program list OR Q10a = don't know] ➔ Q11

[Q2= "No"] **Thank you for your time. Based on your answers you qualify for the study. Would you reconsider and agree to participate?**

[If no – thank and terminate]

[If yes – Continue to Q11 (begin with second sentence).]

(Q11) **It looks like you qualify for our study. Could I give you a few details about the study, and perhaps schedule a time for a visit?**

1 *Yes* → **OK, great!**
2 *No* → **OK, thank you for your time.** [terminate]
3 *Not sure* → **OK, let me tell you a little more about it.**

If you participate in the study, we'll schedule a time when we'll be in the area—and that works for you—for a technician to come out to look at insulation levels, and record information about your lights and appliances. They'll also do an air leakage test, a duct leakage test and do a thermal scan of your home, and so will need access to all rooms in the home. The whole visit typically takes about four hours. Someone needs to be home, but you can go about your business during the visit. At the end of the visit, the technician will discuss any notable findings with you, and provide you with a $100 Visa gift card.

(Q12) **Could we schedule a time for a site visit?**

1 *Yes* → **OK, great! I just need to get some details from you**
2 *No* → **OK, thank you for your time.** [terminate]
3 *Not sure* → **Could I mail or e-mail you some additional information for you to look over before you decide?**

(Q12a) **Please give me your name, address, telephone number and e-mail address.**

Name:
Address:
[If provided address does NOT match premise address on record, re-confirm address, and that home is a new, single-family building. Flag for cross-checking against program list.]

Phone:
Email:

(Q12b) **What is the total square footage of your home?**

1 Record number _____
2 Don't know

Schedule date and time for visit

[if scheduled] **I'll send you some additional information about the study so you know what to expect, and we'll contact you a day or two before the visit to confirm the appointment.** [if no email provided in Q12a] **Could I get an e-mail address for that?** [record e-mail address]

[if email provided in Q12a] **I'd just like to confirm your e-mail address. Is it** [insert email address from Q12a].

[if still unsure] **I'll send you some additional information about the study so you know what to expect, and call back in a few days to talk it over again.**
[if no email provided in Q12a] **Could I get an e-mail address for that?** [record e-mail address]

[if email provided in Q12a] **I'd just like to confirm your e-mail address. Is it** [insert email address from Q12a].

Thank you for your time!

APPENDIX B: SITE VISIT DATA COLLECTION -- PAPER FORM

focus on energy
Partnering with Wisconsin utilities

New Homes Baseline Study

Rating/Building Name:		Date:	

Property Information:

Home Type	Builder Built			
Home Owner 1	First name:		Last Name:	
Home Owner 2	First name:		Last Name:	
Address:				
City:			Zip Code:	
Phone Number:		Email:		

Builder Information: If available

Company Name:			
Address:			
City:		Zip Code:	

Consultant Information:

Company Name:	Seventhwave		
Consultant Name:	John Viner		
Phone Number:	608-210-7146	Email:	jviner@seventhwave.org

Utility Information:

Electric Company:	
Account Number:	

Natural Gas Company:	
Account Number:	
LP Company: (if available)	

Construction Type:

Construction Type:	Stick Built

General Building Information:

Finished Floor Area:	
Housing Type:	
Number of Bedrooms:	

Brick Façade?	
Floors Above Grade:	
Foundation Type:	

Dishwasher: EF (if available)
Refrigerator: Annual KWH/yr

Photo of nameplate if available
Photo of nameplate if available

Building Orientation:

Front of Home Faces:							
	North		South		East		West
	Northeast		Southwest		Southeast		Northwest

Rating/Building Name:		Date:	

Building Calculations:

Areas	Perimeter (ft)	Wall Height (ft)	Area of Conditioned Space	Volume of Conditioned Space (cu. ft.)	Slope/Tray Ceiling Volume (cu. ft.)	Total Volume (cu. ft.)
Basement						
First Floor						
Mid Floor						
Second floor						
Third Floor						
Other						
Other						
Grand Totals						

Foundation Wall Properties:

Name:	FW-Amb	FW-Gar	FW-	FW-	FW-	FW-
Cavity (Interior) Insulation (R-Value):						
Continuous (ext) Insulation (R-Value):						
Length (ft):						
Height (ft):						
Area (sq. ft.):						
Height Above Grade (ft):						
Location:	Ambient	Garage				

Slab Floor Properties Summary:

Name:	Slab-1	Slab-	Slab-3	Slab-4	Slab-5	Slab-6
Under Slab Insulation (R-Value):						
Perimeter Insulation (R-Value):						
Area (sq. ft.):						
Depth Below Grade (ft):						
Full Perimeter (ft):						
Total Exposed Perimeter (ft):						
On-grade Exposed Perimeter (ft):						

Rating/Building Name:		Date:	

Frame Floor Properties Summary:

Name:	FF-Amb	FF-Gar	FF-	FF-	FF-	FF-
Length (ft):						
Width (ft):						
Area (sq. ft.):						
Cavity Insulation (R-Value):						
Exterior Insulation (R-Value):						
Location:	Ambient	Garage				

Rim and Band Joist Properties Summary:

Name:	Rim-Amb	Rim-Gar	Rim-	Band-Amb	Band-	Band- Attic
Length (ft):						
Height (ft):						
Area (sq. ft.):						
Exterior Insulation (R-Value):						
Joist Cavity Insulation (R-Value):						
Joist Cavity Insulation Thickness						
Joist Spacing (in. on-center):						
Location:	Ambient	Garage		Ambient		Attic

Above-Grade Wall Properties Summary:

Name:	AGW-Amb	AGW-Gar	AGW-Attic	AGW-	AGW-	AGW-
Cavity Insulation (R-Value):						
Exterior Insulation (R-Value):						
Stud Spacing & Size (00-0x0):						
Length (ft):						
Height (ft):						
Area (sq. ft.):						
Exterior Color:	Medium	Medium	Medium	Medium	Medium	Medium
Location:	Ambient	Garage	Attic			

Rating/Building Name:		Date:	

Window and Glass Door Properties Summary:

Refer to Window and Glass Door worksheet tab

Door Properties Summary:

Name:	Front	Garage	Side			
Opaque Area:						
Type:						
Is there a storm door?						
R-Value:						
Wall Assignment:	AGW-Amb	AGW-Gar	AGW-Amb	AGW-	AGW-	AGW-

Ceiling Properties Summary:

Name:	CLG-Flat	CLG-Vaulted	CLG-	CLG-	CLG-	CLG-
Insulation (R-Value):						
Length:						
Width:						
Joist/truss spacing and size						
Area Multiplier (vaulted ceilings only):	1	1	1	1	1	1
Area (sq. ft.):					0	0
Exterior Color:	Medium	Medium	Medium	Medium	Medium	Medium

Skylight Properties Summary:

Name:	Skylight-1	Skylight-2	Skylight-3	Skylight-4	Skylight-5	Skylight-6
U-factor / Solar Heat Gain Coefficient:						
Length:						
Width:						
Area (sq. ft.):					0.00	0.00
Winter Shading Factor:						
Summer Shading Factor:						
Orientation:						
Ceiling Assignment:						

Total of Areas

Rating/Building Name:		Date:	

Mechanical Equipment Verification:

(Note: Additional REM/*Rate* inputs are required for Air and Ground Source Heat Pumps, and Duel Fuel heat pump systems. Record the appropriate information in your files)

USING TABLET - Take photos of heating/cooling equipment from afar and nameplate
If boiler check for outdoor reset

Heating System 1 - Type:		Fuel Type:	
Manufacturer:			
Model Number:			
Output capacity (kbtu/h)			
Seasonal Efficiency Value:		Value Type:	
AHRI Certified Ref No.			
AHRI Directory:	http://www.ahridirectory.org/ahridirectory/pages/home.aspx		

Heating System 2 - Type:		Fuel Type:	
Manufacturer:			
Model Number:			
Output capacity (kbtu/h)			
Seasonal Efficiency Value:		Value Type:	
AHRI Certified Ref No.			

Space Cooling:

Cooling System 1 - Type:		Fuel Type:	
Manufacturer:			
Condenser Model Number:			
Evaporator Model Number:			
Seasonal Efficiency Value:		Value Type:	

Cooling System 2 - Type:		Fuel Type:	
Manufacturer:			
Evaporator Model Number:			
Condenser Model Number:			
Seasonal Efficiency Value:		Value Type:	

Rating/Building Name:		Date:	

Water Heating:

Water Htg System 1-Type:						Fuel Type:	
Manufacturer:							
Model Number:							
Energy Factor:		# of Gallons:		Tankless		Geothermal Desuperheater?	
AHRI Directory:	http://www.ahridirectory.org/ahridirectory/pages/home.aspx						

Water Htg System 2-Type:						Fuel Type:	
Manufacturer:							
Model Number:							
Energy Factor:		# of Gallons:		Tankless		Geothermal Desuperheater?	

Duct Distribution System:

	Flow @25pa
Total Duct Leakage	
Duct Leakage to outside	

Number of return grills: RA SA

Percent ducts in unconditioned space

Solid Fuel Burning/Fireplace Design:

Manufacturer:	
Model Number:	

Air Tightness:

	Flow @50pa
Whole House	
Shelter class (1-5)	

Min. 5 point test, remember to do baseline

Whole House Ventilation: (If no ventilation system dedicated to whole house IAQ, SKIP)

Select only one type					
Bath Fan		**HRV/ERV (NOT TESTING)**		**Central Exhaust**	
	Tested Flow (cfm)		Tested Flow (cfm)		Tested Flow (cfm)

If HRV, record make and model

Spot Ventilation for two mainly used Bathrooms:

Exhaust Fan System:		
Tested Flow		

Fan Watts, if available

Rating/Building Name:		Date:	

Based on Plans Drawing:

APPENDIX C: SITE VISIT DATA COLLECTION – TABLET FORM

New Homes Baseline

Field	Question	Answer
intronote	This is the New Homes Baseline data collection form. Please swipe forward or use arrows below to continue.	
Basic data		
bldgid	Building ID	O
address	Building address	
city	Building city	
researcher	Researcher	John John Kevin Kevin
date	Date of site visit	
Exterior Photos		
(Group only displayed for those who consent.)		
exterior_north	Exterior photo - North	
exterior_east	Exterior photo - East	
exterior_south	Exterior photo - South	
exterior_west	Exterior photo - West	
Interview		
Interview > Occupants & tstat type		
occ_adults	Number of adults (18-64 yrs)	
occ_mature_adults	Number of adults (65+ yrs)	
occ_young_children	Number of young children (0-6 yrs)	
occ_minors	Number of minors (7-17 yrs)	
tstat_type	What kind of thermostat do you have?	1 Non-programmable 2 Programmable 3 Connected thermostat
Interview > Tstat details		
tstat_program_winter	Do you set the programmable thermostat in the WINTER?	1 Yes 0 No
tstat_program_summer	Do you set the programmable thermostat in the SUMMER?	1 Yes 0 No
tstat_smart_makemodel	Write down make and model of the smart thermostat *Separate the make and model with a "/"*	
tstat_winter_day	Thermostat setpoint - winter day	

Field	Question	Answer
tstat_winter_night	Thermostat setpoint - winter night	
tstat_winter_away	Thermostat setpoint - winter away	
tstat_summer_day	Thermostat setpoint - summer day	
tstat_summer_night	Thermostat setpoint - summer night	
tstat_summer_away	Thermostat setpoint - summer away	
Interview > Other systems		
furnacefan_winter	Describe furnace fan operation in WINTER	1 Always on 2 Sometimes on 3 Not applicable
furnacefan_summer	Describe furnace fan operation in SUMMER	1 Always on 2 Sometimes on 3 Not applicable
hrv_erv	Describe HRV / ERV operations	1 Not present 2 Not used 3 Used as needed 4 Runs continuously
dehumidifier_qty	Number of dehumidifiers	
ceilingfan_qty	How many ceiling fans are there?	
radon	Do youhave a radon system?	1 Yes 0 No
Interview > Supp heating		
supp_htg_note	The following questions are on any supplemental heating you find in the home. Swipe forward to add new entries.	
Interview > Supp heating > Supplemental Heating (1)		(Repeated group)
Interview > Supp heating > Supplemental Heating (1) > Supp heating group		
supp_htg_type	What type of supplemental heating	1 Natural gas or LP fireplace 2 Natural gas or LP garage heater 3 Wood fireplace 4 Other, describe below.
supp_htg_other	Describe "other:"	
supp_htg_loc	In what room is the supp heating located?	
supp_htg_use	How often do you use this supplemental heating?	1 Daily 2 A few times a week

Field	Question	Answer
		3 A few times a month
		4 Rarely or never
supp_htg_desc	Provide additional information on supplemental heating here	
Heating system 1		
htg_sys_type1	What's the type of the heating system 1?	1 Furnace 2 Boiler 3 Free-standing stove 4 Other, describe below.
htg_sys_other1	Describe the "other" heating type here	
htg_sys_fuel1	What type of fuel does the heating system 1 use?	1 Natural Gas 2 Propane 3 Oil 4 Wood 5 Pellet
htg_sys_make1	Make	
htg_sys_model1	Model	
htg_distance_pic1	Take a distance picture	
htg_nameplate_pic1	Take a picture of the nameplate	
htg_other_pic1	Take another picture, if needed	
htg_zone1	Is this heating system zoned?	1 Yes 0 No
htg_humid1	Is there a humidifier?	1 Yes 0 No
htg_zone_desc1	If yes, describe the zoned heating *Leave blank if not zoned*	
htg_sys_desc1	Provide additional notes on heating system 1	
Heating system 2		
htg_sys_type2	What's the type of the heating system 2?	1 Furnace 2 Boiler 3 Free-standing stove 4 Other, describe below.
htg_sys_other2	Describe the "other" heating type here	
htg_sys_fuel2	What type of fuel does the heating system 2 use?	1 Natural Gas 2 Propane

Field	Question	Answer
		3 Oil 4 Wood 5 Pellet
htg_sys_make2	Make	
htg_sys_model2	Model	
htg_nameplate_pic2	Take a picture of the nameplate	
htg_distance_pic2	Take a distance picture	
htg_other_pic2	Take another picture, if needed	
htg_zone2	Is this heating system zoned?	1 Yes 0 No
htg_humid2	Is there a humidifier?	1 Yes 0 No
htg_zone_desc2	If yes, describe the zoned heating *Leave blank if not zoned*	
htg_sys_desc2	Provide additional notes on heating system 2	
Cooling system 1		
clg_condensor_make1	Condenser make	
clg_condensor_model1	Condenser model	
clg_nameplate_pic1	Take a picture of the nameplate	
clg_distance_pic1	Take a distance picture	
clg_other_pic1	Take another picture, if needed	
clg_evaporator_make1	Evaporator make	
clg_evaporator_model1	Evaporator model	
clg_evap_nameplate_pic1	Evaporator nameplate	
clg_sys_desc1	Provide additional notes on cooling system 1	
Cooling system 2		
clg_condensor_make2	Condenser make	
clg_condensor_model2	Condenser model	
clg_nameplate_pic2	Take a picture of the nameplate	
clg_distance_pic2	Take a distance picture	
clg_other_pic2	Take another picture, if needed	
clg_evaporator_make2	Evaporator make	
clg_evaporator_model2	Evaporator model	
clg_evap_nameplate_pic2	Evaporator nameplate	
clg_sys_desc2	Provide additional notes on cooling system 2	

Field	Question	Answer
DHW		
dhw_make	Make	
dhw_model	Model	
dhw_recirc	Is there a recirculation system present? *If yes, provide detail in the notes below*	1 Yes 0 No
dhw_nameplate_pic	Take a picture of the nameplate	
dhw_distance_pic	Take a distance picture	
dhw_other_pic	Take another picture, if needed	
dhw_desc	Provide additional notes on the DHW system	
HRV/ERV		
hrv_make	Make	
hrv_model	Model	
hrv_nameplate_pic	Take a picture of the nameplate	
hrv_distance_pic	Take a distance picture	
hrv_control	What is the control strategy?	
hrv_location_pickup	Location(s) of stale-air pick-ups	
hrv_location_delivery	Location(s) of fresh-air delivery	
hrv_desc	Provide additional notes on the HRV/ERV	
Lighting		
lighting_note	The following questions are on lighting you find in the home. Swipe forward to add new entries.	
Lighting > Supplemental Heating (1)		(Repeated group)
Lighting > Supplemental Heating (1) > Supp heating group		
lighting_type	Type of luminaire	1 Incandescent/halogen 2 Compact fluorescent: plug-in 3 Compact fluorescent: screw-in 4 Linear Fluorescent 5 LED
lighting_loc	Room location	
lighting_bulbtype	Bulb type	
lighting_bulbqty	Bulb qty	
lighting_watt	Wattage	
lighting_control	Switch/control	1 switch

Field	Question	Answer
		2 dimmer
		3 timer
		4 motion
lighting_desc	Provide additional notes on lighting	
Refrigeration		
		1 Top freezer
		2 Bottom freezer
refr_primary_type	What's the primary refrigerator?	3 Side-by-side
		4 French door
		5 Single door
refr_primary_nameplate_pic	Take a picture of the nameplate	
refr_primary_desc	Provide additional notes on the primary fridge	
Supplemental refrigeration		
refr_supp_yesno	Are there any supplemental fridges or freezers	1 Yes
		0 No
Supplemental refrigeration > Supplemental Heating (1)		(Repeated group)
Supplemental refrigeration > Supplemental Heating (1) > Supp heating group		
		1 Top freezer
		2 Bottom freezer
refr_supp_type	What type of supplemental refrigeration?	3 Side-by-side
		4 French door
		5 Single door
		1 Kitchen
		2 Basement
refr_supp_loc	Where's it located?	3 Enclosed porch
		4 Garage
		5 Other, describe below.
refr_supp_nameplate_pic	Take a picture of the nameplate	
refr_supp_desc	Provide additional notes on the supplemental refrigeration	
Appliances		
appliances_intro	The following questions are on appliances you find in the home *Notes field is at the end of the appliance section*	
Appliances > Dishwasher		
dishwasher_nameplate_pic	Take a picture of the dishwasher nameplate	
dishwasher_distance_pic	Take a distance picture	

Field	Question	Answer
Appliances > Range/oven		
range_fuel	What type of fuel does the range/oven use?	1 Electric 2 Natural gas or propane
range_vent	Is there a range hood?	1 Present, vented outside 2 Present, not vented outside 3 Not present
Appliances > Clothes washer		
clothes_nameplate_pic	Take a picture of the clothes washer nameplate	
clothes_distance_pic	Take a distance picture	
Appliances > Dryer		
dryer_fuel	What fuel does the dryer use?	1 Electric 2 Natural gas or propane
dryer_vent	Does it vent to the outside?	1 Yes 0 No
appliance_desc	Provide additional notes on appliances	
Blower door		
bd_airleakage	Write down the air leakage (CFM50)	
ductleak	Write down duct leakage to outside (CFM25)	
bd_pic	Take a picture of the DG700 gauge showing the air leakage (CFM50)	
ductleak_pic	Take a picture of the DG700 gauge showing the duct leakage information (CFM25)	
bd_notes	Provide additional notes on the blower door	
Modeling Assumptions and notes		
assumptions_note	Provide modeling assumptions and notes for the following:	
assumptions_floorassembly	Floor / Floor assembly	
assumptions_walls	Walls	
assumptions_roofassembly	Roof assembly	
assumptions_rimjoist	Rim joist	
assumptions_doors	Doors	
assumptions_windows	Windows	
assumptions_skylights	Skylights	

Field	Question	Answer
assumptions_airleakage	Air leakage	
assumptions_distribution	Distribution	
assumptions_htg	Heating equipment	
assumptions_clg	Cooling equipment	
assumptions_dhw	Domestic hot water equipment	
assumptions_control	Control systems	
assumptions_light	Light fixtures	
assumptions_refrigerator	Refrigerator(s)	
assumptions_dishwasher	Dishwasher(s)	
assumptions_ceilingfan	Ceiling fans	
assumptions_vent	Mechnical ventilation system(s)	
assumptions_powergen	On-site power generation	
assumptions_other	Additional assumptions	
Ad hoc		
adhoc_intro	The following questions are on for items not on the tablet for which you'd like to record	
Ad hoc > Ad hoc repeat (1)		(Repeated group)
Ad hoc > Ad hoc repeat (1) > Ad hoc grp		
adhoc_type	What's the nature of this adhoc record?	1 Potentially an EE opportunity 2 Additional detail to add to another section of the form. 3 Important energy use that's not captured elsewhere 4 Something else, describe in detail below.
adhoc_desc	Provide detail about what the adhoc is	
adhoc_pic1	Take a picture	
adhoc_pic2	Take another picture, if needed	
Gift card		
giftcard_note	Provide the gift card for the participant and thank them for participation *swipe forward to fill out name and collect signature*	

Field	Question	Answer
giftcard_name	Name of gift card recipient *The name you fill in here will appear on the signature screen*	
giftcard_signature_pic	My signature below confirms that I, [giftcard_name], have received a $100 gift card as a thank-you for participating in the Focus on Energy New Homes baseline study.	
Final notes		
final_notes	Provide additional detail about the site here, if not captured elsewhere.	

APPENDIX D: FINAL REM/RATE USER-DEFINED REFERENCE HOME SCRIPT FOR ANALYSIS OF STANDARD REFERENCE-HOME CONDITIONS

```
UDRH
Label: "WI Baseline (2017)"
AreaRange: -1 -1
Dates: Jan 1, -1 Dec 31, -1
HtgFuelType: All
; The first six lines must have the above format.

ClimateLocation: "All"

SetBothReferenceAndAsIsBuildings

Thermostat:  68 True 75 True
WindowInteriorShading: All All 0.5 0.5

SetReferenceBuildingOnly

CeilingUo:  Attic 0.02163
CeilingUo:  SealedAttic 0.02163
CeilingUo:  Vaulted 0.04751
AGWallUo:  All 0.06903
FndWallUo:  All 0.16509
JoistUo:  All 0.07885
FrameFloorUo:  All 0.04671
SlabFloorLibraryValues:  BelowGrade RadiantNo 0  0 1.245 4.0  No
WindowUo: All All 0.3039
WindowSHGC: All  All 0.3145
DoorUo:    All 0.2163
Infiltration: 1.878 1.878 ACH50 NoChange
DuctLeakageSupplyReturn: 23.91 35.86 CFM25
MechanicalVentilation: All Balanced 20.214  65 24 15 -1 15
HeatingLibraryValues: Gas FuelFiredAirDistribution Gas FuelFiredAirDistribution -1 0
95.24 AFUE 590 Eae 0 0 Watts
HeatingLibraryValues: Gas FuelFiredHydronicDistribution Gas
FuelFiredHydronicDistribution  -1 0 95.24 AFUE -1 NoChange -1 -1 NoChange
CoolingLibraryValues:  Electric AirConditioner NoChange NoChange -1 13.29 SEER -1 0 0
Watts
WaterHeatingLibraryValues:  Gas All NoChange Conventional  0.661 0.80 50 0
WaterHeatingLibraryValues:  Electric All NoChange Conventional  0.901 0.98 50 0
LALightingFanValues: 1.9 65.3 73.9 60.5 -1
PhotovoltaicEliminate:
ActiveSolarEliminate:
SunspaceEliminate:
```

APPENDIX E:
PROPOSED FOCUS ON ENERGY NEW HOMES PROGRAM TABLE FOR ASSESSING SAVINGS RELATIVE TO STUDY-DERIVED STANDARD REFERENCE DESIGN

Building Component	Reference Design	Proposed Design
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame	As proposed
	Gross area: same as proposed	As proposed
	U−Factor: 0.0690	As proposed
	Solar absorptance = 0.75	As proposed
	Emittance = 0.90	As proposed
Basement and crawlspace walls	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U−Factor: 0.1650	As proposed
Above-grade floors	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U−Factor: 0.04671	As proposed
Ceilings	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U−Factor: open or sealed attic, 0.02163; vaulted, 0.04751	As proposed
Roofs	Type: composition shingle on wood sheathing	As proposed
	Gross area: same as proposed	As proposed
	Solar absorptance = 0.75	As proposed
	Emittance = 0.90	As proposed
Attics	Type: vented with aperture = 1 ft^2 per 300 ft^2 ceiling area	As proposed
Foundations	Type: same as proposed	As proposed
Doors	**Total area: same as proposed**	As proposed
	Orientation: same as proposed	As proposed
	U−Factor: 0.2163	As proposed
Glazing	**Total area: same as proposed**	As proposed
	Orientation: same as proposed	As proposed
	U−Factor: 0.3039	As proposed
	SHGC: 0.3145	As proposed
	Interior shade fraction: Summer, 0.70; Winter, 0.85	Same as standard reference design
	External shading: none	As proposed
Skylights	U−Factor: from Table 322.31−2	As proposed
Thermally isolated sunrooms	None	As proposed
Air exchange rate	**air leakage: ACH50 = 1.878** **Mechanical ventilation: balanced ventilation system with 20.2 cfm of continuous ventilation, sensible recovery efficiency of 65% and total recovery efficiency of 15%.**	For residences that are not tested, the same as the standard reference design; For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate but not less than 0.35 ACH; For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate combined with the mechanical ventilation rate, which may not be less than 0.01 X FFA + 7.5 X (N br + 1) where: FFA = finished floor area N br = number of bedrooms
Mechanical ventilation	**15 watts of electrical power draw**	As proposed
Internal gains	IGain = 17,900 + 23.8 x CFA + 4,104 X N br	Same as standard reference design

Building Component	Reference Design	Proposed Design
	(Btu/day per dwelling unit)	
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element but not integral to the building envelope or structure
Structural mass	For masonry floor slabs, 80% of floor area covered by R−2 carpet and pad, and 20% of floor directly exposed to room air;	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table 322.31−2 located on the interior side of the walls;	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed
Heating systems	Fuel type: same as proposed	As proposed
	Electric: air−source heat pump with prevailing federal minimum efficiency;	As proposed
	Nonelectric furnace efficiency: natural gas furnace with AFUE of 95.24	As proposed
	Nonelectric boiler efficiency: natural gas boiler with AFUE of 95.24	As proposed
	Capacity: sized in accordance with section SPS 322.40 (3)	As proposed
Cooling systems	Fuel type: electric	As proposed
	Efficiency: 13.29 SEER	As proposed
	Capacity: sized in accordance with section SPS 322.40 (3)	As proposed
Service water heating	Fuel type: same as proposed design	As proposed
	Electric: conventional, 50-gallon water heater with energy factor of 0.901 and recovery efficiency of 0.98	As proposed
	Non-electric: conventional, 50-gallon water heater with energy factor of 0.661 and recovery efficiency of 0.80	As proposed
	Use: gal/day = 30 + 10 X N br	Same as standard reference design
	Tank temperature: 120º F	Same as standard reference design
Thermal distribution systems	**23.9 CFM25 of supply leakage to outside, 35.9 CFM25 of return leakage to outside**	**For residences that are not tested: same as standard reference design** **For residences that are tested: measured CFM25 duct leakage to outside**
Thermostat	**Type: programmable, cooling temperature set point = 75º F; heating temperature set point = 68º F**	Same as standard reference design
Rim and Band joist	**U−Factor: 0.0788**	**As proposed**
Slab	**Slab on grade, non-radiant: underslab R-value = 5; slab edge R-value = 7.5** **Below-grade-slab, non-radiant: underslab R-value = 0** **Radiant slab: underslab R-value = 10; slab edge R-value = 7.5**	**As proposed**
Lighting	**Interior fixtures CFL%: 65.3** **Exterior fixtures CFL%: 73.9** **Garage fixtures CFL%: 60.5** **Pin-based fluorescent %: 10**	**As proposed**
Ceiling fans	**0 cfm/watt**	**Same as standard reference design**
Appliances	**Refrigerator: location = conditioned space; total consumption = 657 kWh/yr** **Dishwasher: kWh/yr = 268; place-setting capacity = 12**	**As proposed, if known.** **If not known, same as standard reference design.**

Building Component	Reference Design	Proposed Design
	Range/Oven: fuel = natural gas; type = conventional **Clothes washer: location = conditioned space; MEF = 2.36 ; LER=150 ; capacity 4.31 cf; Elec rate = 0.1065 cents/kWh; Gas Rate = $1.22 per therm; Annual gas cost = $11** **Clothes dryer: fuel = electric; non-moisture-sensing; efficiency factor = 3.01**	
DHW Efficiencies	**All faucets and showers < 2gpm: No** **All DHW pipes fully insulated: No** **Recirculation: None** **Pipelengths: default software estimates** **Drainwater Heat Recovery: No**	**As proposed**
Photovoltaic	**Type: None**	**As proposed**
Active solar	**Type: None**	**As proposed**