

**12-Month Report for Appalachian Voices: High Country Home Energy Makeover Contest**  
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**June 8<sup>th</sup>, 2016**

This energy use analysis covers three homes retrofit as part of the High Country Home Energy Makeover Contest by the Energy Savings for Appalachia team at Appalachian Voices:

<http://appvoices.org/energysavings/energycontest/>

Data has been compiled from homeowner online electric utility accounts with Blue Ridge EMC through the utility and weather data analysis service ResiSpeak®. Hourly consumption data has been compiled through the “Green Button” data download provided by Blue Ridge EMC for use by third party data service providers.



Additional data on non-electric fuel consumption has been provided by Appalachian Voices through consultation with the homeowners. Asheville Airport is used for temperature analysis – the closest National Weather Service ASOS weather station to the homes is generally Hickory Airport, but the weather in Asheville is more representative of that at the location of the homes due to the lower altitude at Hickory. Heating and cooling degree day weather models are computed in ResiSpeak on both the pre-retrofit and post-retrofit periods using 60 °F as the balance point temperature for heating and 70 °F for cooling. The January 2014 electricity bill is selected as the first billing month of the pre-retrofit period for all three homes, thereby providing at least 14 months of pre-retrofit data for baseline modeling. The energy savings measurement detailed below is fully compliant with IPMVP Option C and ASHRAE Guideline 14 measurement and verification (M&V) procedures, and therefore appropriate for any relevant regulatory filing or other electricity savings claims. Note that post-retrofit data is as of March 2016; April and May 2016 usage is not included in this analysis.

**Summary of Three Homes’ Electricity Savings based on Weather-Adjusted Monthly Billing**

	<b>Home #1</b>	<b>Home #2</b>	<b>Home #3</b>
Retrofit Date	2/17/2015	3/2/2015	2/27/2015
Number of Post-Retrofit Billing Months Analyzed	13	13	13
As-Of Date	3/17/16	4/4/16	3/20/16
Savings to Date, kWh	1939	1339	845
Savings to Date, \$	\$196	\$136	\$84
<b>Weather-Adjusted Electricity Savings %</b>	<b>15%</b>	<b>15%</b>	<b>8%</b>
Est. Annualized Savings, kWh	1790	1236	780
Est. Annualized Savings, \$	\$181	\$125	\$78
Cost of Retrofit	\$3,200	\$1,300	\$800
Return on Investment, Cumulative	6.1%	10.4%	10.5%
Return on Investment, Annualized	5.7%	9.6%	9.7%
Est. Annual Operating Cost Reduction, \$/sqft	\$0.08	\$0.08	\$0.08
Pre-retrofit Electrical Use Intensity kWh/sqft/yr	5.5	5.2	9.9
Post-retrofit Electrical Use Intensity kWh/sqft/yr	3.9	4.4	9.2
12-Month Electrical Use Intensity Improvement	28%	16%	8%

## Home #1

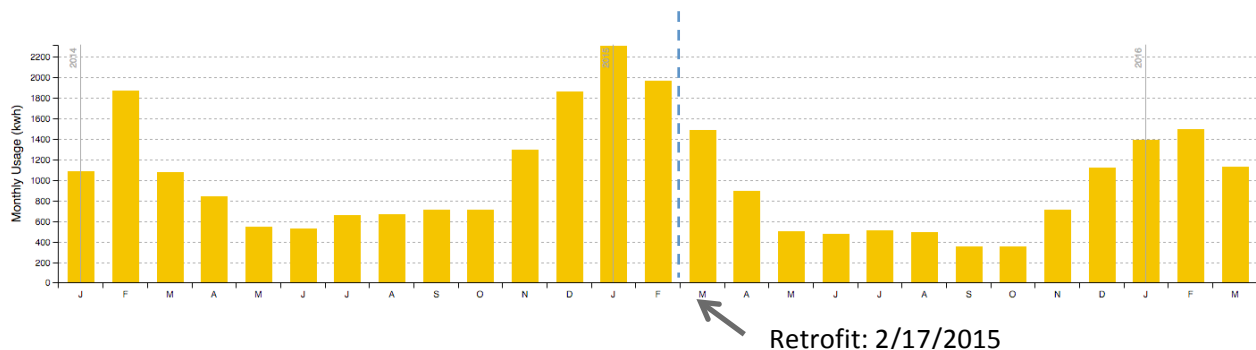
Homeowner: Zackary Dixon  
Electric Utility: Blue Ridge EMC  
Interior Area: 2400 square feet  
Weather Data: AVL Asheville Regional Airport  
Heating: Plug-in electric space heaters  
Cooling: Ceiling fans  
Retrofit Date: February 17<sup>th</sup>, 2015

### Retrofit Details:

- Air sealing penetrations in the ceiling, including around light boxes, tops of interior walls, electrical and plumbing penetrations, etc.
- Insulating the attic hatch and weather-stripping around opening
- Blowing in fiberglass insulation in attic to at least R-38 (by adding R-19)
- Air sealing and insulating the garage ceiling with fiberglass batts (R-30); air sealing bands and penetrations prior to insulating
- Replacing and installing weather-stripping on front door, back door and door to garage

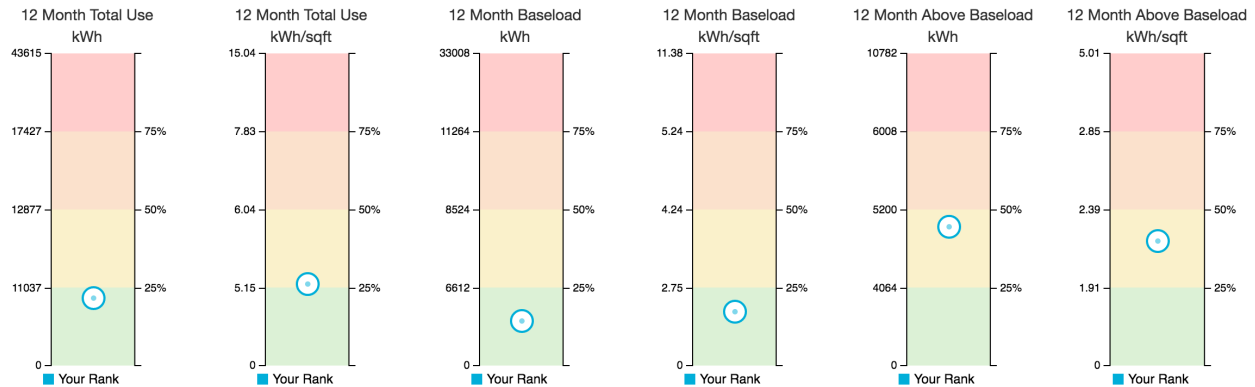
## A – Monthly Utility Billing Data Analysis

### Monthly Billing Electricity Consumption History:



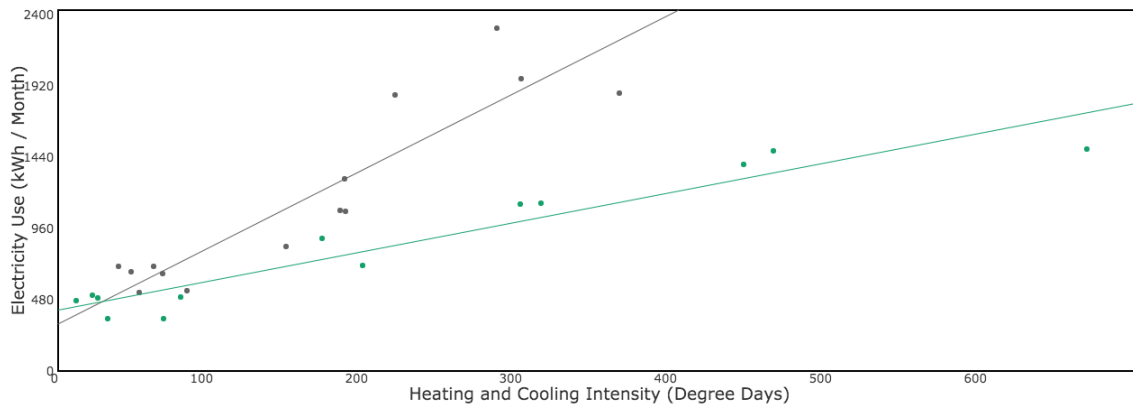
Home #1 shows a baseload electric consumption that reduced from ~550 kWh/month pre-retrofit to ~350 kWh/month post-retrofit. Peak monthly winter usage has dropped from near or above ~2000 kWh/per month to not more than 1500 kWh/month in the post retrofit winter.

## Electricity Use Ranking vs. Other Electric Heat Homes in North Carolina:



Compared to a sample of other electric heated homes in North Carolina, the home's total annual energy use has gone from just below average to lowest quartile and nearly lowest quartile on a per sqft basis. Above baseload energy use has gone from highest quartile to better than average.

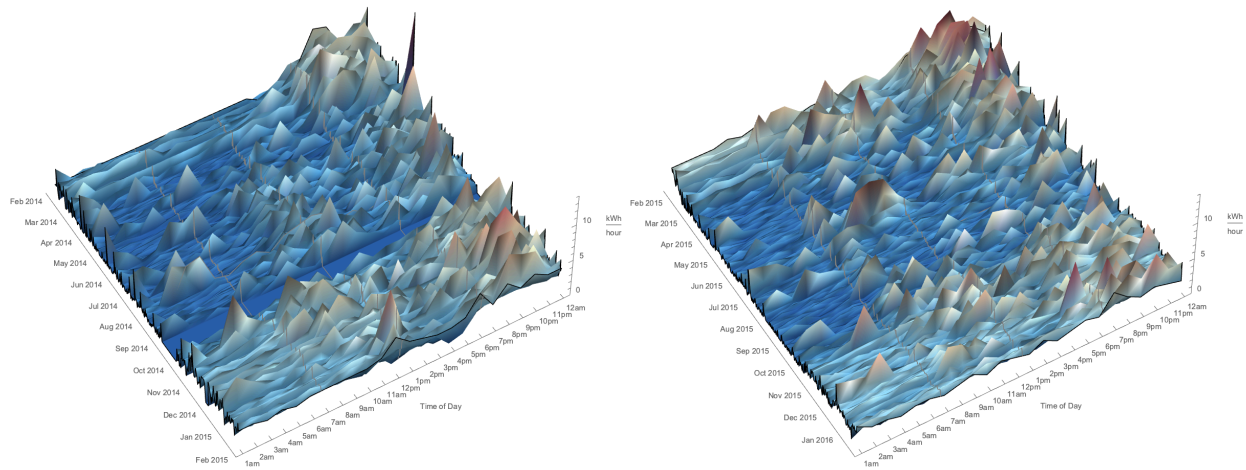
## Electricity Consumption vs. Degree Days



The home shows a reduction in heating performance index from 2.2 kWh/°F-day pre-retrofit to 1.7 kWh/°F-day post retrofit. The weather-corrected pre-retrofit model indicates that ~1940 kWh of electricity not used in the 13 post-retrofit months analyzed, a 15% savings.

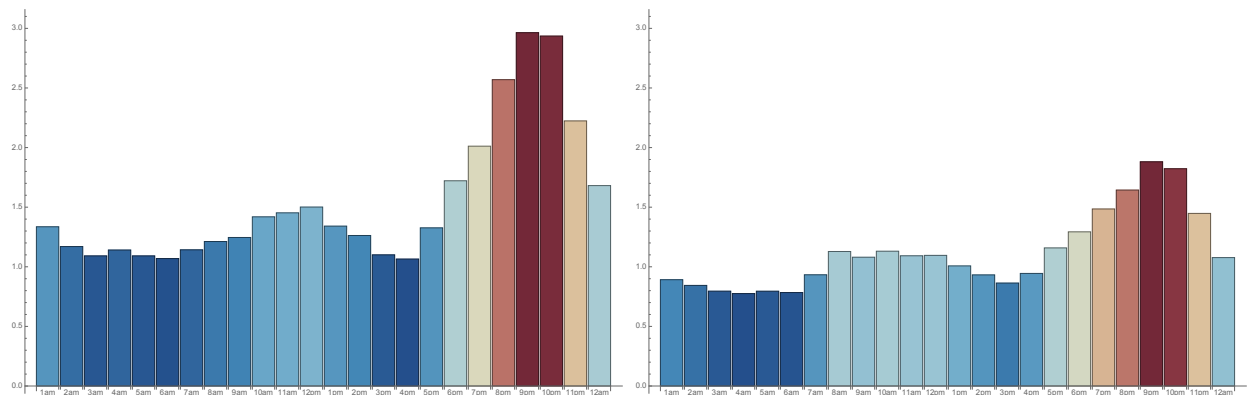
## B – Hourly Meter Data Analysis

### Pre-retrofit and Post-retrofit 12-Month Hourly Electric Plot:



The two plots reflect hourly electric use from 2/18/2014 to 2/17/2015 and 2/18/2015 to 2/17/2016 respectively. Both plots show irregular daily use, with the highest usage in the evening hours, and a high baseline usage (i.e. 24-hour use) from late October through March.

### Pre-retrofit and Post-retrofit 12-Month Hourly Electric Averages:



The two plots reflect hourly electric use averages from 2/17/2014 to 2/16/2015 and 2/18/2015 to 2/17/2016 respectively. Both plots show peak use in the 7-10pm range with maximum use typically in the irregular daily use, with the highest usage in the 8-9pm hour. Note that while off-peak hour averages reduced by ~20%, the peak use hour average dropped from ~3 kWh to ~1.9 kWh, a 35-40% reduction in use in the peak hours.

## Home #2

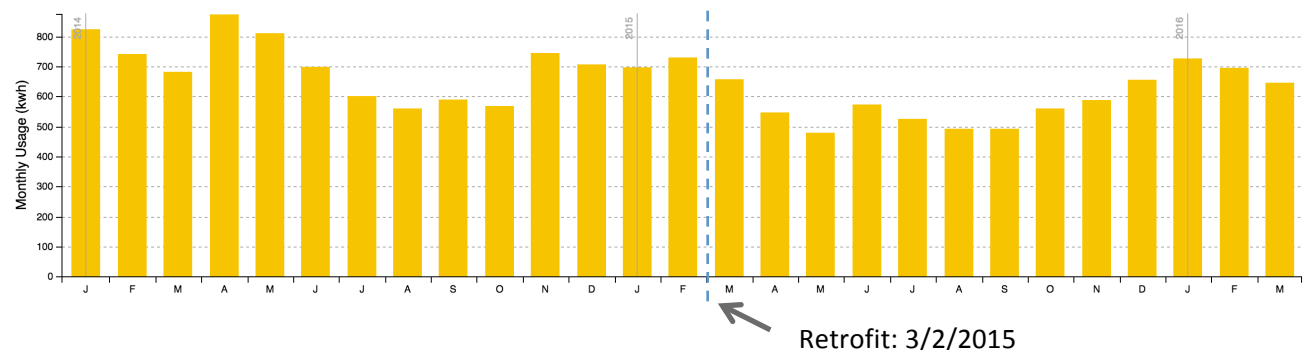
Homeowner: Vance Woodie  
Electric Utility: Blue Ridge EMC  
Interior Area: 1600 square feet  
Weather Data: AVL Asheville Regional Airport  
Heating: Fuel oil furnace with electric air circulation  
Cooling: Portable A/C unit, ceiling fans  
Retrofit Date: March 2<sup>nd</sup>, 2015

### Retrofit Details:

- Air sealing (with mastic) and insulating (with rolled batts) all HVAC ducts in basement

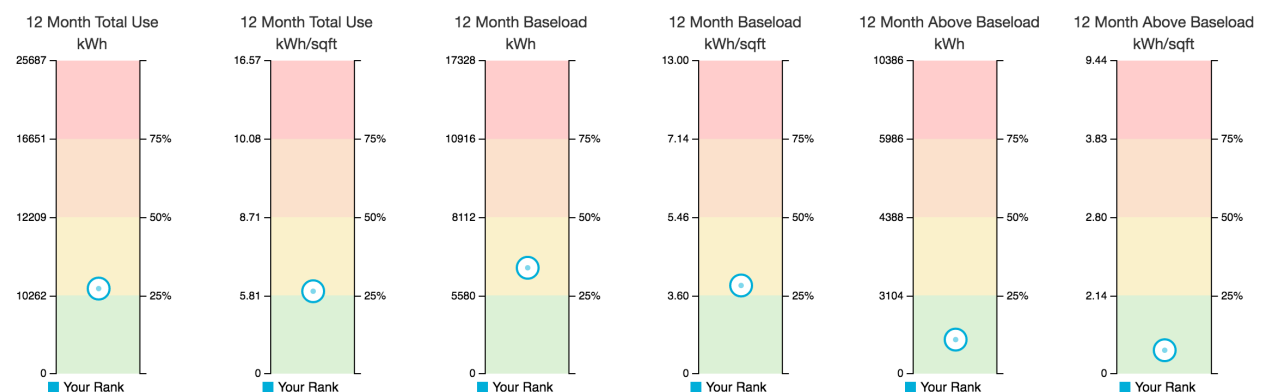
## A – Utility Billing Data Analysis

### Monthly Billing Electricity Consumption History:



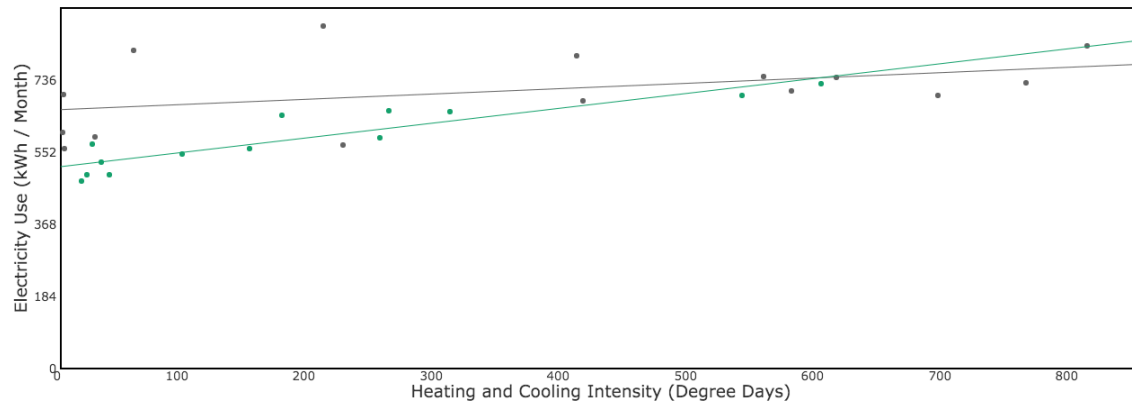
Home #2 shows a baseload electric consumption reduction from just under 600 kWh/month pre-retrofit to under 500 kWh/month post-retrofit. Pre-retrofit usage is erratic and shows little seasonality, while post-retrofit usage has distinct heating load centered around January and February 2016.

### Electricity Use Ranking vs. Other Electric Heat Homes in North Carolina:



Home #2 shows second-quartile and nearly top quartile ranking in total use and baseload use – note that prior to retrofit, the home's use was higher than average on 12-month baseload use (both total and per square foot). Given the low seasonality of use, even post retrofit, the home's above baseload ranking is top quartile.

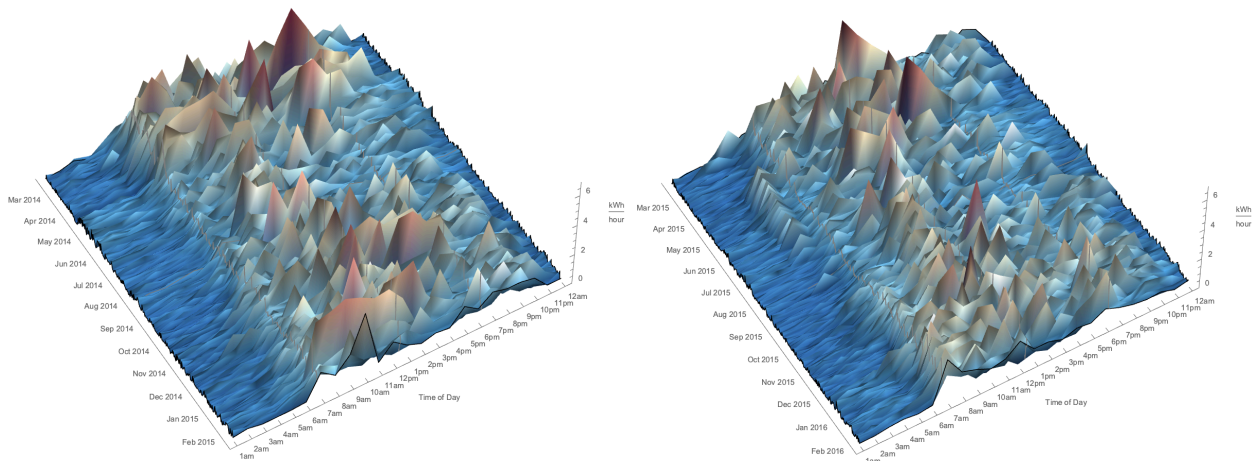
## Electricity Consumption vs. Degree Days



The home shows a reduction in monthly baseline usage from ~600 kWh/month pre-retrofit to ~515 kWh/month post-retrofit. The pre-retrofit weather correction model shows little seasonality, but a heating performance index of .14 kWh/ $^{\circ}$ F-day is computed. The post-retrofit heating performance index is computed to be .31 kWh/ $^{\circ}$ F-day with a higher degree of statistical confidence than the more erratic pre-retrofit model. The weather-corrected pre-retrofit model indicates ~1340 kWh of electricity not used in the 13 post-retrofit months analyzed, a 15% savings.

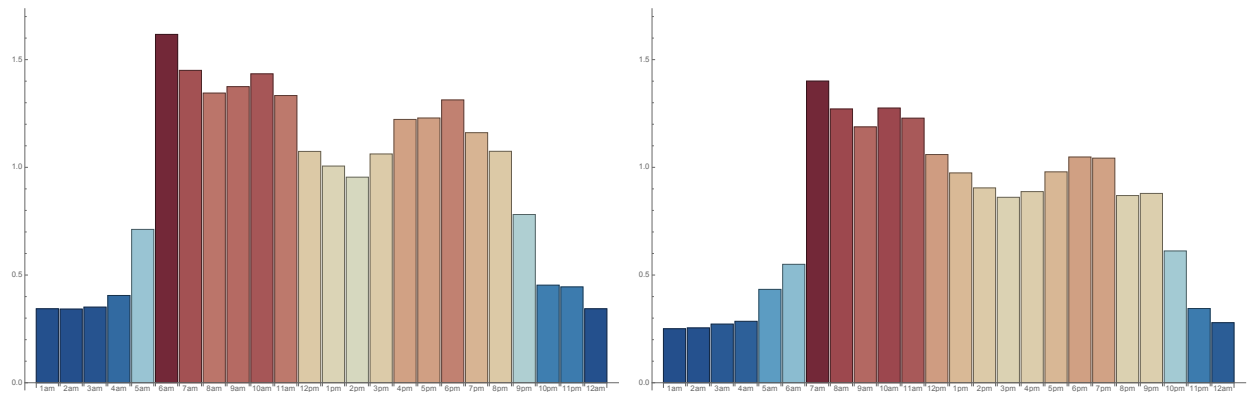
## B – Hourly and Data Meter Data Analysis

### Pre-retrofit and Post-retrofit 12-Month Hourly Electric Plot:



The two plots reflect hourly electric use from 3/3/2014 through March 3/2/2015 and 3/3/2015 to 3/2/2016 respectively. Both plots show regular daily use, a typical ramp-up in the 6-7am usage hour, and consistent even shutdown by 10pm. There is virtually no overnight electric use, reflecting a general lack of automated electric heating and cooling systems in the house. Both plots show winter daytime electric peak load, with such peaks more frequent during the pre-retrofit period, and moderate period demand spikes throughout the year between 8am and 6pm.

## Pre-retrofit and Post-retrofit 12-Month Hourly Electric Averages:



The two plots reflect hourly electric use averages from 3/2/2014 to 3/1/2015 and 3/3/2015 to 3/1/2016 respectively. Both plots show regular daily usage between 6am and 9pm, with peak use reduced from an average of 1.6 to 1.4 kWh/hour, morning use in the subsequent hours reduced from ~1.4 to ~1.25 kWh/hour, and overnight use reduced from ~0.35 to ~0.27 kWh/hour.

## C – Fuel Consumption

In addition to electricity use, data on furnace fuel oil was provided:

### Summary of Fuel Oil Consumption

	Pre-Retrofit	Post-Retrofit	Difference
Delivery Period	Oct 2014-Mar 2015	Nov 2015-Feb 2016	
Consumed Quantity (gallons)	500	375 <sup>1</sup>	125
Average Price per gallon (consumed)	\$3.76	\$2.08	\$1.68
Total Cost of Consumption	\$1881	\$780	\$1101
Heating Degree Days (60°F balance point temp.)	2798	2229	569
Fuel Heating Intensity (gallons/°F-day)	.18	.17	.01
2015-2016 Forecast Consumption <sup>2</sup>		398	
Estimated Savings, gallons		23	
Estimated Savings, \$		\$48	
Estimated Savings, %		6%	

Though the homeowner realized a fuel bill \$1100 less than the prior winter (net of inventory), \$630 of that savings was due to the lower fuel price, and ~20% of the reduction in fuel was due to the more mild winter of 2014-2015 as compared to the subsequent winter. Regardless, the ~\$50 in post-retrofit net fuel savings still adds 3-4% to the return on investment for the retrofit.

<sup>1</sup> A total of 750 gallons was delivered during the winter of 2015-2016, with 350-400 gallons remaining in inventory. No inventory was noted after the pre-retrofit winter.

<sup>2</sup> Estimated consumption considering pre-retrofit usage rate and post-retrofit weather

## Home #3

Homeowner: Sean Dunlap

Electric Utility: Blue Ridge EMC

Interior Area: 950 square feet

Weather Data: AVL Asheville Regional Airport

Heating: 2014: Oil furnace; 2015+: Wood furnace; plug-in space heaters

Cooling: Window unit, ceiling fans

Retrofit Date: February 27<sup>th</sup>, 2015, with work ongoing

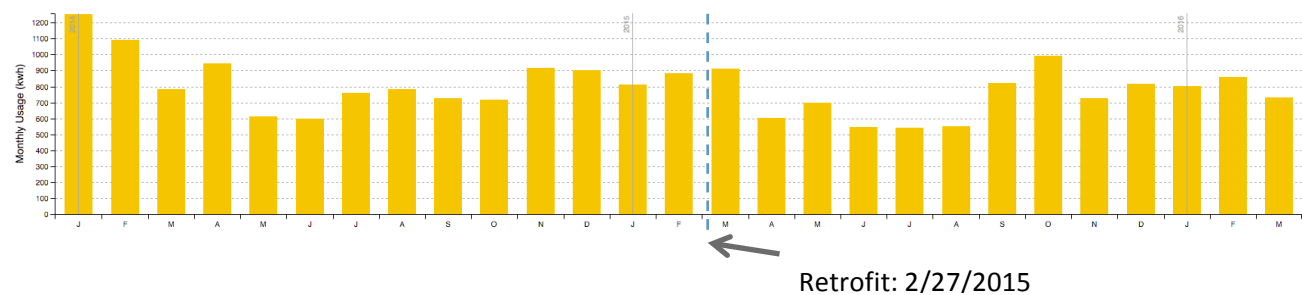
### Retrofit Details:

- Air sealing and insulating attic and knee wall
- Additional work completed after the retrofit date (see below)

Note: post-retrofit hourly data was unavailable for analysis after July 2015 due to a name change on the electricity account.

## A – Utility Billing Data Analysis

### Monthly Billing Energy Consumption History:



Home #3 shows a pre-retrofit baseload electric consumption of less than 700 kWh, the highest baseload usage of the three homes by ~100 kWh/month, while also the smallest footprint of the three homes. Post-retrofit baseload use is ~550 kWh/month. Though this is a marked improvement from the summer of 2014, it is unclear to what extent this decrease is due to a lack of occupancy during the summer of 2016, in which case a semi-occupied or unoccupied baseload of 500-550 kWh/month reflects both unoccupied baseload and also home improvement related electricity use<sup>3</sup>. Further, additional work on the home occurred following the formal post-retrofit date of 2/27/2015:

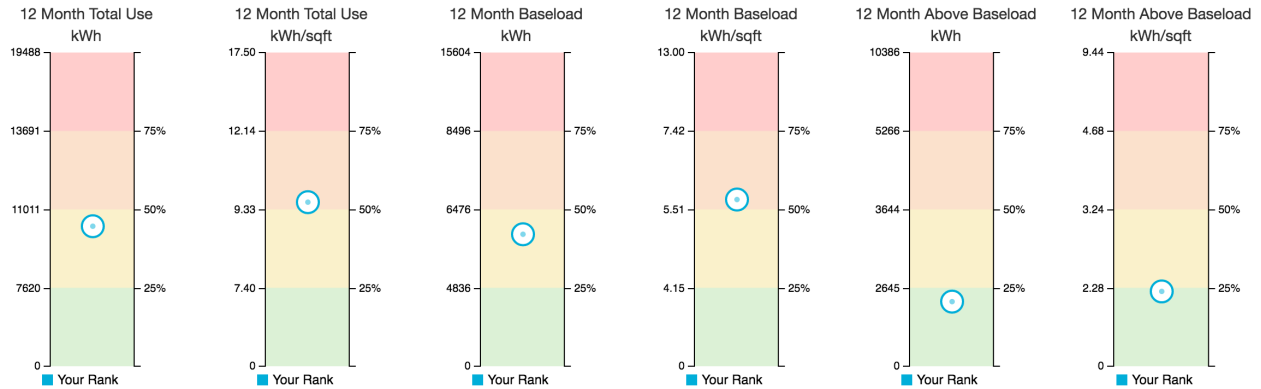
- applied spray foam,
- replaced flooring,
- applied drywall to exterior walls, and
- added insulation.

The additional work was mostly performed July-Sept 2015: and completed by December. Thus calendar year 2016 may prove to be a better post retrofit assessment period than March-December 2015, presuming that occupancy and usage in 2016 is reasonably similar to that of 2014. Regardless, the electric usage of the winter of 2015-2016 is slightly less than the prior winter, though both are significantly less than January-February 2014. The energy savings analysis is therefore very sensitive to the selection of pre-retrofit period length (i.e. how far back in time to consider as the pre-retrofit usage period for comparison).

<sup>3</sup> Hourly data analysis during the work period could, in theory, isolate patterns of irregular energy use from regular occupied patterns.

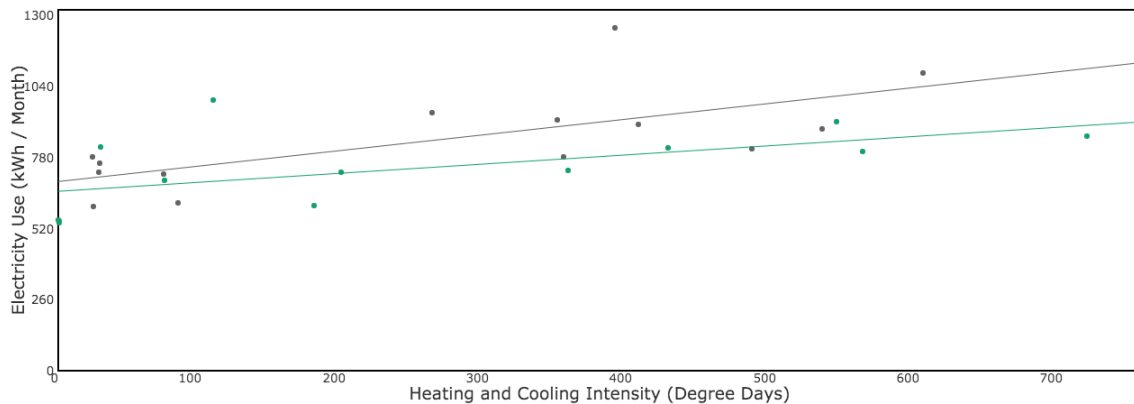


## Electricity Use Ranking vs. Other Electric Homes in North Carolina:



Home #2 shows a third-quartile ranking in total use per square foot as compared to electric heated home in North Carolina, though this ranking has improved from a bottom quartile rank pre-retrofit. Baseload usage rank, as discussed above, has also improved as the home is now right about average in baseload use.

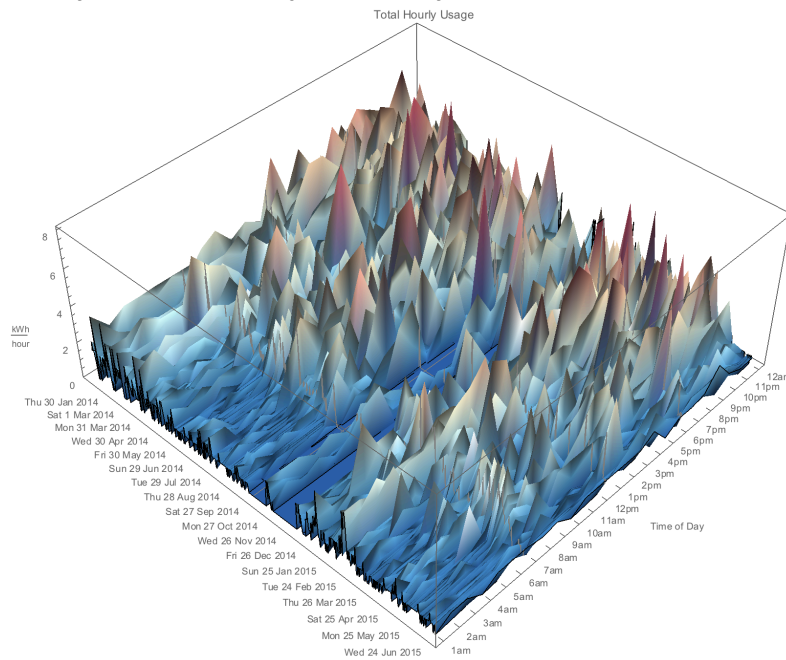
## Electricity Consumption vs. Degree Days



The home shows a reduction in heating performance index from 0.43 kWh/°F-day pre-retrofit to 0.34 kWh/°F-day post-retrofit. The weather-corrected pre-retrofit model indicates ~850 kWh of electricity not used in the 13 post-retrofit months analyzed, an 8% savings.

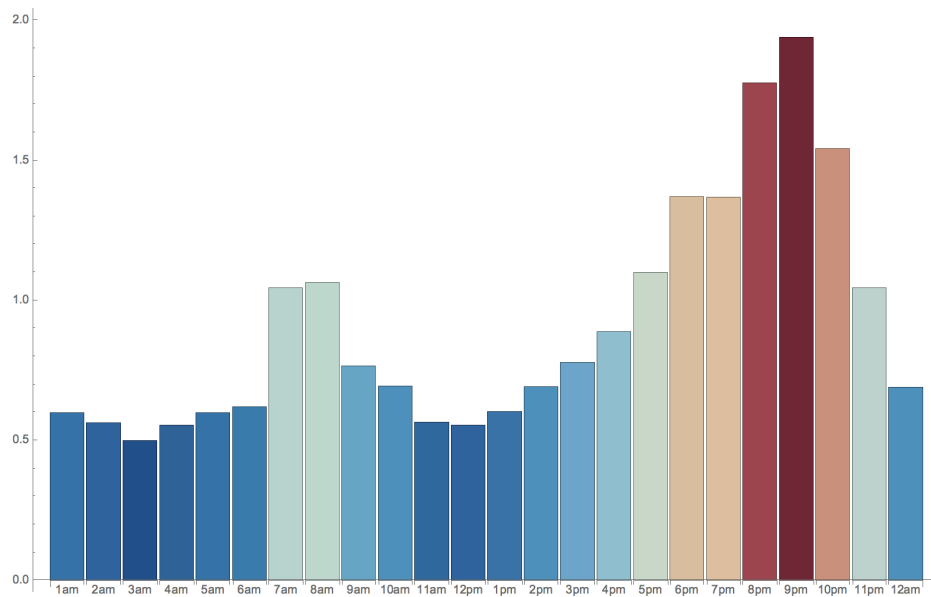
## B – Hourly and Data Meter Data Analysis

### Hourly Electric Consumption History:



The data reflects electric usage from January 1<sup>st</sup> 2014 through June 27<sup>th</sup> 2015. The home's consumption pattern shows somewhat regular morning ramp-up in the 6-7am meter read, and irregular usage during the day, reflecting the periodic usage of high-watt appliances.

### Electric Consumption Averages by Hour:



The average hourly profiles reflect the normal operation for a home in which there is limited operation during normal working hours, and the bulk of the electric use is during the 7-10pm period.