Accelerating the Adoption of Residential Efficiency Standards Across Tennessee

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Introduction

There are a number of limitations holding the state of Tennessee back from progressing as a leader in the high-performance housing market. Firstly, there is a myth within the state that our ability to effectively adopt 2015 IECC building codes is unachievable because of the state's limited resource of Home-Energy-Rating-Service (HERS) raters. Whether this is true or not is unknown, as we have no comprehensive database of HERS raters to reference.

Secondly, traditional builders and codes-officials tend to believe that building high-performance homes is unachievable with off-the-shelf products and that homes should 'breath' and should not be sealed to new standards. However, as experts in the field of home performance, E3 INNOVATE has observed and worked with progressive builders who are building homes that far surpass code requirements.

Lastly, there is a drastic inconsistency among counties in adopting and implementing building codes. It is that inconsistency that makes it difficult to move forward as a state.

The primary goal of this project was to provide educational workshops and presentations to builders, architects, contractors, and codes officials across Tennessee to help prepare the state for the adoption of more aggressive building codes.

This project also worked to organize the state's residential building codes and develop a database of HERS raters to share with workshop attendees and others in the building community. Other objectives were to:

1. Analyze whether or not the state has a sufficient capacity of HERS raters to implement the 2015 IECC building code standards.
2. Identify companies and individuals actively building and marketing high-performance homes.
3. Review building codes implemented by county.
4. Determine key industry allies to educate and collaborate with regarding high-performance building strategies, as well as LEED and WELL certification.
5. Help organize statewide Building Performance Institute (BPI) and HERS trainings and improve access to required continuing education opportunities.

This report summarizes the work completed and recommended next steps for research and future education opportunities for the state of Tennessee.

Section 1: Efficiency Standards in Tennessee

Of the states with statewide energy efficiency code adoptions, Tennessee ranks one of the lowest performing in the United States. Tennessee has currently adopted the 2009 version of the International Energy Conservation Code (IECC). However, each county has the choice to amend the code as they see fit. This gives builders the opportunity to scale back the air leakage requirements or opt out of third-party testing all together. As a result, the state is performing less efficient than 2009 standards, according to the latest study by the Department of Energy [1].

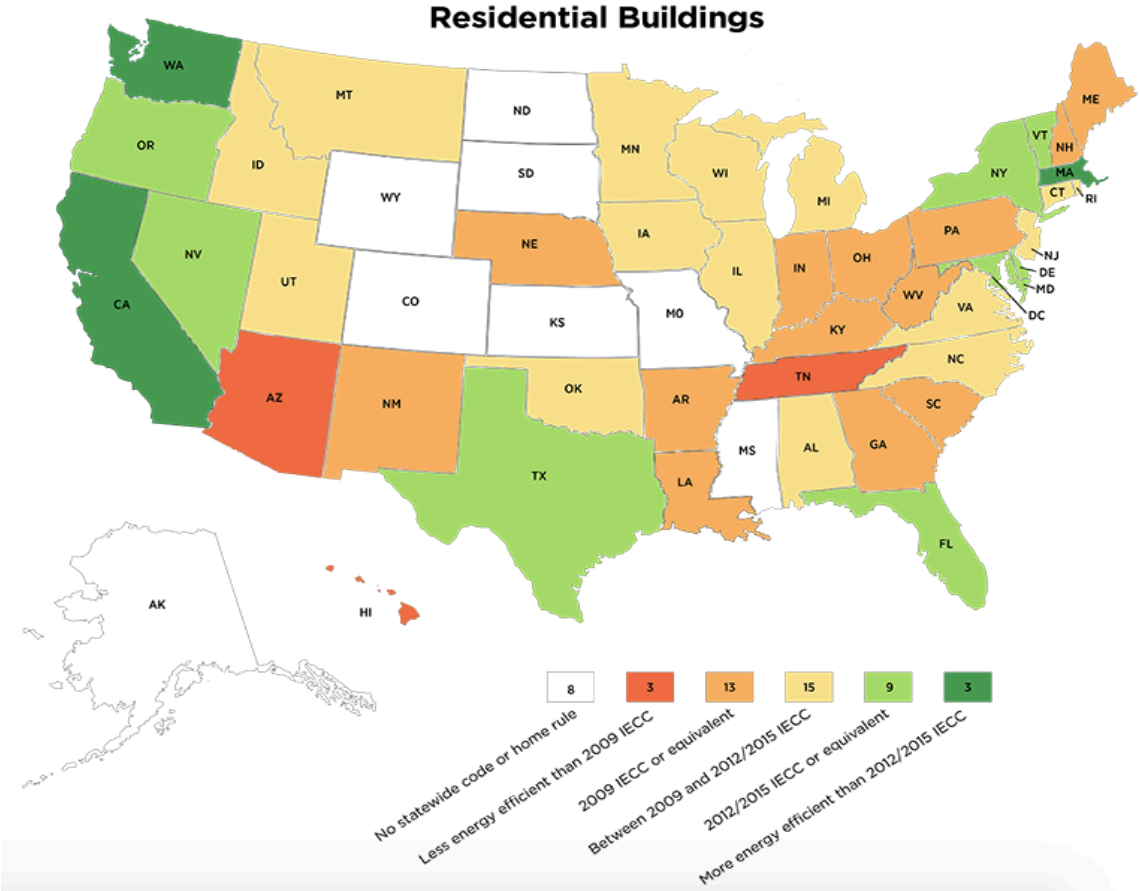


Figure 1: Representation of Residential Building Performance by State (DOE, 2018)

There are a few key performance differences between the 2009 and earlier IECC versions:

1. In the 2009 version, blower door testing was optional. In 2012 and earlier, blower door testing is required.
2. Envelope tightness in the 2009 IECC is 7.0 air changes per hour at 50 Pascals (ACH50) and in the 2012 version it is 3.0 ACH50 for climate zones 3-8, (including Tennessee) and 5.0 ACH50 for climate zones 1 and 2.

3. Mechanical ventilation becomes mandatory in the 2012 IECC because of tighter envelope requirements (ventilation is required for an envelope tightness of 5 ACH50 or less, according to ASHRAE 90.1).
4. In the 2015 IECC, the energy rating index pathway becomes an option for compliance.
5. The testing requirements induce the need for a third-party certified Rating Field Inspector to complete testing on all new homes.

Of these changes, mechanical ventilation may be the most challenging for builders to achieve because of their unfamiliarity with the technology options, their operation and integration with other mechanical systems, and the cost involved with adding additional equipment.

State Diversity

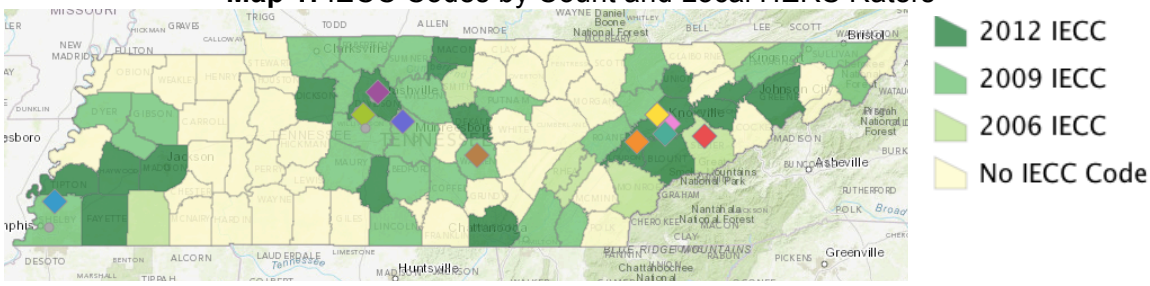
To better understand the diversity in code adoption around the state and to identify where high performance homes are more common, a set of color-coded, interactive maps was developed using the ArcGIS platform. Twenty-two maps were created using data collected from local codes officials, the RESNET database of Home Energy Rating System (HERS) rated homes, and the USGBC database of LEED certified homes.

Map 1 shows the adopted code for each county; however it does not represent any amendments that may apply. The user can click on the county to bring up a link to the county's website for more information. The colored dots represent active HERS raters in the state that have publically available contact information, such as a phone number, email, business address or website. Again, the user can click on the dot to bring up the rater's contact information. The other maps displayed below show the number of HERS rated homes, the average HERS score and the number of LEED certified homes for each county. The remainder of the maps displayed in ArcGIS show additional information about the number of HERS rated and LEED certified homes as well and the average HERS score for each county from 2013 to 2017. For access to all 22 maps, please visit the public web link below:

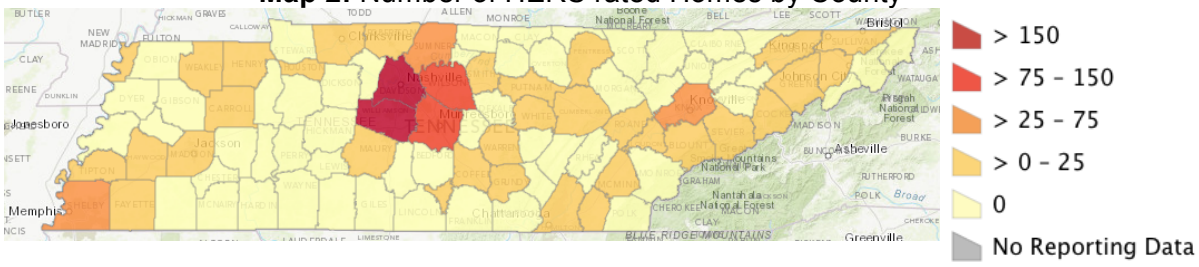
https://arcg.is/vTCir

E3 is currently looking for an interested party who would be willing to maintain these maps moving forward. As county codes change and more raters become available, the input files will need to be updated to keep the information current.

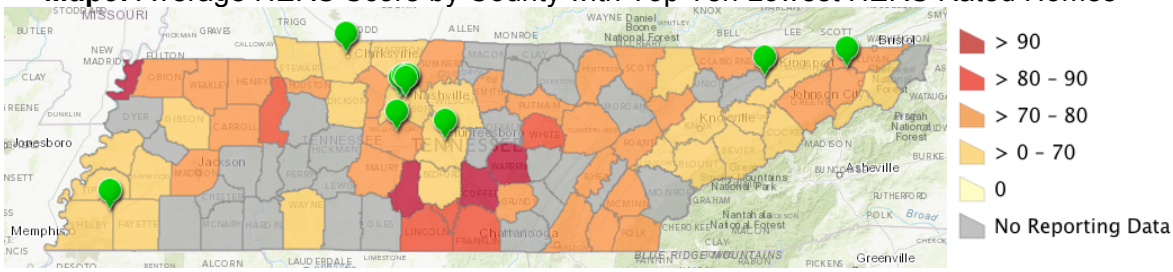
Map 1: IECC Codes by Count and Local HERS Raters



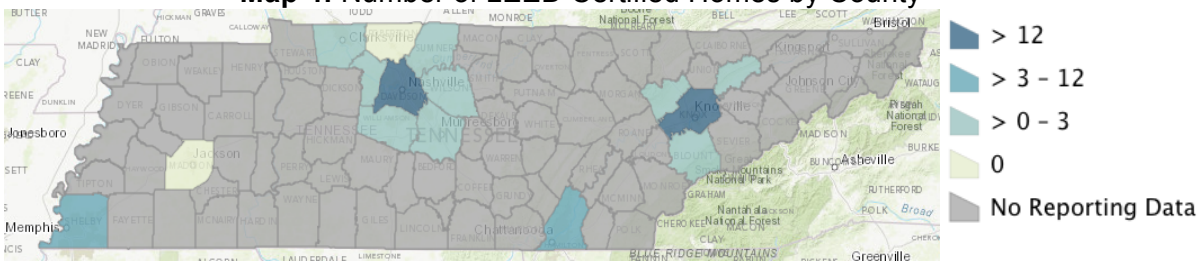
Map 2: Number of HERS rated Homes by County



Map3: Average HERS Score by County with Top Ten Lowest HERS Rated Homes



Map 4: Number of LEED Certified Homes by County



Map Development

To create the maps, an Excel spreadsheet was created to collect and organize each county website and contact number. Then, individual phone calls were made to each county to confirm the IECC code. Often times, the call was transferred to two or three different people before finding an individual who knew with certainty what the code was. Other times, a message was left and a return call came in a few days later.

During this process, E3 came across a pre-existing (Excel) database of county codes managed by the Tennessee State Fire Marshal, Tim Planner. He shared his spreadsheet with E3 to use as a comparison. Unfortunately, there were a number of discrepancies so additional phone calls were made to clarify the confusion. Once the spreadsheet was finalized, the data was input into ArcGIS.

A web search, LinkedIn, and the RESNET online directory were used to find active HERS raters in Tennessee. Their contact information, including phone number, email, and website were collected to create the interactive online database in ArcGIS. Some companies did not have company information available online, so they were not included in the database. A full list of active HERS raters is listed in Appendix A.

HERS data was provided by RESNET from 2013 to 2017. This data included the city, state, HERS rating, and date of rating for each home with a HERS score in Tennessee. The data was sorted to calculate the number of homes rated in each county (see Map 2) and the average score in each county (see Map 3). The location of the top ten lowest HERS scores are also shown (see Map 3).

LEED data was collected from the USGBC database and organized into counties. Map 4 shows the number of all LEED Certified homes by county.

These web-based maps are interactive in that the user can click on the county and bring up more information about the data that is available. The user can also click on any of the colored diamonds to bring up contact information about the HERS raters or on the flags to see the top ten lowest HERS scores in the state.

State HERS Statistics

With the data collected from RESNET, the following state statistics were formulated (see Figures 2-4 for details):

1) The number of HERS rated homes increased in 2017; however, data for the number of permits issued in this year is not yet available through the U.S. Census. The increase is likely a result of an increase in total number of homes built.
2) The average state HERS score increased four points from 2016 to 2017, likely due to an aggressive housing market where energy efficiency was not needed for market differentiation.
3) The average HERS score between 2013 and 2017 is 69.
4) In 2016, only 3% of the single family home built received a HERS score (1,189 homes of 36,157 total) [3].

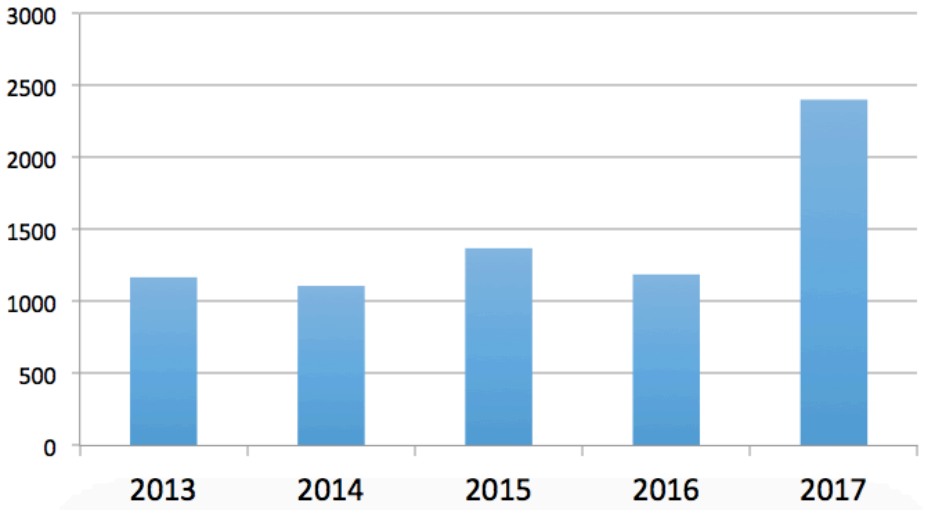


Figure 2: Number of HERS Rated Homes in Tennessee

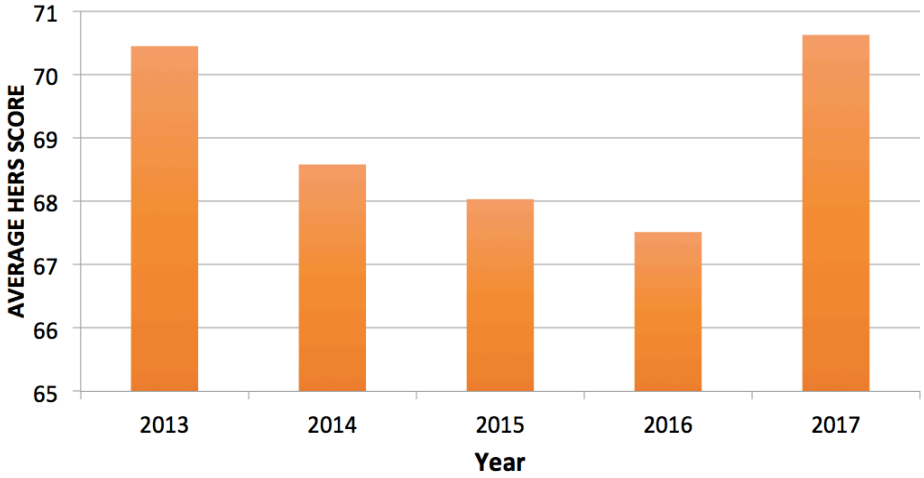


Figure 3: Average HERS Score for the State of Tennessee

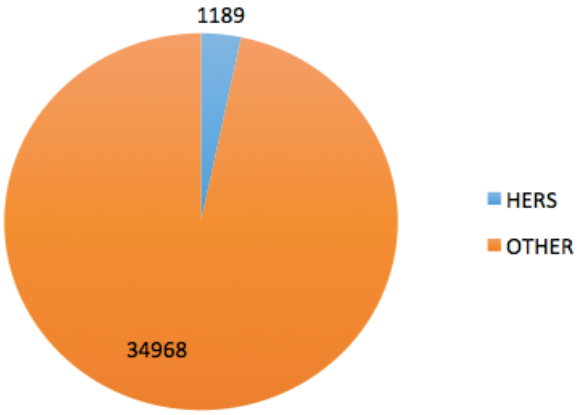


Figure 4: Percent of New Homes Built in 2016 with HERS Ratings (3%)

Many volume builders advertise their homes as saving a certain percentage of energy each year. Many times, this comparison is done using a HERS score. Unfortunately, this can be misleading for a consumer because few homebuyers understand the baseline used for the comparison. Some builders compare their construction to the "standard new home" with a HERS score of 100; however, a score of 100 represents a house built to comply with the 2006 IECC, a 12 year-old outdated standard. Below is a quote from one volume builder's website who's average HERS score is a 65:

> *"A … home with a 65 rating is over 30% more efficient than a standard new home, which is awarded a baseline rating of 100."*

The table below shows the HERS scores that correspond to the 2009, 20012, and 2015 IECC codes [2]. These ratings would make for a more up-to-date comparison.

Table 1: Corresponding HERS Scores for IECC Standards

IECC Code Version	Corresponding HERS Score
2009 IECC	82
2012 IECC	76
2015 IECC	54

Section 2: Interview With Builders

HERS Rater Survey Results

A 10 question survey was sent out to all of the HERS raters in the state that had email addresses available online. The primary goal of the survey was to determine which counties these raters served and their rating capacity, and to identify the lowest HERS scores in the state. Results from this survey were helpful in the development of the interactive map of HERS raters (see Appendix B for more information).

Builder Survey Results

E3 used its database of builders to send out a ten-question survey to 259 builders in Tennessee to gather feedback about the acceptance of and obstacles around the implementation of more efficient codes, building rating, and other certification programs. Five out of the 66 anonymous builders who opened the email provided feedback. A summary follows (see Appendix C for details).

- Builders believe that stricter building codes will induce higher costs, create slow-downs in the building process, and require time-intensive training programs.
- The primary reason for not providing a HERS rating or other building certification is the belief that these homes cost more to build.
- The builders that provide HERS ratings or other certifications do so because they believe that these ratings/certifications serve as a quality-check. Interestingly, however, none of the builders mentioned the connection between ratings/certifications and decreased liability.
- One benefit of stricter code adoption would be the improvement in consistency of standards across the state.

This exercise proved difficult. Builders were either unwilling or not interested in provide their feedback in a survey sent via email. Although multiple reminder emails were sent, only 2% of recipients participated.

Eagle CDI Inc. – Knoxville TN

Dan Mitchel, President and Owner of Eagle CDI Inc. in Knoxville Tennessee was interviewed to gain feedback on his perspective on high performance homes in Tennessee and the obstacles builders face in implementing stricter energy codes. Eagle was selected for this interview because this company was identified as having one of the lowest HERS score reported by the HERS raters in the rater survey. Dan Mitchel has served as president of the Building Systems Councils (BSC) of the National Association of Home Builders and represents the voice of builders in the Knoxville area.

From your perspective, why does TN have some of the lowest residential building codes in the country?

Tennessee has a lot of rural counties, and rural areas are less advanced. However, there may be some misconception in a blanket energy code. Many municipalities have adopted stricter energy codes, and these regions have the majority of the population. So, if you look at energy efficiency per capita rating, "*we're doing pretty good*."

Also, may people who live in rural areas are looking for cheaper housing options. Because there is a (perceived or real) correlation between energy efficiency and price, builders are going to build to the minimum standards because it keeps prices down and profits high.

From your perspective, what is the biggest obstacle to implementing stricter energy codes?

Cost. Typically, volume builders will keep the same building standards no matter where they build; however, if there is an opportunity to increase profit, they will. Builders will likely find building in counties with weaker building standards as an opportunity for increased profit.

Are your clients interested in building an energy efficient home?

Clients of custom builders tend to have more interest in energy efficiency than the typical homebuyer. However, volume builders will build to the level of what most consumers want, are willing to pay for, and can afford.

What do you think is the most effective way to increase the number of HERS rated homes?

Educating the consumer *and* the builder is key. The maps that E3 has developed could be used as a centerpiece for educational campaigns for these two groups.

Builders understand the befits of reducing future liabilities, and if they can be shown case studies (preferably from other builders) that building "high-performance" will save them money in the long-run, then reducing liability as a promotion for high-performance is a good rout to take.

Builders aren't educated on how to build high-performance, and the current task force is not well educated; the laborers haven't had enough experience building high-performance homes. This is a challenge.

To successfully increase efficiency standards, we need systems in place to educate the younger generation, case studies from builders to help educate other builders, and we need to use the technologies that are available on the market effectively. We also need to educate buyers so to raise the bar for energy efficiency standards. Mitchell used the analogy of the GPS technology in cars, "*Kids these days just expect new cars to have built-in GPS systems, so in the same way, new home buyers need to expect their home will have a sealed crawlspace system, for example*." Buyers need to know what to look for in terms of high performance.

This interview initiated an interesting question around the comment Mitchel made about energy efficiency per capita. Metropolitan areas are more densely populated but is this were the majority of construction is taking place? To answer this question, the top 16 counties with the greatest population growth between 2010 and 2017 was plotted and compared to the adopted IECC [3]. As the figure below shows, most counties with the greatest growth are building to the 2009 IECC standards at best (amendments were not considered). So, as the population of Tennessee continues to increase, the efficiency per capita may actually decrease until surrounding counties adopt more efficiency codes.

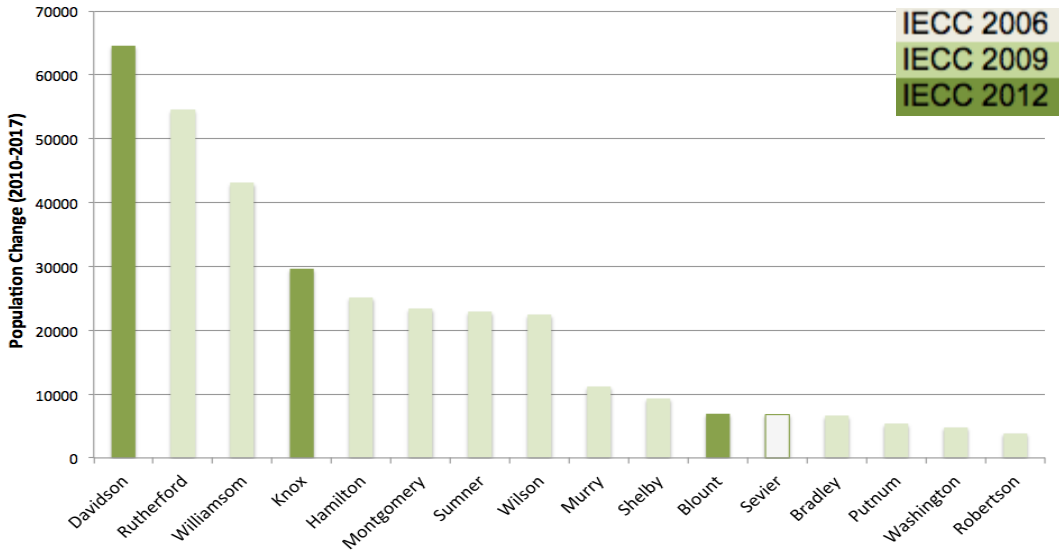


Figure 4: Counties with the greatest population growth in (2010-2017) and their corresponding energy codes.

Ryan Homes – A Regional Volume Builder

Ryan Homes was selected for an interview because this company was identified as the volume builder with the lowest HERS score in the state, according to the survey issued to HERS raters.

E3 connected with Bryant Airey of Ryan Homes who is the head of the Energy and Performance Program. He oversees the program for the 16 states where Ryan Homes is actively building (including Delaware, Florida, Illinois, Indiana, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, Washington D.C., and West Virginia). Below are the highlights from the conversation.

Ryan Homes has an energy standard program (ESP) in place, which they call their *BuildSmart* program. This is a performance-based approach to construction that is intended to surpass local code requirements. It is based on state requirements and climate zone and is driven by rebate programs from utilities. Ryan Homes has systems in place to manage the state-to-state differences; however, Airey mentioned that of all the states they build in, Tennessee is the most challenging because of the diversity in energy codes from county to county. Airey states, "*Tennessee is a unicorn*."

Airey mentioned that the benefits of following their ESP standards are "*blatantly visible*" in terms of the number of liability claims they receive on an annual basis. He sees a drastic difference in the number of call-backs for hot/cold spots, comfort issues, HVAC performance problems, and other issues as a result of this program.

Ryan Home's national average HERS score is a 65 although they have different targets for each state they operate in, depending on local codes and incentive programs from utilities. Their lowest score in Tennessee was a 52, according to their rater, Think Green Midwest. Their strategy for achieving their HERS score goals includes the following:

- Using off-the-shelf products with high quality.
- Working with their own in-house team of designers and architects to make sure each design is well thought out.
- Building a select number of floor plans thousands of times a year (i.e. experience).
- Building many of their components in factories, which increases precision.

Like most of the industry, Ryan Homes is experiencing a skilled-labor shortage. However, they and their partner (Think Green Midwest) invest heavily in training programs both in-office and in the field, to insure everyone has the same end goal in mind and the skills they need to achieve those goals. This helps ensure high pass rates when it comes code compliance.

According to a buyer's survey issued by Ryan Homes, energy efficiency was ranked in the lower tier of the top 10 most desirable features of a new home. Airey stated that there is a general assumption that a new home will be more energy efficient than an existing home, but beyond that, customers aren't asking about specific details that make a home more energy efficient. The company doesn't see the consciousness of energy efficiency among their buyers or their realtors. Additionally, their buyers are not concerned or interested in solar PV. These studies were issued across all markets where Ryan Homes is actively building.

Section 4: Case Studies and Examples

Finding builders with case studies that highlighted an economic analysis of high performance strategies proved challenging. However, during the process, E3 was able to contact resourceful individuals in North Carolina and Virginia who shared their building performance and sustainability reports. Some of the highlights form these reports are summarized below.

North Carolina

E3 INNOVATE interviewed Ryan Miller from the North Carolina Building Performance Association (NCBPA) to gain feedback on what the state of North Carolina had done in terms of gathering case studies from builders who have made energy efficient building a viable business model. Miller referenced the NCBPA's 2017 Annual Energy Efficient, Green and High Performance Home and Building Inventory Report published in March of 2018 [4]. This report identifies 34,152 high performance homes and buildings built or retrofitted in the state in 2016 and found a 9.5% price premium for high performance homes sold in metro markets. These markets included Charlotte, Triad, and Triangle. This report references certification and rating programs used to measure home and building energy efficiency and high performance building features. According to the NCBPA, this may be "the most comprehensive high performance home sale price analysis performed to date in the country."

Miller also referenced the following builders as having an effective energy efficient product and business model.

- BuildSense (Durham, NC): http://www.buildsense.com
- Banister Homes (Charlotte, NC): https://www.banisterhomes.com
- Homes by Dickerson (Raleigh, NC): http://www.homesbydickerson.com

Virginia

E3 INNOVATE interviewed Chelsea Harnis, Executive Director of the Virginia Energy Efficiency Council (VEEC) to gain feedback on what the state of Virginia had done in terms of gathering case studies from builders who have made energy efficient building a viable business model. Ms. Harnis referenced the report Why Energy Efficiency is A Smart Investment for Virginia, Making the Business Case for Energy Efficiency, which provides many references to studies that make the case for energy efficiency for new home construction [5].

Virginia has adopted the 2012 IECC, but weakening amendments create a code that looks more like 2009. Although many builders are reluctant to adopt stricter standards because of the concern over higher building costs, this report highlights the business case for energy efficiency.

According to a study by the National Association of Home Buyers referenced in this report, nine out of ten homebuyers are willing to spend two to three percent more for a home that includes "permanent energy efficiency features." Given that the cost for implementing the 2012 code without amendments is estimated to cost an additional

$2,197 for the average new home built in Virginia, the potential profit for builders would be $5,00-7,500 for a median new home price of $250,400.

This report also serves as a referenced for addition case studies on the benefits of EarthCraft homes.

Section 5: Energy Study

To demonstrate the process of performance monitoring, two houses in North Nashville were monitored from late summer 2017 through late spring 2018. These houses were built in the 1980's and have the same orientation and original footprint, with 2,200 SQFT of living space. Each home has 3 bedrooms and two baths, a living room, dining room, kitchen, and family room. The foundation type is crawlspace.

The homes are shown in Figure 6. The home on the left had significant home performance upgrades completed in 2008, while the home on the right did not. Features of each house are listed in Table 2. As you can see from the figure below taken in winter of 2017, the high performance house has frost on the roof and the standard house does not. Frost on a roof during a cold day is an indication that the home is well insulated, resulting in less heat loss.

Figure 6: Two North-Nashville homes built in the 1980's used for the performance monitoring study

Table 2: Features of Homes Monitored During Performance Comparison

	High Performance Home	Standard Home
Insulation	Spray foamed roof deck R-19 exterior walls (spray foam) R-38 attic insulation (cellulose)	R-13 exterior walls (fiberglass) R-19 attic insulation (cellulose)
Foundation	Encapsulated crawlspace system	Vented crawlspace
HVAC System	Geothermal system	Gas furnace + AC
Ventilation Strategy	Energy recovery ventilator (ERV) Smart bathroom exhaust fans Kitchen exhaust fan	Standard bathroom exhaust fans Kitchen exhaust fan
Occupancy	One adult, two children	Two adults

HOBO data loggers were used to track temperature and relative humidity; HOBOs were placed in the attic, crawlspace, family room, and master bedroom of each house. SiteSage Energy Monitoring systems (a product of Power Wise Dynamics) were used to capture the electrical performance. SiteSage is a consumer-based electrical monitoring system that allows homeowners to view the electrical energy consumption of a variety of circuits monitored from the electrical panel. The system uses a gateway device to transmit information to an online account where users can log in and view their consumption history. The data can also be downloaded in a CSV file for analysis. The web interface provides a cost summary based on local utility rates. A snap shot of the web-based interface is shown below.

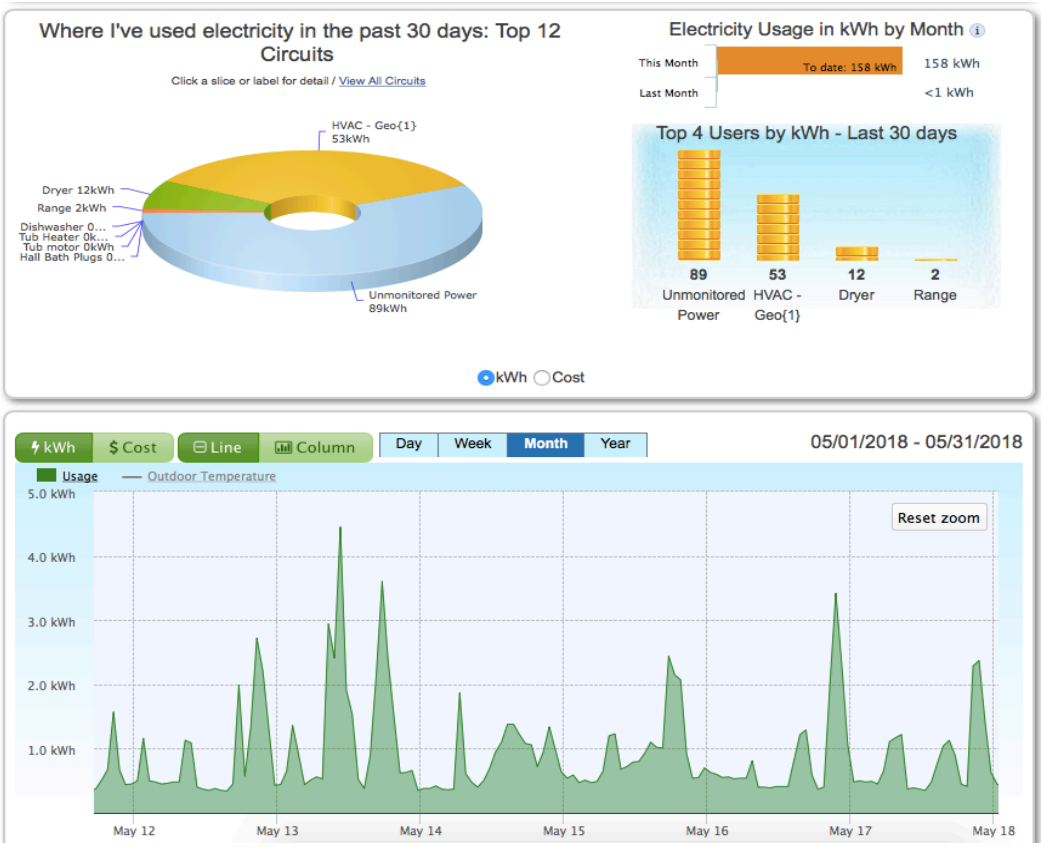


Figure 7: Snap Shot of User Account Interface

Performance Results

A summary of the temperature and relative humidity (RH) for the high performance and the standard home are shown in Table 3. A few key points to notice:

1. The humidity in the high performance home stayed within the comfort range (45-55%) for more hours than the standard house.
2. The high performance home utilizes a seasonal temperature setback from 72 F in the summer to 68 F in the winter. The standard house maintains the same set point of 72 F all year.
3. The low minimum relative humidity of 15% in the stand house indicates that air leakage is significant. As cold dry air infiltrates from the outdoors and warms up, the relative humidity of that air decreases because warm air has a greater capacity to hold water. Leaky homes tend to be much drier in the winter and more humid in the summer than well-sealed homes, which creates discomfort.

Table 3: Summary of Indoor Temperature and Relative Humidity

	Percent of Time Outside Comfort (45-55%)	Max RH	Min RH	Average Summer Temp	Average Winter Temp	Average Spring Temp
High Performance	48%	71%	34%	72.4 F	67.6 F	72.3 F
Standard	81%	70%	15%	72.7 F	72.3 F	72.7 F

HOBO data shows the effects of an encapsulated crawlspace. The sealed crawlspace in the high performance home stays within a narrower temperature and humidity range over the summer and winter seasons. A warmer crawlspace in the winter helps prevent frozen pipes and increases the comfort of the occupants by maintaining warmer floors, while a dryer crawlspace in the summer reduces the risk of moisture issues, odors, and mold both in the living space and in the crawlspace. Refer to Figures 8 and 9.

Unfortunately, the attic sensor in the high performance house was damaged in a way that caused the device to stop logging data, so an attic comparison was not completed.

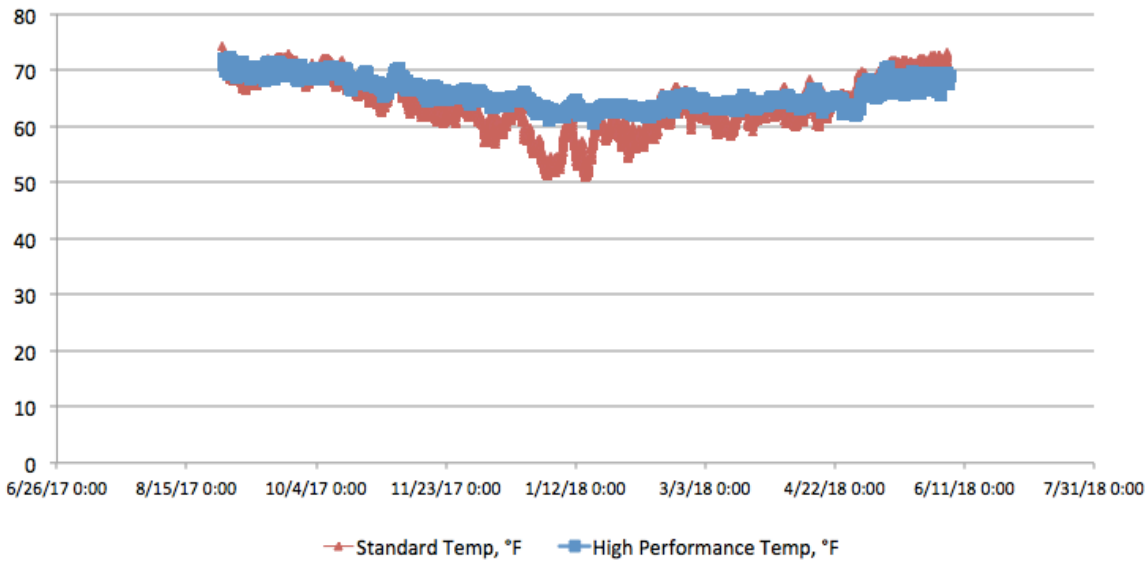


Figure 8: Crawlspace Temperature

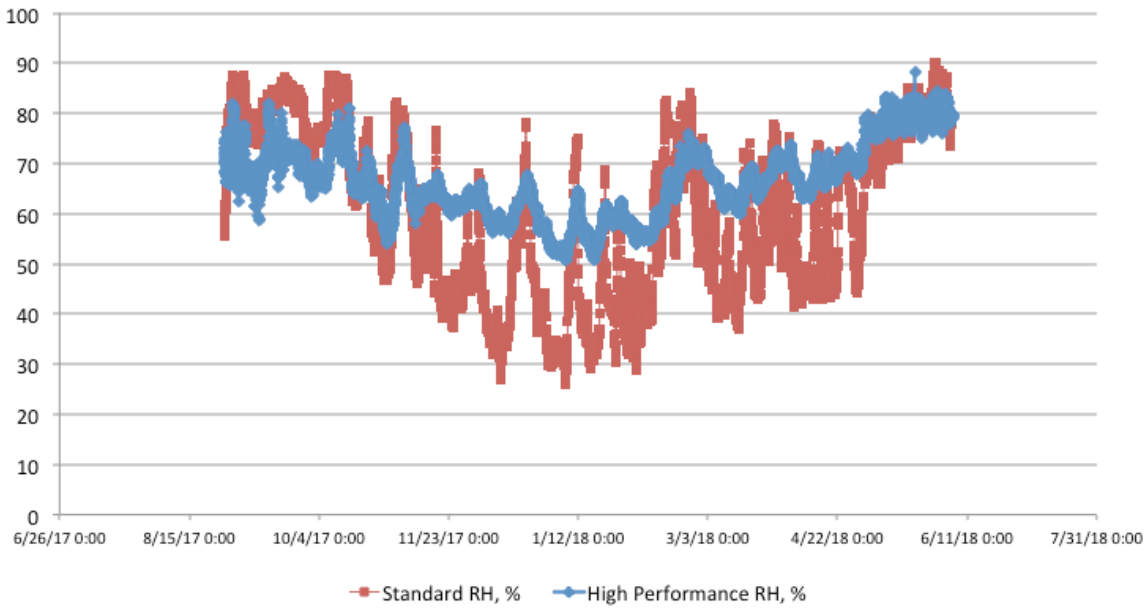


Figure 9: Crawlspace Relative Humidity

The electrical energy consumption results for the hottest week of May (May 12-18, 2018) are shown in Figure 10 and Table 4. The maximum daily outdoor temperatures during this week were in the upper 80's and lower 90's. The high performance house consumed 70% less HVAC energy compared to the standard home. These energy savings translate to a $52 dollar difference in cooling cost for the month of May, assuming $0.104/kWh. Factors that contribute to this reduction include a more efficient cooling system (geothermal), a tighter envelope, and additional insulation.

Note that a winter comparison was not performed because the standard house uses gas for heating and the difference in thermostat set points did not support a one-to-one comparison.

Table 4: Energy and Cost Comparison for May 12-18, 2018

	Weekly Cost ($)	Whole House (kWh)	HVAC (kWh)	HVAC Percent of Whole House
Standard House	$34	329	178	54%
High Performance House	$16	149	53	35%

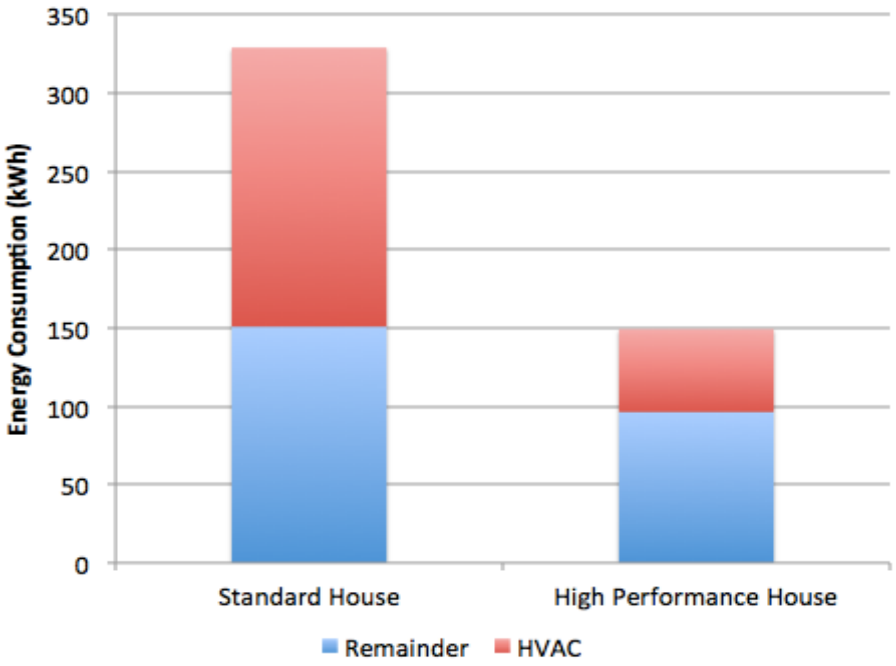


Figure 10: Cooling energy consumption compared to whole house

This study brought to light a few key lessons learned regarding the use of the monitoring equipment that E3 would like to share with others who perform similar studies:

1. Make sure the SiteSage gateway is plugged into an outlet that will not be tampered with. Make sure the plug is labeled with a “DO NOT REMOVE” sticker. E3 faced some challenges with communication losses and later discovered that the gateways had been unplugged in both houses, which resulted in gaps in the data.
2. Use an outdoor temperature and relative humidity sensor with a solar shield. Direct sunlight will skew the daily temperature fluctuations.
3. Equivalent indoor temperature set points are important for comparing energy consumption. Do your best to get homeowners to agree to the same indoor temperature for the duration of a comparison study.

Conclusion and Recommendations for Future Research

As part of this project, E3 presented three workshops around the state at green|spaces in Chattanooga, Lake Shore Park Administration Building in Knoxville, and ANF Architecture in Memphis. The presentation was accepted for 1.5 GBCI credits. The information was well received and attendees showed an interest in the material. E3 was also accepted as a speaker to present a summary of this research at the 2018 Home Performance Coalition Conference in Philadelphia PA in April of 2018. E3 plans to present at a Home Builders Association meeting in the Nashville area later this year and will use this content for other workshops in the future.

Prior to the launch of this project, there were a number of assumed limitations holding the state back from adopting stricter building codes (see Introduction above). The following limitations were verified:

1. There is a lack of skilled labor to satisfy the need for high performance construction.
2. There are not enough HERS raters to serve the growing residential market, especially in rural counties.
3. There is a lack of market awareness and consumer understanding around energy efficient new construction.
4. Tennessee lacks the utility incentives that drive builder-initiated efficiency programs, such as Ryan Home's BuildSmart energy standard program.

Other key takeaways and recommendations include:

1. Builders are profit-driven and therefore need to see case studies from other builders that show financial gains from building energy efficient, high performance homes. Builders may be more likely to adopt new strategies that are recommended and demonstrated by other builders rather than being instructed by officials.
2. Training sessions for builders also need to include information on ventilation strategies, since this is a major difference between the 2009 and 2012 IECC.
3. There is significant potential for increased efficiency with the implementation of quality of construction. However, this may be challenging with an undereducated labor market.
4. A blanket statewide energy code would be an effective way to reduce the confusion between counties and help builders and codes officials comply with and manage codes. Volume builders who build in multiple states and/or in multiple counties in Tennessee may be advocates for normalization.
5. Metropolitan and suburban areas are experiencing rapid growth, which creates bottlenecks for codes officials. Raters and codes officials need to work together to find solutions in each county.

Recommendations for further research include:

1. Constructing trainings for realtors and homebuyers that focus on home health as a selling point for high performance homes.
2. Further investigation into sustainability reports, utility incentives, and other programs established in others states that can serve as examples for Tennessee.

3. Compiling case studies from builders in the southeast who have successfully adopted high performance building practices to use as training materials for Tennessee builders. These case studies need to show market demand, increased revenue, and a reduction in liability claims.

The funding required for E3 INNOVATE to continue this additional research is $10,000, which includes 140 hours of research and 20 hours of presentation time. The target audiences for these presentations are homeowners, realtors, and builders.

In summary, Tennessee must work across market boarders to help educate builders, laborers, buyers, and realtors on the benefits of high performance homes to successfully implement stricter building codes.

For more information, questions regarding this project, or to request a presentation, please contact:

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green|spaces, the City of Knoxville, and ANF Architecture for hosting the presentations.

Appendix A: HERS Raters in Tennessee

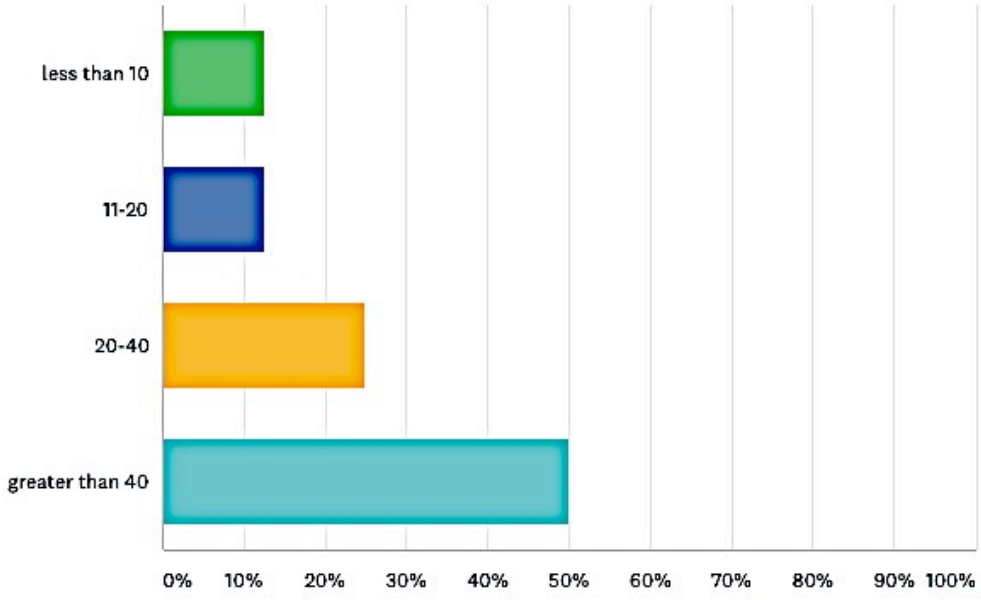
Company	Physical Address	City	Zip	Phone	Email Address	Areas/Counties Served
Accu-Spec Inspection Services	400 Park Road, Suite 111	Sevierville	37862	(865) 453-9965	accuspecinc@gmail.om	Sevierville, Sevier County, Knox County, Knoxville, Green County, Eastern Tennessee
Think Green MidWest	Not Listed	Nashville	37203	(513) 477-0131	info@thinkgreenmidwest.com	Nashville
Energy Home Basics	12500 Martel Road	Lenoir City	37772	(865) 310-1601	bg@bruceglanville.com	Knoxville, Eastern Tennessee
Green River, LLC	Not Listed	Knoxville	37950	(865) 919-7464	http://www.greenriver-llc.com	Knoxville, Knox County, Sevier County, Blount, Jefferson, Monroe County, Green County, Roane County
Cowanhouse	8105 Donnell Road	Rosemark	38053	(901) 829-5062	jackwcowan@aol.com	Memphis, Western Tennessee
Real Green Solutions	304 South Lowry Street, Ste F	Smyrna	37167	(615) 589-9600	http://realgreensolutions.net	Tennessee
E3 INNOVATE	909 E Trinity Ln	Nashville	37207	(615) 876-5479	info@e3innovate.com	Middle Tennessee
TN Professional Inspections	669B McPherson Dr.	Nashville	37221	(615) 564-0074	will@tnproinspections.com	Nashville, Belleview
Thompson Engineers, Inc.	97 Tillman Street	Memphis	38111	(901) 452-2500	jerry@thompsonengineers.com	Memphis
Home Energy Concepts	2419 Smithville Hwy,	McMinnville	37110	(931) 668-7277	Dave@homeenergyconcept.com	McMinnville
Prudent Energy Systems	3430 Topside Road,	Knoxville	37920	(865) 200-3647	scotth@prudentenergysystems.com	Knoxville, Knox County
Doc Air	4014 Flagstone Ct.	Franklin	37212	(615) 373-2498	info@docair.com	Franklin
TN Home Energy Professionals	Not Listed	Franklin	37068	(615) 465-2550	info@tnhomeenergypros.com	Unknown
Efficient Energy of Tennessee	1707 Depot Street	Powell	37849	(865) 947-3386	rthomas@eetenn.com	Unknown

NOTE: This list represents the HERS raters that have information publically available online (websites or listed in the RESNET database). There may be other raters that do not advertise themselves on the Internet.

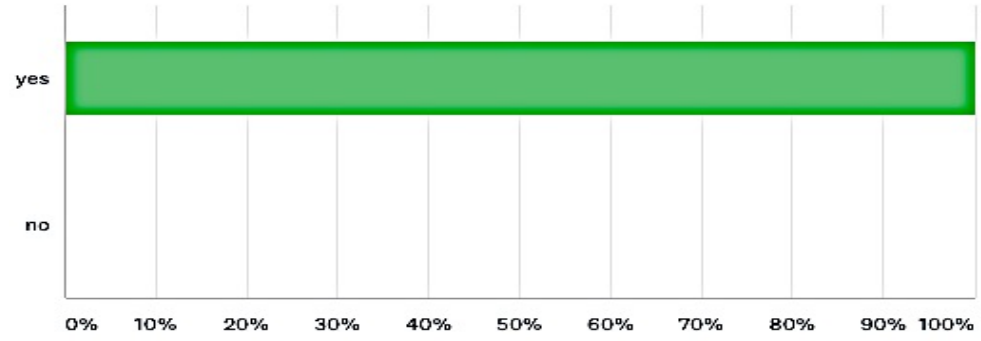
Appendix B: HERS Rater Survey Results

Company	Counties Served	Number of Certifications	Rater Capacity
Real Green Solutions	All of TN	2 HERS	>40/month
Green River LLC	Knox, Sevier, Blount, Jefferson, Monroe, Green, Roan	1 HERS + BPI Air Sealing	11-20/month
Think Green Midwest	Davidson	2 Green Raters + BPI 6 HERS	>40/month
Accuspec Inc.	Sevier, Knox, Green, and most of Eastern TN	1 HERS + WAP Auditor + BPI	20-40/month
ARR TN	150 mile radius of Knoxville	1 HERS + NABCED PV Installation Professional + PV Technical Sales Professional	
Bruce Glanville	9 surrounding counties around Knoxville	1 HERS + GBCI + BPI	20-40/month
Jack Cowan	West TN	1 HERS	<10
Anonymous (Not Provided)	Knox, Roane, Loudon, Hamblen	4 BPI	>40

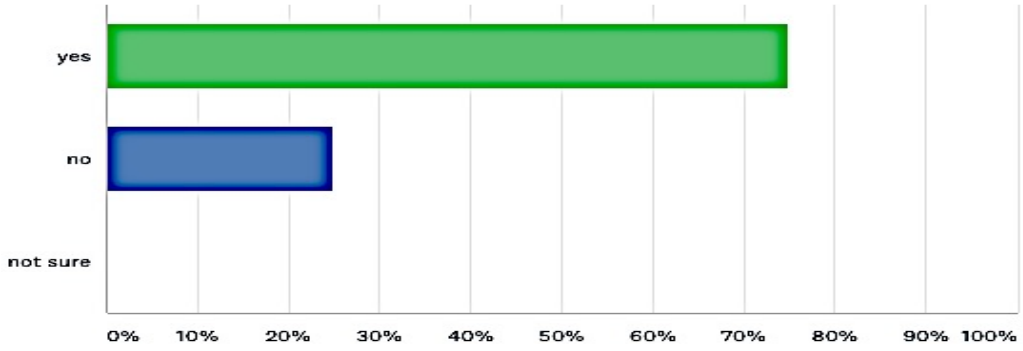
What is your team's energy auditing capacity per month?



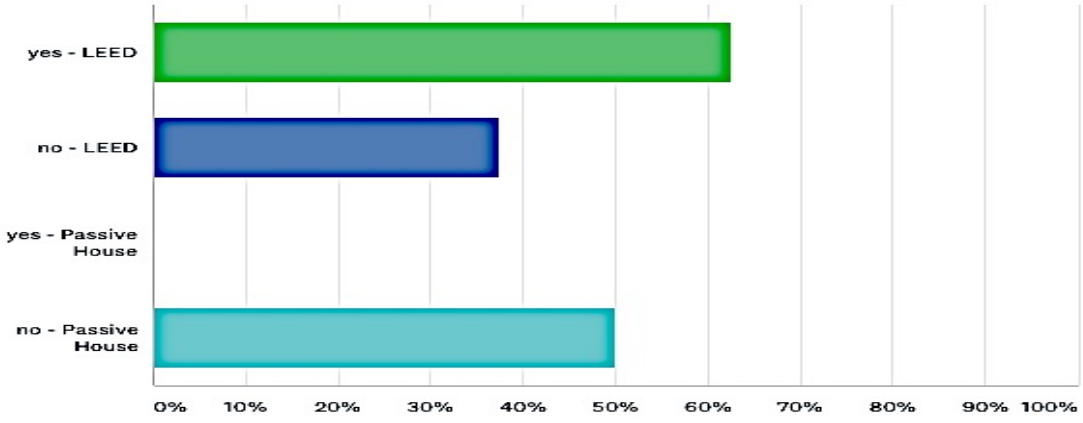
Have you faced challenges with homes having moisture issues or improperly designed HVAC systems?



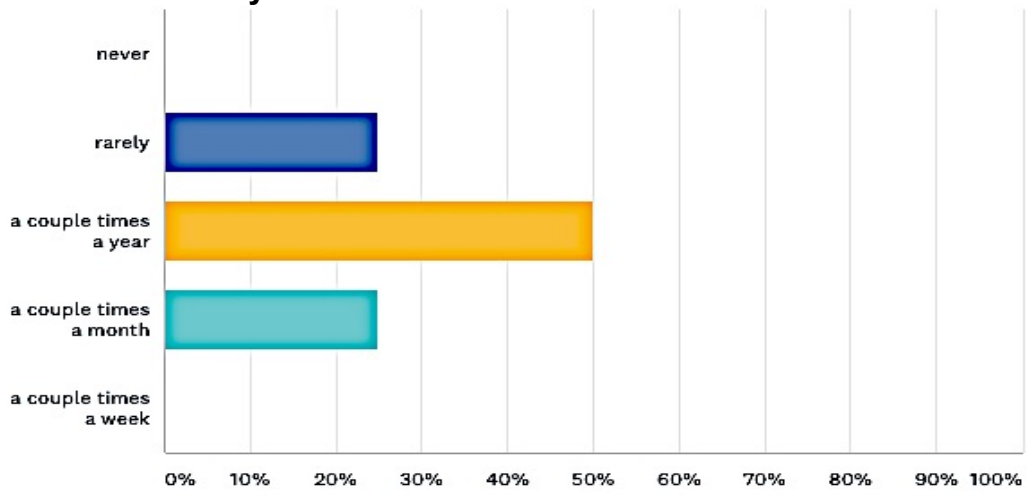
Do your clients show interest in learning more about radon, indoor air quality, efficient heating and cooling design, and/or moisture and mold management?



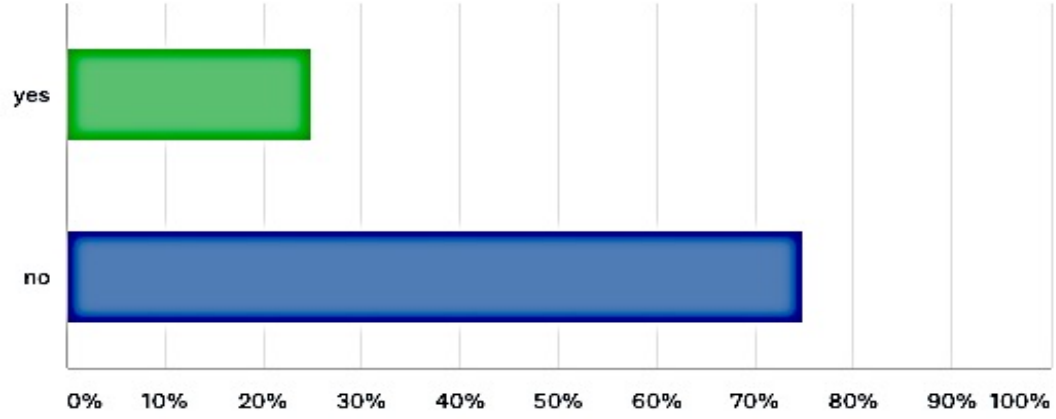
Have you ever been involved in a LEED project or contracted for a Passive House project?



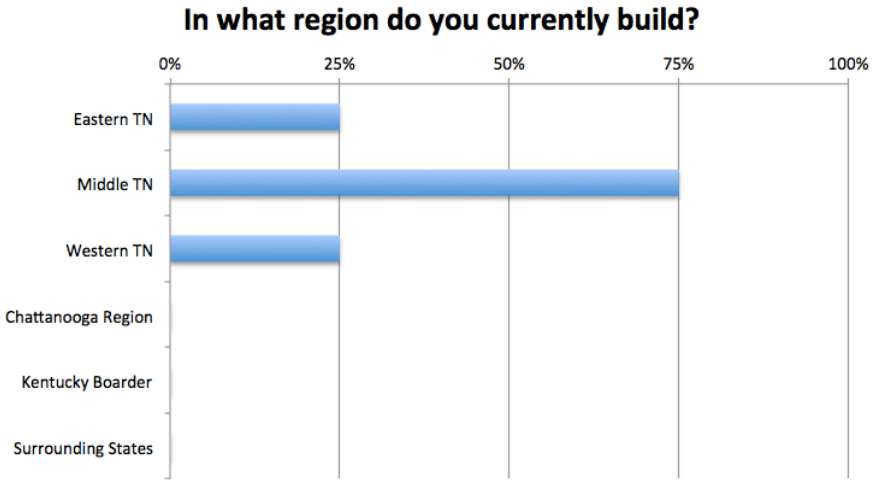
How often are you asked for information on solar PV for homes?

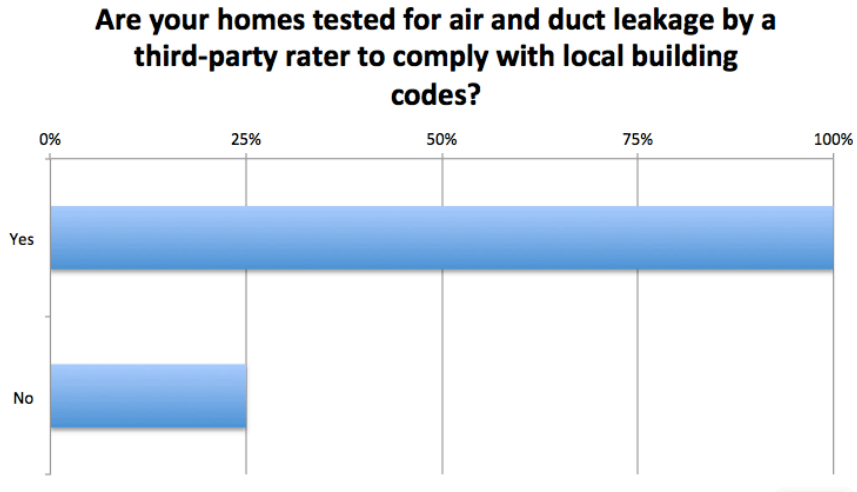


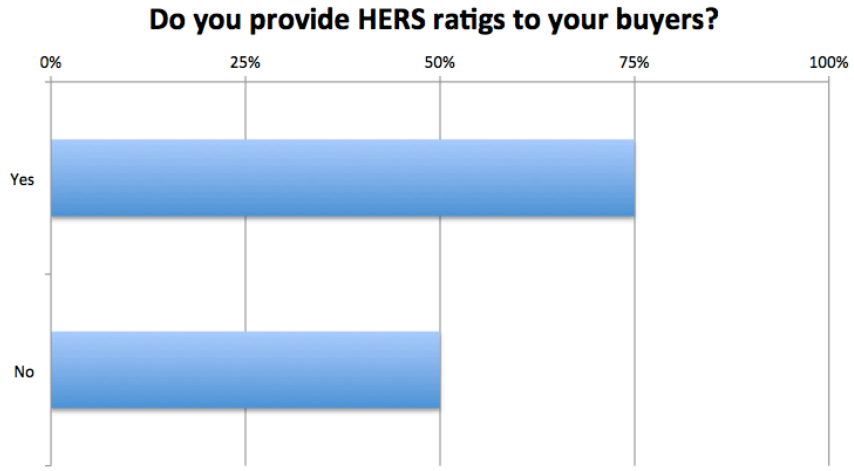
Do you provide weatherization for homes?

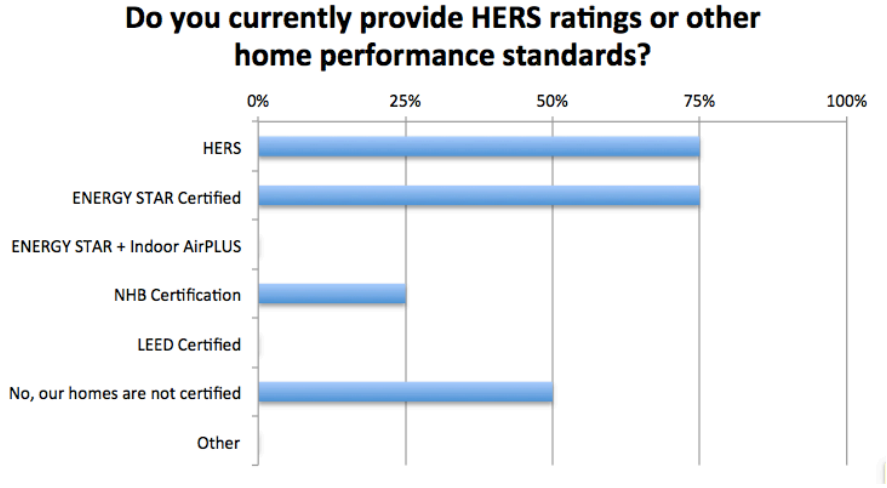


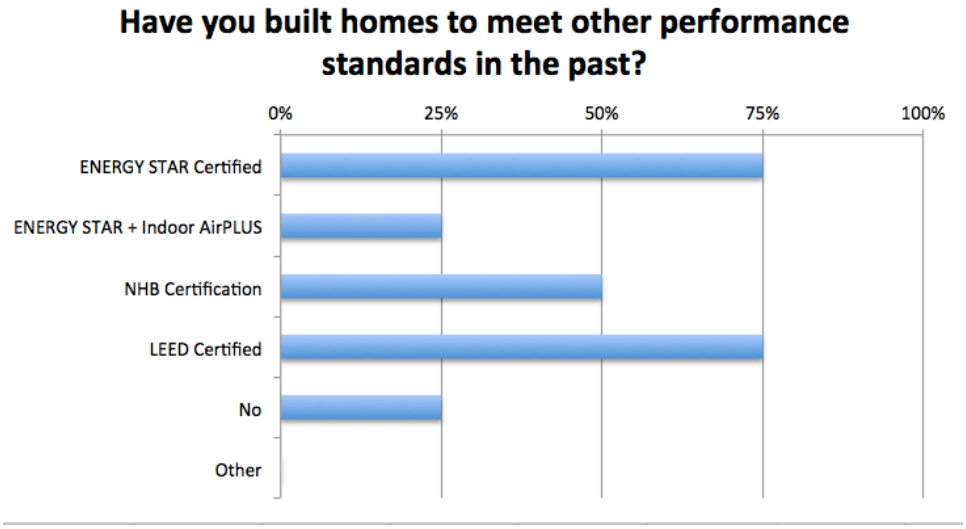
Appendix C: Builder Survey Results







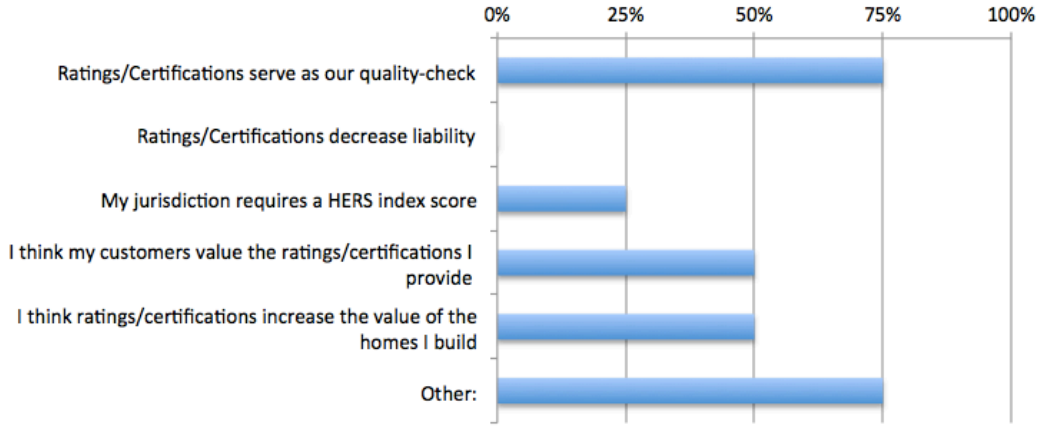




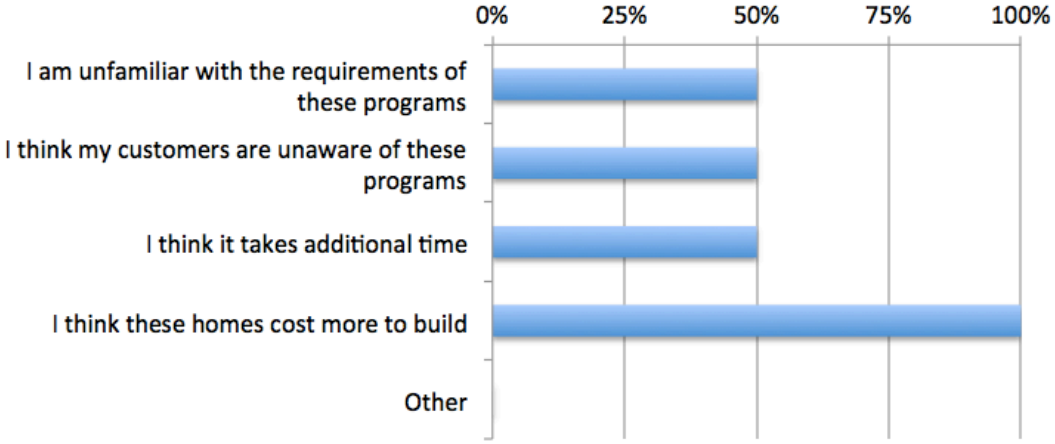
Reasons listed for this change:

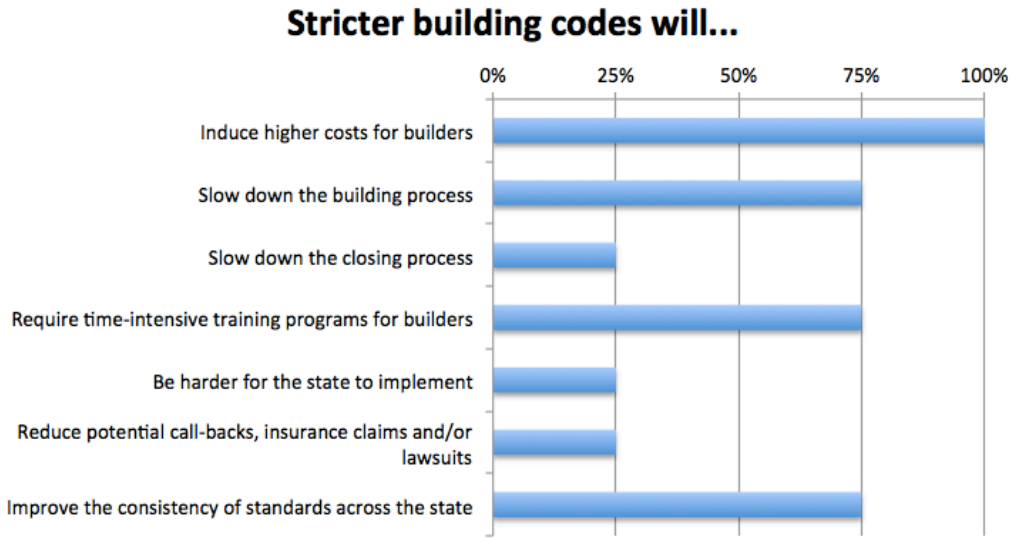
1. There is a lack of feasibility in the market.
2. Utility incentives drive energy program requirements by the state.

Reasons for providing HERS ratings or other performance standards



Reasons for NOT providing HERS ratings or other performance standards




Stricter building codes will...
0%
25%
50%
75%
100%
Induce higher costs for builders
Slow down the building process
Slow down the closing process
Require time-intensive training programs for builders
Be harder for the state to implement
Reduce potential call-backs, insurance claims and/or lawsuits
Improve the consistency of standards across the state

References

(1) DOE Residential Building Codes, available at https://www.energycodes.gov/status-state-energy-code-adoption. Last updated December 5, 2017.

(2) Energy Rating Index Performance Path, HERS Index Scores and Versions of the IECC. Residential Energy Service Network (RESNET). Available at http://www.resnet.us/uploads/documents/EnergyRatings_FactSheet6_Final.pdf.

(3) U.S. Census. (2016). New Privately Owned Housing Units. Available at https://www.census.gov/construction/bps/txt/tb2u2016.txt.

(4) 2017 Annual Energy Efficient, Green and High Performance Home and Building Inventory Report. North Carolina Building Performance Association. March 12, 2018. Available at http://buildingnc.org/resources/research/.

(5) Why Energy Efficiency is A Smart Investment for Virginia, Making the Business Case for Energy Efficiency. Virginia Energy Efficiency Council. 2017. Available at https://vaeec.org/wp-content/uploads/2017/05/VAEEC-2017-Report-FINAL.pdf.