# Adapting to the 2018 North Carolina Energy Conservation Code Lessons from the Home Energy Rating System (HERS) Index

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# Author

William D. Bryan, Built Environment Project Manager, SEEA, <u>wbryan@seealliance.org</u>

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The Southeast Energy Efficiency Alliance (SEEA) is a 501(c)(3) nonprofit organization headquartered in Atlanta, Georgia. Established in 2007, SEEA is a Regional Energy Efficiency Organization (REEO) serving eleven states across the Southeast, including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Virginia.

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## Introduction

The Home Energy Rating System (HERS), administered by the Residential Energy Services Network (RESNET), is one of the most popular methods for measuring the energy performance of new and existing homes. Overall, RESNET has audited more than two million houses in the United States, and the detailed data available from these audits provides a snapshot of home energy performance that can be used to better understand the status of energy efficiency and code compliance nationally.

HERS ratings are an especially valuable source of data on construction trends in North Carolina. In 2016 RESNET reported that the state was second only to Texas in the total number of homes rated, and that year the HERS Index was the most commonly used energy performance certification standard in North Carolina.<sup>1</sup>

As North Carolina adapts to a new residential energy code that went into effect on January 1, 2019, we expect that more homes will demonstrate code compliance by utilizing a new performance pathway, R406: Energy Rating Index (ERI), of which the HERS Index is currently the most established method. Data shared by RESNET with the Southeast Energy Efficiency Alliance (SEEA) provides a detailed look at the energy performance of HERS-rated homes in the state. This data can show how prepared the state's construction industry is to comply with the updated standards, and what energy efficiency features builders will likely use to meet the new pathway.

## Methodology

In 2018 RESNET agreed to provide SEEA with data from all HERS-rated homes in North Carolina that were rated between 2014 and 2016. SEEA has not verified the accuracy of this data in the field, and this study is based solely on a dataset that we were given access to by RESNET.

In order to conduct the following analysis, we have cleaned this data to exclude all homes outside the 2014-2016 time period and to exclude all low-rise multifamily homes, so that this report only focuses on new single-family and duplex homes. The cleaned data also excludes zip codes that are not in North Carolina and all homes that are significant outliers in terms of their energy performance.

<sup>&</sup>lt;sup>1</sup> Residential Energy Services Network (RESNET), <u>"Record Number of Homes HERS Rated in 2016 Over 206,000."</u> <u>RESNET Blog</u>, January 12, 2017. Sajad Hosseini and Ryan Miller. *Energy Efficient, Green and High Performance Home and Building Inventory Report: 2017 North Carolina* (Raleigh: North Carolina Building Performance Association, 2017), 5.



The data provided to SEEA only provides approximate locations for each home by zip code, which do not correspond to climate zones that are defined by county boundaries. The data does not specify which climate zone corresponds to each home, nor does it provide home addresses. In order to determine the climate zone of each home, we assigned zip codes to the county and corresponding climate zone where more than half of the area of that zip code was located. While this provides only an approximation of the climate zone distinctions in the dataset, it is the closest correlation possible given available data.

This analysis does not make a distinction between the different types and versions of the software used to calculate HERS ratings. However, it is important to note that the records RESNET provided were compiled using several different software packages (RemRate, EnergyGauge, and Ekotrope) and different versions of each package. Studies demonstrate that there are differences in the resulting HERS rating depending on the type and version of software used, but these differences are not considered in this analysis.

## The HERS Rating System

Under the HERS rating system, RESNET-accredited Energy Raters estimate the energy performance of a home by measuring the overall tightness of the building envelope, the level, type, and quality of insulation, the efficiency of HVAC system and associated ductwork, and the presence of any potential safety hazards. In select cases, HERS raters will model a home's performance on a nearby residence, though they must indicate that the features in these homes have been "sampled" rather than "confirmed." Energy Raters collect more than seventy unique data points for each home, which are used to calculate a HERS Index score—a measure of the overall energy performance of the building.

The HERS Index is measured on a scale from 0 to 100. The lower the score the more efficient the home. A score of 100 is designed to represent the energy performance of a standard home of like size and type complying with the 2006 International Energy Conservation Code (IECC), and all ratings are measured relative to this standard.<sup>2</sup> Each percentage point that a HERS score differs from the standard home, which is assigned a score of 100, represents a 1 percent difference in energy performance. For instance, a home with a score of 80 is 20 percent more efficient than the standard home of like size and type, while a home with a score of 120 is 20 percent less efficient than the standard home. A score of zero represents a home that produces the same amount of energy that it consumes, or a zero-energy home.

<sup>&</sup>lt;sup>2</sup> Z. Todd Taylor and Vrushali Mendon. *Identification of RESNET HERS Index Values Corresponding to Minimal Compliance with the IECC Performance Path* (Richland, WA: Pacific Northwest National Laboratory, 2014), 1.2-1.3.



## North Carolina's Energy Code

On January 1, 2019, the 2018 North Carolina Energy Conservation Code (NCECC) went into effect. This new code is based on the 2015 IECC, and it replaces the 2012 NCECC, a code based on the 2009 edition of the IECC.

The 2018 NCECC includes more stringent energy efficiency requirements for the building envelope of new homes, primarily in efficiency requirements for windows and insulation in walls, foundations, and ceilings. Perhaps the most significant change is the state's adoption of the new performance pathway, R406: ERI from the 2015 IECC, which allows select energy performance standards—including the HERS Index—to be used to determine code compliance. Although the 2012 NCECC allowed licensed design professionals to verify code compliance through a simulated performance pathway (R405), R406 includes more home components within its purview while providing builders with more flexibility on what pathways are used to achieve compliance.

Because the HERS Index can now be used to determine code compliance, data from home assessments conducted between 2014 and 2016 is valuable to gauge how prepared the state is to meet this new standard moving forward, as well as what component-level steps builders are taking to meet more flexible ERI thresholds.

## The HERS Index in North Carolina

In 2016, the HERS Index was the most used energy performance certification standard in North Carolina, which makes the state a useful case to understand what steps builders are taking to create high-performance residential buildings. That year the state's HERS ratings made up nearly 6.5 percent of all homes audited by RESNET in the United States.<sup>3</sup>

Between 2014 and 2016 there were 28,757 new duplex and single-family homes and 4,792 low-rise multifamily units in North Carolina that were HERS-rated. Overall, HERS-rated single-family and duplex homes made up 24 percent of the 1- and 2-unit building permits that were issued in the state from 2014 to 2016. In 2014 and 2015 HERS-rated homes were 27 percent of all 1- and 2-unit building permits. In

<sup>&</sup>lt;sup>3</sup> Hosseini and Miller, *Energy Efficient, Green and High Performance Home and Building Inventory Report: 2017 North Carolina*, 5; RESENT, "Record Number of Homes HERS Rated in 2016 Over 206,000."



2016 the proportion of HERS-rated homes to total building permits fell to 20 percent due to a spike in new construction.<sup>4</sup>

Homes were HERS-rated in 455 different zip codes. The densest clusters of HERS homes surround the rapidly growing metropolitan areas of Charlotte-Concord, Raleigh-Durham-Chapel Hill, and Wilmington, where the level of new construction activity is high. The most homes rated by RESNET was in the 27519 zip code – Cary, North Carolina – which had over 1,100 homes rated during this three year span. This was 300 more homes than the next highest zip code, 27587, another suburb of Raleigh.



Figure 1: Number of HERS-rated homes by zip code, 2014-2016

Zip codes with less than 10 HERS-rated homes were typically located in rural areas. Of the 98 zip codes with only 1 HERS-rated home, 68 percent are in census-designated rural areas, further demonstrating that construction of high-performance homes is concentrated in the state's growing metropolitan areas.

HERS scores range from a low of -12 in Castalia (Nash County) to a high of 116 in the Charlotte metropolitan area (Mecklenburg County), with a statewide average of 66. Only 2 percent of all homes

<sup>&</sup>lt;sup>4</sup> Data on residential building activity is available from the U.S. Census Bureau's Building Permits Survey. See U.S. Census Bureau, <u>"New Privately Owned Housing Units Authorized."</u> Building Permits Survey.



achieved a score of 50 or less, while 15 percent received a score over 75. The largest proportion of homes (25 percent) received a score between 66 and 70.



Figure 2: Distribution of all HERS Scores by Construction Year

## The Average Home

The average HERS-rated home in North Carolina is 4 bedrooms and 2 stories on a slab foundation, covering 2,712 square feet with 25,529 cubic feet of conditioned space. This is larger than the average size of single-family homes in the South Atlantic region (2,007 square feet) as estimated by the U.S. Energy Information Agency, but it does not reflect a substantial difference from the average size of homes (2,730 square feet) measured by U.S. Department of Energy's Residential Energy Code Field Study for North Carolina.<sup>5</sup> This suggests that the size of HERS-rated homes in North Carolina is more

<sup>&</sup>lt;sup>5</sup> Bartlett, R., et. al. *North Carolina Residential Energy Code Field Study: Baseline Report* (Richland, WA: Pacific Northwest National Laboratory, 2017), 3.16; U.S. Energy Information Agency. <u>"2015 RECS Square Footage Methodology.</u>" (Washington, D.C.: U.S. EIA, 2007).



representative of the state's residential building stock than in other states, where HERS-rated homes tend to be larger than the typical home.<sup>6</sup>

The average home in North Carolina has a HERS score of 66 – making it 5 percent less efficient than the average HERS-rated home in the United States, and it is ENERGY STAR certified. Over the course of a year, this house is projected to use 76 MBTU of energy across all home components, 26 BTU per square foot, with energy costs around \$1756. This is significantly less energy intensive than the average single-family home nationally, which is projected to use 95 MBTU each year. It is also a savings of 7 MBTU every year compared to the typical single-family home in the South Atlantic region. This energy efficiency translates into a significant cost savings for owners or renters of HERS-rated homes in North Carolina, who spend on average \$200 less on energy bills than other households in the region.<sup>7</sup>

Despite the efficiency of HERS-rated homes, the state's builders have been slow to incorporate on-site power generation, especially solar technology. Only .7 percent of homes (207 homes) had any on-site power generation, which averaged just .4 MBTU, or .1 kWh a year per home. This is enough to offset only half a percent of the annual energy required for the average home. The proportion of HERS-rated homes with the capability to generate solar power was even lower, with only .3 percent of all homes (95 homes) having any of their energy use offset by household solar.<sup>8</sup> Houses with on-site power were largely concentrated in the suburbs of the Charlotte metropolitan region, especially in the 28227 and 28025 zip codes.

## How prepared is the state to meet the 2018 NCECC?

The 2018 NCECC divides the state into three climate zones and allows for different ERI ceilings in each zone. In CZ3, the maximum HERS rating for a home without on-site generation is 65, while in CZ4 and CZ5 the maximum is 67. These values remain in effect until January 1, 2023, when the threshold will drop to 61 for CZ3 and 63 for CZ4 and CZ5.

<sup>&</sup>lt;sup>6</sup> Ian Blanding, *What Makes a HERS Home So Special, Anyway?: A Comparison of Field-Tested Homes* (Chicago: Midwest Energy Efficiency Alliance, 2018), 6-7.

<sup>&</sup>lt;sup>7</sup> U.S. Energy Information Administration (EIA), <u>"2015 Residential Energy Consumption Survey: Energy Consumption and Expenditures Tables"</u> (Washington, D.C.: U.S. EIA, 2015).

<sup>&</sup>lt;sup>8</sup> Data provided by RESNET does not indicate what type of power is used by homes with onsite generation that is not solar.



The 2018 NCECC requirements are weaker than the ERI requirements in the model 2015 IECC. In CZ3 North Carolina's code maximum is currently 14 percent less efficient than the model requirement of 51, while in CZ4 and CZ5 North Carolina's code is 13 and 12 percent less efficient than the 2015 IECC respectively.



Figure 3: Distribution of HERS Ratings by Climate Zone

In North Carolina, CZ3 has an average HERS rating of 68, while CZ4 and CZ5 have average HERS ratings of 65 and 60, respectively. ERI compliance rates vary a great deal by climate zone, however. In CZ3 37 percent of HERS-rated homes (4,972 homes) have a rating below the ERI threshold of 65. In CZ4 59 percent of homes (8,918 homes) fall under the ERI maximum of 67. CZ5 had the highest proportion of homes below the ERI ceiling (81 percent). However, the overall number of homes rated in this zone was extremely low with only 16 homes, and we have decided not to draw conclusions specific to CZ5 in this analysis based on so few homes.

All these homes were built before the ERI requirement went into effect and were not designed or built to this standard, but they provide a good indication of how the market is primed to respond to the changes in the 2018 NCECC. In fact, despite variations by climate zone half of all new HERS-rated homes built before the current code was in place are already in compliance with the new standards via the ERI pathway. This suggests that the North Carolina market is well-prepared to meet the new code without dramatically changing existing building practices.



## **Common Component-Level Practices**

Data from RESNET provides a valuable picture of how builders are working to meet the 2018 NCECC standards at the component level. Examining the characteristics of homes that meet the 2018 ERI requirements shows that builders make few tradeoffs in priority areas, including building envelope tightness, insulation, and window specifications.

This suggests that the North Carolina market can meet the requirements in both the prescriptive and ERI compliance path from the 2018 NCECC without requiring builders to adopt radically different approaches to construction. Data from HERS-rated homes can also be valuable for assessing the market potential of future energy efficiency measures.

### **A. Building Envelope Tightness**

One of the key metrics in assessing the energy efficiency of a home is the tightness of the building envelope. The 2018 NCECC specifies that building envelope tightness, if measured with a blower door test, must have less than 5 air changes per hour when the house is pressurized to 50 Pascals with a blower door (ACH50). HERS-rated homes analyzed in this study had an overall average ACH50 value of 3.89 – below the overall state average of 4.13 but in line with the homes examined by the Field Study, which had an average ACH50 of 3.90.<sup>9</sup>

92 percent of all homes had an ACH50 level below the code maximum of 5 – a proportion that also mirrors the findings of the Field Study. In CZ3, 96 percent of homes that meet the zone's ERI standard had an ACH50 value under 5, and only 266 homes had more than 5 air changes per hour. In CZ4, 92 percent of homes that meet the ERI standard have an ACH50 value below 5, while 473 homes exceed this mark.

These findings suggest that in overall envelope tightness new homes are ready to meet market standards more efficient than the 5 air changes an hour required if blower door testing is used to measure the tightness of the building envelope. Adopting mandatory blower door testing in future energy code upgrades is possible without being burdensome to builders, who are already building homes that fall well below the ACH50 threshold.

<sup>&</sup>lt;sup>9</sup> Bartlett, et. al, North Carolina Residential Energy Code Field Study: Baseline Report, 3.2.





Figure 4: ACH50 values for CZ3 and CZ4 homes under ERI thresholds

However, the fact that 739 otherwise high-performing homes did not meet this standard shows that builders still have room to improve. Given that the 5 ACH50 prescriptive requirement has been in place since 2012, we would expect the level of compliance, particularly for high performing HERS-rated homes, to be higher. Therefore, along with updating the state energy code to require blower door testing, achieving better compliance with this requirement through education is also critical to improving the overall energy performance of homes in North Carolina.

#### **B.** Foundations

Most homes (64 percent) were built atop a slab foundation, with 25 percent having a closed crawl space and 4 percent having a conditioned crawl space, though popular foundation types varied by climate zone. In CZ3, 71 percent of homes have a slab foundation with 21 percent of homes having a closed crawl space. In CZ4 43 percent of homes have a closed crawl space while 34 percent of homes are built on a slab foundation.





Figure 5: Dominant Foundation Type by Climate Zone

In North Carolina, foundation insulation is an area that builders can use to gain additional efficiencies without incurring additional costs for labor or materials. The installation quality of foundation insulation is generally poor. Only about one-third of all HERS-homes in the state (32 percent) have foundation insulation with a Grade I installation. Even homes that comply with the ERI ceiling for their climate zone have low quality insulation installations. In CZ3 only 28 percent of homes under the ERI ceiling had foundation insulation that was Grade 1, while CZ4 did significantly better with 63 percent of homes having Grade 1 foundation insulation. Yet nearly 7,000 homes in the state were able to comply with the ERI ceiling for their climate zone while having foundation insulation rated at Grade 2 or lower. This suggests a pressing need for more builder education in order to realize the significant efficiency savings left behind as a result of the quality of foundation insulation insulations.

#### C. Walls

The 2018 NCECC prescriptive path requires wood frame wall cavity insulation to be at least R-15 (in CZ3 and CZ4), though this can be substituted by using R-13 cavity insulation combined with at least R-2.5 continuous insulation. In CZ5, the 2018 NCECC provides for several paths. The prescriptive path requires either R-19 cavity insulation overall, R-13 cavity insulation combined with R-5 continuous insulation, or R-15 cavity insulation combined with R-3 continuous insulation.

The level of compliance with the prescriptive path was high. Overall, homes in CZ3 and CZ4 averaged R-15 insulation in the wall cavity, with 99.7 percent of homes (25,315 homes) having R-13 or greater cavity insulation. Only 78 homes had wall cavity insulation that was below R-13. Since the quality of wall cavity insulation was largely up to code, it is not surprising that few builders chose to use additional continuous insulation. Only 10 percent of homes (2,509 homes) in CZ3 and CZ4 had any additional continuous insulation, and only 3 percent of these (626 homes) were at or above R-2.5. Because compliance rates were so high, they did not change a great deal when only homes that were below the ERI ceiling for their respective climate zone were considered.

The quality of the installation of wall insulation was higher than in foundations. Overall, 77 percent of homes in all climate zones had insulation that was installed to a Grade 1 standard. This proportion was the same in CZ3 – not surprising given the more temperate coastal climate in this zone – but CZ4 had a



higher proportion of homes (93 percent) with insulation of Grade 1 quality. Although CZ4 had a better track record this still means that overall 23 percent of all HERS-rated homes (5,817) had less than Grade 1 insulation. This suggests a need for better education in order to improve insulation install quality and ensure that all benefits of higher quality insulation are realized.

### **D.**Ceilings

Builders are making tradeoffs in ceiling insulation, even in homes that are designed to be more efficient than the current ERI ceiling. The 2018 NCECC prescriptive path requires ceiling cavity insulation to have an R-value of 38 in all climate zones. Yet the average R-value of cavity ceiling insulation in all HERS-rated homes overall is R-34, and there are low rates of compliance in homes that are under the ERI ceiling for their climate zone. Only 35 percent of all homes (3,561 homes) had insulation with an R-value greater than or equal to the R-38 standard, while more than 10,000 homes did not meet this prescriptive requirement for ceiling insulation. This proportion remained relatively static even for homes below the ERI ceiling in their climate zone. This suggests a need for greater attention to ceiling insulation to improve building efficiency, even in high-performing homes.

#### **E. Windows**

While there are a range of approaches to insulation, there is less variation in pathways that builders use when it comes to their choice of windows. The average window U-factor – a measure of a window's insulating potential - was .32, significantly more efficient than the maximum of .35 required for all climate zones under the 2018 NCECC. The compliance rate of all homes was 99.8 percent, which mirrors the rate for homes that comply with their respective ERI ceilings.



Figure 6: Window U-Factor by Climate Zone



Only 0.2 percent of all homes (58 homes total) had windows with a U-factor above .35. This rate fits with the findings of the Field Study, and it suggests that the state's building stock is already well prepared to meet 2018 NCECC fenestration requirements.<sup>10</sup>

The state's HERS-rated homes also overwhelmingly met the prescriptive code Solar Heat Gain Coefficient (SHGC) requirements for windows, a metric used to describe the amount of solar heat allowed to penetrate the window and measured from 0-1. The lower the SHGC value, the less solar radiation that can penetrate the window and the more efficient it is.

North Carolina's 2018 code specifies an SHGC value of .30 for glazed windows in all climate zones. SHGC values ranged .06 to 1.0, but the overall average SHGC for all HERS homes was well under the code requirement at .25, and only 258 homes (1 percent) exceeded the state's SHGC requirements – a level that again mirrors the compliance rate of all representative homes in North Carolina.<sup>11</sup>



Figure 7: Window SHGC Distribution by Climate Zone

The high rates with which HERS homes in North Carolina meet code window requirements suggests that the North Carolina building market is already well prepared to meet updated requirements from the latest model codes when the state adopts a new energy code. In fact, almost 40 percent of HERS homes built between 2014 and 2016 in CZ3 and CZ4 meet the window u-factor standards from the 2018 IECC,

<sup>&</sup>lt;sup>10</sup> Bartlett, et. al, North Carolina Residential Energy Code Field Study: Baseline Report, 3.4.

<sup>&</sup>lt;sup>11</sup> Bartlett, et. al, North Carolina Residential Energy Code Field Study: Baseline Report, 3.3.



and a similar proportion meet the code's more stringent SHGC requirements.<sup>12</sup> This suggests that the market can easily adapt to even more efficient window standards than those in the state's new code, which are already largely being met.

## F. Lighting

One surprising challenge is in the installation of high-efficacy lighting (HEL) – a component that is often assumed to be prevalent in new homes. The 2018 NCECC includes a mandatory requirement that all new homes must be built with a minimum of 75 percent of high-efficacy lighting. While 90 percent of homes overall (22,841 homes) had more than the code minimum, this means that more than 2,500 homes were not in compliance with this requirement.



Figure 8: Proportion of High-Efficacy Lighting by Climate Zone

Looking at the homes that are below the ERI requirements for each climate zone reveals a similar proportion of homes that meet the code requirement for lighting. In CZ3, 90 percent of homes have more than 75 percent of HEL, while 467 homes are not in compliance. In CZ4, 92 percent of homes meet the HEL requirement, while 680 homes do not. Each of these cases has a significantly higher rate than the compliance rate measured by the Field Study of 57 percent statewide.<sup>13</sup> Yet the fact that over 1,000

 <sup>&</sup>lt;sup>12</sup> 37 percent of homes in CZ3 meet more stringent SHGC requirements in the 2018 IECC. Virtually all homes in CZ4 meet the SHGC requirements from the 2018 IECC, but these requirements are less efficient than the 2018 NCECC.
<sup>13</sup> Bartlett, et. al, *North Carolina Residential Energy Code Field Study: Baseline Report*, 3.10.



homes that otherwise meet the ERI ceiling for their climate zone have less than the required proportion of HEL – already a low bar – suggests that improving the proportion of highly efficient lighting in new homes is an area that builders can use to achieve significant energy saving in the future.

#### **G.Non-Code Upgrades**

North Carolina does not have specific energy code requirements for HVAC systems, aside from requiring that heating and cooling units meet federal minimum efficiencies and be sized according to the standards developed by the Air Conditioning Contractors of America (ACCA). Yet these units are critical for builders looking to reduce the energy footprint of their home and are a popular path to receiving low HERS scores. Because federal efficiency standards have increased little for heating and cooling equipment, builders are able to obtain substantial gains in RESNET's rating software by investing in efficient heating and cooling units, offsetting less efficient aspects of home performance in other areas and allowing flexibility with prescriptive code requirements.<sup>14</sup>

As a result, HERS-rated homes in North Carolina have high-efficiency HVAC equipment. The average air conditioning unit is a 14 SEER unit with a 33.8 BTU capacity, and this did not change across climate zones and HERS scores. Most furnaces are powered by natural gas and have an average efficiency of 90.1 AFUE, significantly more efficient than homes measured in the Field Study, which averaged only 84 AFUE. In fact, 54 percent of all HERS-rated homes had a furnace efficiency that was at or above 90 AFUE, suggesting that builders are frequently installing high-efficiency condensing furnaces that exceed federal standards.

We only have partial data on homes that use a heat pump for climate control, making it difficult to draw conclusions about their prevalence. However, we can estimate that approximately 2,907 homes overall are using a ground or air source heat pump, which is 10 percent of all HERS-rated homes.<sup>15</sup>

Over half of all homes (51 percent, or 13,064 homes) have an electric water heater, while 44 percent (11,835 homes) use natural gas. Only 2 percent of homes have a propane-fueled water heater. We have incomplete data on which of these homes have heat pump water heaters. We can assume that homes with an electric water heater that has a capacity over 50 gallons are potentially using heat pump water heaters. Using this as a rough guide, we estimate that there are at most 2,080 homes (8 percent) using a heat pump water heater.

 <sup>&</sup>lt;sup>14</sup> Blanding, What Makes a HERS Home So Special, Anyway?: A Comparison of Field-Tested Homes, 6.
<sup>15</sup> To determine this, we eliminated all homes with a furnace, NULL values, and all homes that were identified as having no duct leakage. The remaining homes were assumed to be using a heat pump.



Another way that builders are achieving efficiencies through non-code elements is by installing appliances that are ENERGY STAR-rated or beyond, which can dramatically lower a home's HERS score. To meet federal "most efficient" standards of 2016, a refrigerator must be ENERGY STAR certified and use no more than 637 kWh of energy each year. The average refrigerator used 660 kWh each year, and a quarter of all homes had a refrigerator that exceeded ENERGY STAR standards and met the federal "most efficient" standard of 2016. In CZ3, the proportion of homes with refrigerators meeting this standard dropped to 17 percent, while in CZ4 24 percent of homes have refrigerators at this standard.

ENERGY STAR standards require that dishwashers use no more than 270 kWh of energy each year. Dishwashers in all HERS homes average 268 kWh per year, and 67 percent of all homes (6,030 homes) had an ENERGY STAR-qualified dishwasher, a high proportion that is similar in homes below the ERI ceiling in CZ3 and CZ4. Because the HERS rating incorporates appliance efficiencies relative to a reference home, builders in North Carolina are using high-performance appliances to lower HERS scores, even though these appliances are not reflected in prescriptive or mandatory aspects of the code.

As builders work to reduce HERS scores and bring homes into compliance with the 2018 NCECC, HVAC equipment and appliances are likely pathways that they will use to prioritize higher standards of efficiency than the federal minimums in new construction. Because minimum equipment efficiencies for items like heating and cooling systems have not kept up with new technology, however, builders can obtain lower HERS scores by focusing on these areas. Although the data does not indicate a serious imbalance in the use non-code items as compared with code items, it will be important to assess whether an overreliance on high-efficiency features like appliances and HVAC equipment is diminishing the appetite to invest in other energy efficiency components as the ERI path continues to become more popular as a code compliance pathway.



## Conclusions

Data from RESNET's HERS database in North Carolina provides a valuable window into current construction practices and can be used to measure energy efficiency in new homes and to gauge how well the state is prepared to adapt to the standards of the 2018 NCECC. Because the profile of HERS-rated homes in the state is similar to homes measured by the Field Study, this data is especially useful in illuminating the state of new construction in North Carolina.

The data shows that homes with a HERS score below the ERI ceiling for their climate zone achieve significant efficiency gains by focusing on components like envelope tightness, high-quality insulation, efficient HVAC systems, and the installation of high-performing windows. The high rate of compliance on component-level code requirements among newly built HERS-rated homes – homes that were built before the 2018 NCECC went into effect – suggests that the state's builders are well prepared to meet the updated code requirements. Many builders already are, and the 2019 changes will not require radical changes in existing building practices in the North Carolina market.

These is less consistency in homes with HERS scores at the low end of the spectrum, and the closer that homes get to zero energy ready the more varied the pathways that builders are using to get there – a topic that will be explored in a subsequent report.

These findings show that North Carolina has an opportunity to add more stringent energy requirements in future code adoptions without requiring builders to pay more or to radically change existing building practices. The state should particularly consider updating code requirements for the building envelope (ACH50), window standards, and insulation R-value requirements – all of which were being met by a significant proportion of builders even before the current code was in place.

These findings also show that there are still areas where efficiency gains can be made even within the state's high-performance housing stock. The installation quality for insulation is an area that can be improved across the board through builder and contractor education and outreach. Advanced building technologies like heat pumps and heat pump water heaters are still rare. Yet these technologies offer significant cost and energy savings over standard heat pumps or HVAC equipment and should be incorporated into new homes moving forward. High-efficacy lighting also offers low-hanging fruit that builders can use to make new homes more efficient and appealing to potential homeowners and renters. Finally, builders should expand opportunities for renewable energy generation in new homes, which when combined with energy efficiency can radically lower the energy profile of the state's building stock and provide homes that approach Zero Energy/Zero Energy Ready status.

It is important to note that these results are necessarily skewed toward urban and suburban markets, since HERS-rated homes are more prevalent in these parts of North Carolina. As the state adapts to the 2018 NCECC ERI path, it is likely that this pathway will be less frequently used in rural North Carolina, where the building expertise and HERS raters are not yet as prevalent. As a result, there will likely be a



need for outreach to these areas to make sure that builders and others in the industry understand this new ERI pathway and that resources are available to make it available in this region.

Ultimately, the data shows that while the state's builders are largely prepared to meet the 2018 NCECC, more education and discussion needs to be focused on component-level steps – aside from energy generation – that can be used to achieve significant reductions in the energy use of new homes.

## Recommendations

Based on this analysis, we have several recommendations to help North Carolina's builders, policymakers, homeowners, and renters realize the full value of energy efficiency available to them without requiring significant changes in construction practices or occupant behavior:

- Add more stringent efficiency requirements to the state's energy code in future adoptions in areas with high rates of compliance and market adoption, especially building envelope standards, insulation heat resistance, and window requirements
- Provide education opportunities for builders and contractors on aspects of the state's energy code where compliance is low like the installation of insulation
- Provide expanded opportunities for the generation of renewable energy in new homes, which when combined with energy efficiency can radically lower the energy profile of the state's building stock and move efficient homes closer to Zero Energy and/or Zero Energy Ready status