Energy Performance Comparison of 2020 NGBS and 2021 IECC

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Background / Purpose

The purpose of this analysis is to compare the energy performance of the 2021 International Energy Conservation Code (IECC), and the ICC-700-2020 National Green Building Standard (NGBS). The intent is to determine if the NGBS meets or exceeds the energy performance of the 2021 IECC.

2021 IECC Overview

The IECC is a model building code first published as a 1998 edition by the International Code Council (ICC) that establishes mandatory minimum energy efficiency requirements for new commercial buildings and residential homes. A version of the IECC is adopted and enforced by the vast majority of states. The IECC uses prescriptive and performance-related measures to create an energy efficiency baseline, which includes requirements on buildings' thermal envelopes, heating and cooling systems, ventilation, lighting, and water heating. The ICC updates the IECC on a 3-year cycle, which then can be referenced by various state and local governments, as well as other organizations, to establish minimum efficiency requirements for new buildings.

The IECC contains mandatory provisions that must be met for all buildings but offers three different pathways to achieve compliance with the code:

> **Prescriptive Path (R401-R404 and R408)** - Offers compliance through a prescriptive set of energy efficiency measures that must be met (e.g., Insulation levels, air leakage). This path is generally simpler and can be achieved without the use of energy modeling software but provides less flexibility in choosing different energy efficiency measures.
>
> **Performance Pathway (R405)** - Allows compliance with the IECC based on whole house energy modeling and provides flexibility for more tradeoffs. In this pathway, a reference design home is specified, and the home being evaluated must be shown to have an annual energy cost at least 5% lower than the cost of the reference design home. Although this path allows for more flexibility in the energy efficiency measures used, compliance must be verified using energy modeling software.
>
> **Energy Rating Index (ERI) Pathway (R406)** - Relies on energy modeling through ANSI/RESNET/ICC 301, to establish an ERI, which is a score that represents the energy efficiency of a home. A home must have an ERI that is equivalent to or lower than (i.e., equal to or more efficient) the IECC-specified ERI based on Climate Zone.

For this analysis, the prescriptive path was used for the comparison of the IECC to the NGBS. This was done to align with the path and associated assumptions the Department of Energy (DOE) and the Pacific Northwest National Laboratory (PNNL) used in the *Energy Savings Analysis: 2021 IECC for Residential Buildings*, which indicates it is the predominant path used for code compliance.[1]

NGBS Overview

The ICC-700-2020 National Green Building Standard (NGBS) is an American National Standards Institute (ANSI) approved standard that utilizes third-party inspections to certify aspects of buildings at various levels. The NGBS, first published in 2008, is a voluntary standard that builders can elect to certify homes to. The 2020 NGBS was developed based upon the 2018 IECC (and other I-Codes), and projects that comply with the 2018 IECC are deemed to comply with the energy efficiency requirements of the NGBS Bronze level. The scope of the NGBS includes energy efficiency, water efficiency, resource efficiency, lot development, operations and maintenance, and indoor environmental quality. This analysis focuses on Chapter 7 of NGBS, "Energy Efficiency," as it has a comparable scope to the 2021 IECC.

Similar to the structure of the 2021 IECC, Chapter 7 of the NGBS has three compliance paths:

[1] https://www.energycodes.gov/sites/default/files/2021-07/2021_IECC_Final_Determination_AnalysisTSD.pdf

Prescriptive Path (§ 703) – Requires compliance with specific measures (e.g., insulation, envelope leakage), with limited availability for efficiency tradeoffs.

Performance Path (§ 702) – Establishes a reference design against which a proposed home will be benchmarked. Energy modeling software is required to demonstrate that a home achieves performance that meets or exceeds the reference design.[2] This path allows flexibility to trade off features to demonstrate compliance (e.g., improved HVAC performance, while reducing insulation).

ERI Target Path (§ 704) – Relies on energy modeling through ANSI/RESNET/ICC 301, to establish an Energy Rating Index (ERI), which is a score that represents the energy efficiency of a home. A home must have an ERI that is equivalent to or lower than (i.e., equal to or more efficient) the NGBS-specified ERI Target based on Climate Zone.

For this analysis, the NGBS performance path was used as the path to compare to the 2021 IECC. Within the NGBS each path is considered equivalent, but in practice the stringency of each can vary, and a code or standard is only as efficient as the least stringent path. As discussed later in this analysis, the NGBS performance path was considered the least stringent due to the lower efficiency values in the reference design and a lack of mandatory backstops, which are discussed later in this analysis.

Each compliance path in the NGBS provides some ability to achieve different 'levels' of certification, representing improved energy efficiency at each level. For the performance path, the level is determined by percent energy savings against the 2020 NGBS Reference Home, which is translated into 'points' as shown in Table 1 below.

Level	Percent Savings against 2020 NGBS Reference Home	Points
Bronze	0%	30
Silver	7.5%	45
Gold	15%	60
Emerald	20%	70

Table 1: NGBS Performance Metrics

Additionally for the performance path, NGBS requires at least two practices from § 705 (Additional Practices), or one from § 705 and one from § 706 (Innovative Practices). Some of these practices would have no impact on energy consumption, which is the focus of this analysis; for example, §706.13 provides credit for cooling equipment that uses low global warming potential (GWP) refrigerant, which does not necessarily have an efficiency benefit but does have a potential emissions benefit. For a home complying with the 2021 IECC prescriptive path, this requirement in the NGBS would likely already be met because several items that are mandatory in the 2021 IECC are comparable to measures in § 705 and § 706, such as Interior lighting (§705.2.1.1), and Exterior lighting (§705.2.1.2). Thus, this analysis does not assume any energy efficiency impact from these additional practices.

Methodology

This analysis has a limited scope that looks at several representative single-family homes, while utilizing the U.S. Department of Energy's *Methodology for Evaluating Cost Effectiveness of Residential Energy Code Changes* (DOE Methodology).[3]

[2] https://www.homeinnovation.com/-/media/Files/Certification/Green_Building/NGBS-Green-Program-Policy-Handbook.pdf
[3] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf

Building Models and Prototypes

This analysis looked at three locations in different Climate Zones (CZ) and utilized weighting factors from the DOE Methodology to identify the most representative location, HVAC system type, domestic hot water (DHW) fuel, and foundation type. Table 2 summarizes these values for each home. Other aspects of the home (e.g., conditioned floor area, window area) align with the DOE Methodology.

Climate Zone	Modeling Location	HVAC System Type	DHW Fuel	Foundation Type
2	Houston, TX	Furnace / AC	Gas	Slab
4	Baltimore, MD	Heat Pump	Electric	Conditioned Basement
6	Burlington, VT	Furnace / AC	Gas	Unconditioned Basement

Table 2: Building Model Summary

Modeling Tool and Outputs

This analysis utilized Ekotrope Version 4.2.2 as the modeling software, as it provides reports that automatically evaluate compliance with the 2021 IECC and NGBS. Specifically, Ekotrope's built-in NGBS performance reports were utilized to compare a home configured to meet the 2021 IECC prescriptive path requirements against the NGBS levels. Figure 1 below shows an example report from Ekotrope that demonstrates a home meeting the NGBS Emerald level achieving 70 points, or 20% above the 2020 NGBS Reference Home.

Annual Energy	Reference		As Designed	
Type	**Cost ($/yr)**	**MBtu**	**Cost ($/yr)**	**MBtu**
Heating	$1,071	26.6	$954	23.7
Cooling	$293	7.3	$291	7.2
Water Heating	$183	4.5	$181	4.5
Lights & Appliances	$1,369	34.0	$906	22.5
Onsite Generation	-$0	0.0	-$0	0.0
Total	$2,915	72.4	$2,333	57.9

NGBS Points: 70

The As Designed home consumes 20% less energy than the NGBS Reference Home and MEETS the requirements of the 2020 NGBS Section 702 for Chapter 7, Energy Efficiency, Performance path and is eligible for 70 points in section 702.2.2. This energy use summary compares the NGBS Proposed Design to the NGBS Reference Design. The NGBS Proposed Design includes improvements in building envelope, air infiltration, heating system efficiencies, cooling system efficiencies, ventilation system efficiencies, duct sealing, water heating system efficiencies, lighting, appliances, and on-site renewable energy production. Points are assigned using the following formula: Points = 30 + (percent above NGBS Reference Design) * 2.

Figure 1: Example Ekotrope 2020 NGBS Reference Home Report

Modeling Assumptions of 2021 IECC Homes

Generally, modeling inputs align with the requirements of the 2021 IECC Prescriptive Path (e.g., insulation levels, air leakage, duct systems, mechanical ventilation). Section R408 requires homes utilizing the prescriptive path to select one additional efficiency package. This analysis followed PNNL and DOE assumptions, which modeled homes with the Reduced Energy Use in Service Water Heating Option.[4] This efficiency package upgrades homes with gas water heating to an instant gas water heater at 0.82 Energy Factor (EF), and upgrades homes with electric hot water heating to a heat pump water heater at 2.0 EF.

[4] https://www.energycodes.gov/sites/default/files/2021-07/2021_IECC_Final_Determination_AnalysisTSD.pdf

There are several important aspects of a home that do not affect compliance with the 2021 IECC Prescriptive Path and are not specified within that path. This analysis aimed to accurately model what was considered standard practice for new construction homes. Therefore, typical new home building practices and equipment were selected unless mandated by the 2021 IECC.

Appliances

Appliances are not within the scope of the 2021 IECC prescriptive path, so there is no additional credit or penalty within the IECC for appliances that are more or less efficient than federal minimums set by DOE standards. In contrast, NGBS does provide credit for appliances that are more efficient than the NGBS reference design. Therefore, this analysis considered the prominence of ENERGY STAR certified products (i.e., market share)[5] to establish modeling inputs that reflect standard practice.

Refrigerators, Dishwashers, and Clothes Washers – ENERGY STAR products have a majority market share as shown below. Therefore, homes were modeled with ENERGY STAR products for these appliances.

- Refrigerators - 66% ENERGY STAR Market Share
- Dishwashers - 96% ENERGY STAR Market Share
- Clothes Washers - 61% ENERGY STAR Market Share

Clothes Dryers - ENERGY STAR products have a minority (48%) market share. Therefore, homes were modeled with a clothes dryer that meets the current DOE energy conservation standards for Clothes Dryers.

While lighting is within the scope of the 2021 IECC prescriptive path, it is worth noting that it was modeled per those requirements. Specifically, 100% lighting is high efficacy (i.e., 100% CFLs).

Heating and Cooling Equipment

Heating and cooling equipment is not within the scope of the 2021 IECC prescriptive path, nor the 2021 IECC performance path, which was not analyzed. This means there is no additional credit or penalty within the IECC for commonly installed equipment that exceeds federal minimums set by DOE standards. In contrast, NGBS does provide credit for equipment more efficient than the NGBS reference design.[6] Therefore, this analysis aimed to model what was standard practice in each location by considering baseline studies that surveyed characteristics of new construction homes. This analysis considered the most recent studies available, but there are cases where recent DOE energy conservation standards require equipment performance that exceeds the baseline study values found at the time the studies were conducted (which in some cases is several years old at the time of this analysis). Since the DOE standards must be met, if the baseline studies indicated past performance was worse than the DOE energy conservation standard, the DOE standards were used.

Houston TX (CZ 2)

Homes in this climate zone were configured with a gas furnace and central air conditioner. The *Texas Residential Energy Code Field Study*[7] found that central air conditioners had an average Seasonal Energy Efficiency Ratio (SEER) of 15.1 (for Phase I of the study) and 14.7 (for Phase III of the study). The current DOE energy conservation standards for central air conditioners in Texas is 15 SEER, so due to the similarity of the study values, homes were modeled with 15 SEER central air conditioners.

[5] https://www.energystar.gov/sites/default/files/2022%20Unit%20Shipment%20Data%20Summary%20Report.pdf
[6] Note that there is one option in Section R408 (More efficient HVAC equipment performance option), which would require higher efficiency equipment, but this analysis assumed the use of the Reduced Energy Use in Service Water Heating Option.
[7] https://www.energycodes.gov/sites/default/files/2022-09/Texas_Field_Study_State_Report_Final_Report_pub.pdf

The *Texas Residential Energy Code Field Study* found that gas furnaces had an average Annual Fuel Utilization Efficiency (AFUE) of 83 (for Phase I of the study) and 82 (for Phase III of the study). The current DOE energy conservation standard for gas furnaces is 80 AFUE, indicating that standard practice in this region slightly exceeds DOE standards. Therefore, homes were modeled with 82 AFUE furnaces.

Baltimore Maryland (CZ 4)

Homes in this climate zone were configured with air source heat pumps. The *Maryland Residential Energy Code Field Study*[8] found that air source heat pumps had an average performance of 14 SEER / 7.7 Heating Seasonal Performance Factor (HSPF). The current DOE energy conservation standard for air source heat pumps is 15 SEER / 8.8 HSPF. Therefore, homes were modeled with 15 SEER / 8.8 HSPF air source heat pumps because the current DOE standards exceed the values from the baseline study.

Burlington VT (CZ 6)

Homes in this climate zone were configured with a gas furnace and central air conditioner. The *2020 Vermont Single-Family Residential New Construction Baseline and Code Compliance Study*[9] found that central air conditioners had an average SEER of 15.2. The current DOE energy conservation standard for central air conditioners in Vermont is 14 SEER, indicating that standard practice in this region exceeds DOE standards. Therefore, homes were modeled with 15.2 SEER central air conditioners.

The *2020 Vermont Single-Family Residential New Construction Baseline and Code Compliance Study* found that gas furnaces had an average AFUE of 92.5. The current DOE energy conservation standard for gas furnaces is 80 AFUE, indicating that standard practice in this region exceeds DOE standards. Therefore, homes were modeled with 92.5 AFUE furnaces.

Results

For the representative homes in Climate Zones 2, 4, and 6, compliance with the 2021 IECC results in energy costs that are roughly equivalent to the NGBS Emerald level, this is shown in Figure 2, Figure 3, Figure 4, and Table 3 below as an energy cost savings of close to 0%. The less stringent NGBS levels (i.e., Gold, Silver, Bronze) are shown to have negative savings compared to the 2021 IECC, meaning they are less efficient and result in higher energy costs.

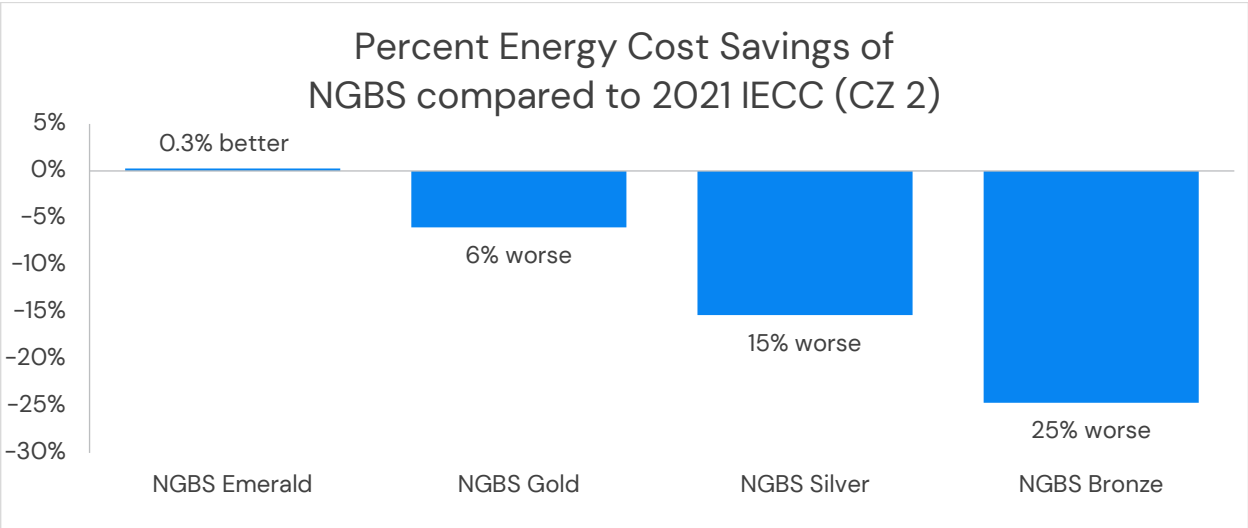


Figure 2: Percent Energy Cost Savings of NGBS compared to 2021 IECC in Climate Zone 2

[8] https://www.energycodes.gov/sites/default/files/2022-09/Maryland_Field_Study_State_Report_Final_pub.pdf
[9] https://publicservice.vermont.gov/sites/dps/files/documents/VT_2020_SF_RNC_Baseline_Final_Report_Jan242023.pdf

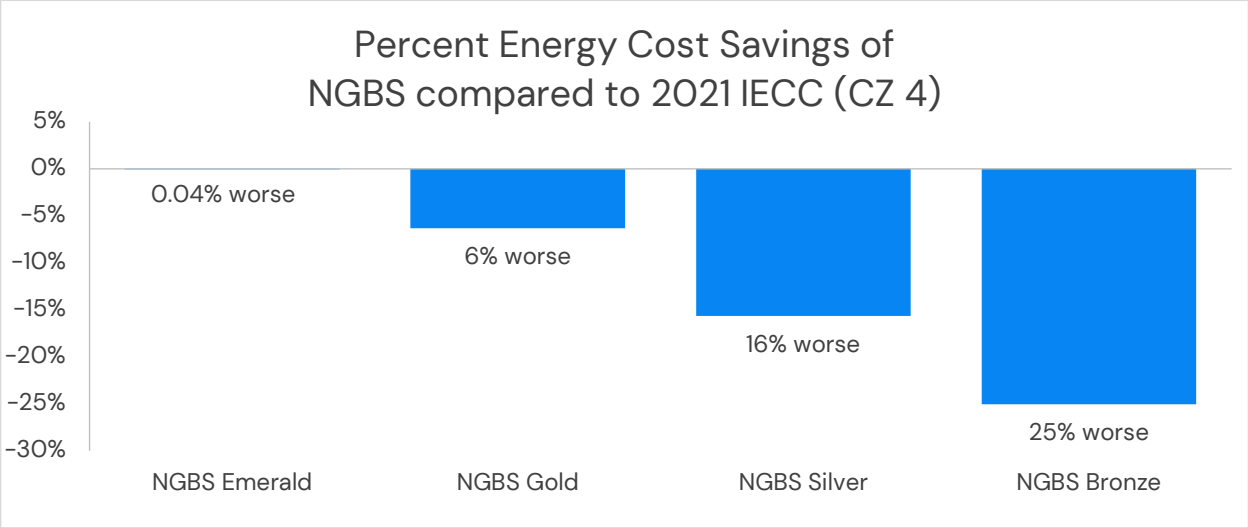


Figure 3: Percent Energy Cost Savings of NGBS compared to 2021 IECC in Climate Zone 4

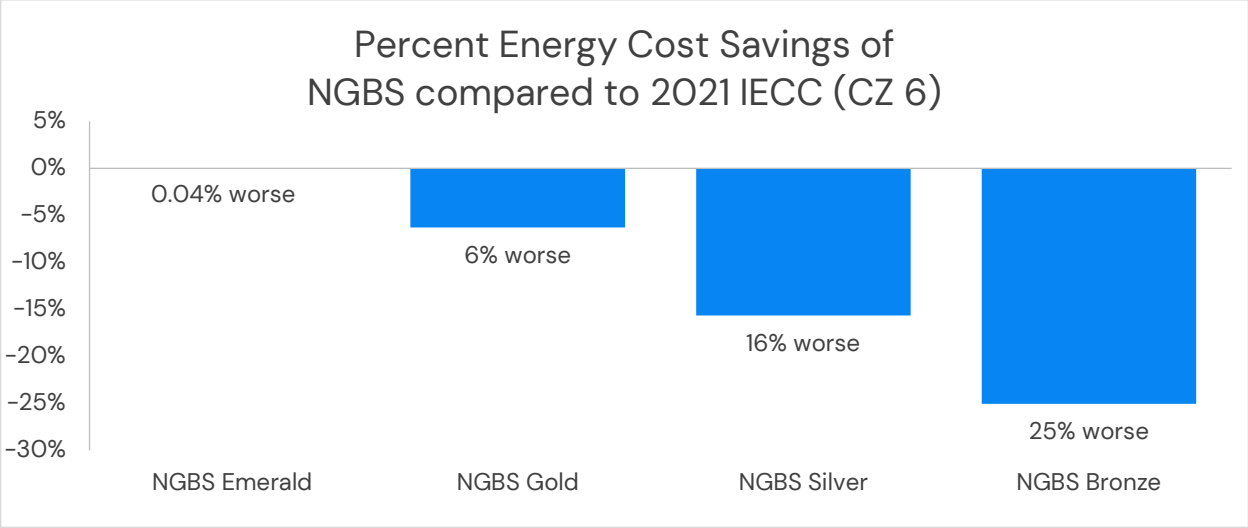


Figure 4: Percent Energy Cost Savings of NGBS compared to 2021 IECC in Climate Zone 6

	Climate Zone 2		Climate Zone 4		Climate Zone 6	
	Annual Energy Cost	% Savings vs 2021 IECC	Annual Energy Cost	% Savings vs 2021 IECC	Annual Energy Cost	% Savings vs 2021 IECC
2021 IECC	$1,553	NA	$2,332	NA	$2,548	NA
NGBS Emerald	$1,549	0.27%	$2,333	-0.03%	$2,549	-0.03%
NGBS Gold	$1,646	-6.0%	$2,479	-6.3%	$2,708	-6.3%
NGBS Silver	$1,791	-15.3%	$2,697	-15.7%	$2,947	-15.7%
NGBS Bronze	$1,936	-24.7%	$2,916	-25.0%	$3,186	-25.0%

Table 3: Annual Energy Costs and Percent Savings compared to the 2021 IECC across Climate Zones.

Interpretation of Results

The highest level of NGBS certification (Emerald) resulted in approximately equivalent annual energy costs as the 2021 IECC for the homes analyzed. Lower levels (i.e., Bronze, Silver, Gold), do not meet or exceed the performance of the 2021 IECC and result in higher annual energy costs, or in other words, negative savings when compared to the 2021 IECC.

Based on this analysis, only homes achieving the 2020 NGBS Emerald level are equivalent to the 2021 IECC.

All homes analyzed at the Bronze, Silver, and Gold levels result in worse performance and higher energy costs when compared to the 2021 IECC.

The 2021 IECC achieves better performance compared to the NGBS through several measures. The NGBS uses the 2018 IECC as a reference for much of the 2020 NGBS Reference Home, while the 2021 IECC achieves savings through measures that were improved with the development of the 2021 IECC. According to the PNNL and DOE *Energy Savings Analysis: 2021 IECC for Residential Buildings*,[10] this results in the 2021 IECC achieving a weighted average energy cost savings of 8.66% over the 2018 IECC. Some of the key improvements include:

- Improved insulation for walls in CZ 4-5, slabs in CZ 3-5, ceilings in CZ 2-8, and windows in CZ 3-4.
- Higher efficacy mechanical ventilation systems.
- Increased high-efficacy lighting.
- Additional efficiency options in Section R408 (i.e., improved water heaters in this analysis).

Additional savings for the homes analyzed are a result of the structure of the 2020 NGBS Reference Home, which aligns with historical values for heating and cooling equipment, domestic hot water equipment, and lighting and appliances that are less efficient than current DOE energy conservation standards and current standard practice. This means that nearly any new home built today would include equipment that is more efficient than the 2020 NGBS Reference Home, and a significant amount of energy efficiency measures could be reduced in exchange for commonly installed equipment. Additional details on this are provided below.

Heating and Cooling Equipment

The 2020 NGBS Reference Home uses DOE energy conservation standards from 2015 for heating and cooling equipment, which have since been surpassed by more recent standards for many products. DOE energy conservation standards also reflect minimum levels of efficiency that all products are required to meet, and consumers routinely choose to install more efficient equipment independent of codes, standards, or certification programs.

Table 4 shows a comparison of the heating and cooling equipment energy efficiency ratings for the 2020 NGBS Reference Home, current DOE energy conservation standards, and the energy efficiency ratings that were representative of standard practice which were used in this analysis and may align with the DOE standards.

Equipment	NGBS Reference	Current DOE Standard	Standard Practice
Gas Furnace	80 AFUE	80 AFUE	CZ2: 82 AFUE CZ6: 92.5 AFUE
Air Source Heat Pump	14 SEER / 8.2 HSPF	15 SEER / 8.8 HSPF	CZ4: 15 SEER / 8.8 HSPF
Central Air Conditioner (North Regions)	13 SEER	14 SEER	CZ6: 15.2 SEER
Central Air Conditioner (South Regions)	14 SEER	15 SEER	CZ2: 15 SEER

Table 4: Heating and Cooling Equipment Summary

[10] https://www.energycodes.gov/sites/default/files/2021-07/2021_IECC_Final_Determination_AnalysisTSD.pdf

Lighting and Appliances

The 2020 NGBS Reference Home uses default lighting and appliance values from ANSI/RESNET/ICC 301-2014. The structure of this standard uses a reference home that represents a typical home built to 2006 codes and standards. Due to advancement in technology and DOE energy conservation standards over nearly the past 20 years, there have been significant improvements in efficiency of products. For example, the 2020 NGBS Reference Home assumes 90% of lighting in the home will be inefficient incandescent bulbs, which have essentially been phased out in new homes by DOE energy conservation standards and requirements of the IECC which requires 100% high efficacy bulbs. Another example is that the refrigerator used in the 2020 NGBS Reference Home uses roughly 50% more energy than a typical ENERGY STAR refrigerator built today, which is the predominate level of efficiency consumers choose. With an artificially low baseline in the Reference Home, the NGBS provides free credit for commonly installed appliances, which can allow for reductions in other energy efficiency measures.

Sensitivities Analyzed

One notable difference between the 2021 IECC and 2020 NGBS performance path is that the NGBS path includes lighting, appliances, and on-site renewable energy in the end-uses used to determine compliance. A home that improves these measures in these categories above the 2020 NGBS Reference Home can take credit for them to achieve higher efficiency levels in the NGBS.

In contrast, the 2021 IECC does not include these end-uses when evaluating compliance with the performance path. For example, selecting an ENERGY STAR appliance would have no impact on compliance with the 2021 IECC performance path, but is often standard practice for new homes.

Similarly, installing on-site renewable energy, like a rooftop PV system, would have no impact on compliance with the 2021 IECC performance path, but can receive substantial credit in the structure of the NGBS. Additionally, the NGBS performance path does not include any mandatory minimum insulation levels, or "backstops" where the 2021 IECC performance path has a backstop that insulation levels must be greater than or equal to 2009 IECC levels. This means that within the structure of the NGBS there is no limit for the amount of insulation that could be removed in exchange for other measures like rooftop PV, and that homes certified to the NGBS can fail basic mandatory requirements within the IECC such as insulation levels and infiltration limits.

Given the different structure of the performance paths, and potential for large impacts on energy cost, these issues were analyzed further to understand the potential magnitude of their impact.

Lighting and Appliance Impact

The impact of standard practice lighting and appliances compared to the 2020 NGBS Reference Home was evaluated by configuring the 2021 IECC compliant home in Climate Zone 4 with the same inputs as the NGBS reference home. To recap, the 2020 NGBS Reference Home, which is equal in performance to the Bronze level, uses default lighting and appliance values that aim to represent a typical home built to 2006 codes and standards, which is significantly less efficient than lighting and appliances used today.

The 2021 IECC compliant home had annual energy costs that were $584 lower than the 2020 NGBS Reference Home (or the Bronze level). This sensitivity analysis showed that the majority of that difference, $424, was a result of savings from lighting and appliances. More specifically, $325 of that was from lighting, and $99 was from appliances, as seen in Figure 5 below.

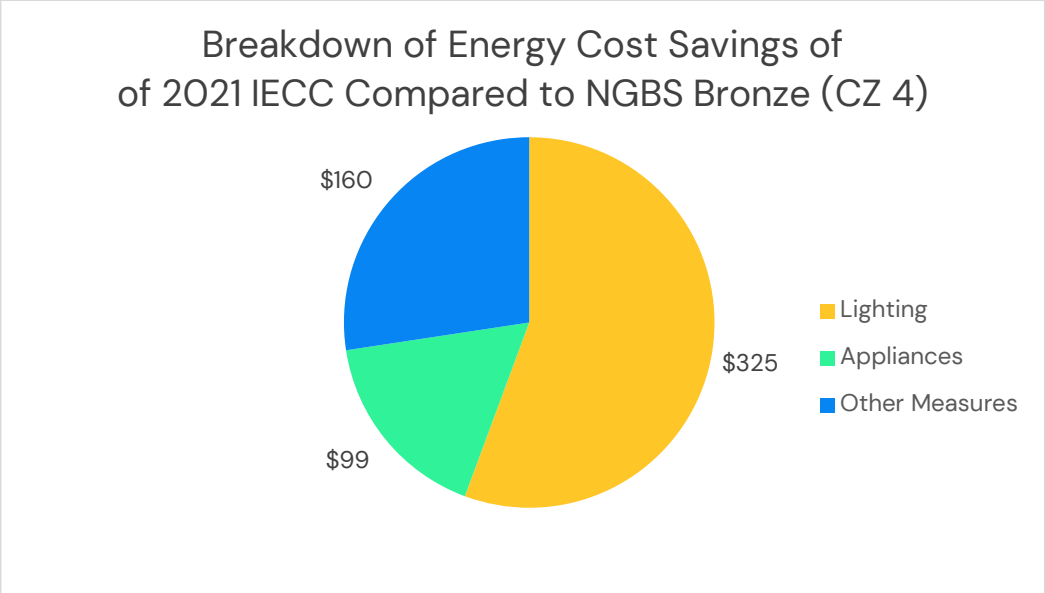


Figure 5: Breakdown of Energy Cost Savings of 2021 IECC Compared to NGBS Bronze in Climate Zone 4

This shows that standard practice of lighting and appliances in new homes today (built to any code including the 2021 IECC) is significantly better than the 2020 NGBS Reference Home, and results in substantial credit with the structure of the NGBS performance path.

	Annual Energy Cost	$ Savings vs NGBS Bronze
2021 IECC	$2,332	$584
IECC w/o Lighting	$2,657	$259
IECC w/o Lighting and Appliances	$2,756	$160
NGBS Bronze	$2,916	NA

Table 5: Annual Energy Costs and Savings when accounting for Lighting and Appliances compared to the NGBS Bronze in Climate Zone 4

Onsite Generation Impact

The impact of on-site renewable energy was evaluated by determining how much credit a home would receive in the NGBS performance path from a typical rooftop solar PV system, and subsequently, how much other measures (i.e., insulation) could be reduced.

The home in Climate Zone 4 was configured with an envelope equal to the 2009 IECC, which is the worst performing envelope allowed in the structure of the 2021 IECC performance path. All other measures were kept the same as the home compliant with the 2021 IECC (e.g., infiltration, lighting, HVAC equipment). The insulation values for each are shown in Table 6 below, and result in a total building envelope UA (a measure of the overall envelope performance), that is 31% worse than a 2021 IECC envelope.

Component	2021 IECC	2009 IECC
Ceiling	R-60	R-38
Above Grade Wall (Cav. + Cont.)	R-20 + 5	R-13
Basement Wall	R-10ci	R-10ci
Window U-factor	0.30	0.35

Table 6: Envelope Configuration of the 2021 IECC and 2009 IECC in Climate Zone 4

Reducing the insulation to 2009 IECC levels increased annual energy cost by $438 to $2,770. Which is still 5% better than the 2020 NGBS Reference Home and achieves the Bronze level.

For the home analyzed, a typical rooftop PV system was estimated based on the NREL PVWatts Calculator[11], which resulted in a system with a nominal 4 kW capacity. Configuring the home with this system significantly decreased the annual energy cost by $768, resulting in a total annual energy cost of $2,002. This is 31.3% better than the 2020 NGBS Reference Home, and significantly surpassed the Emerald level.

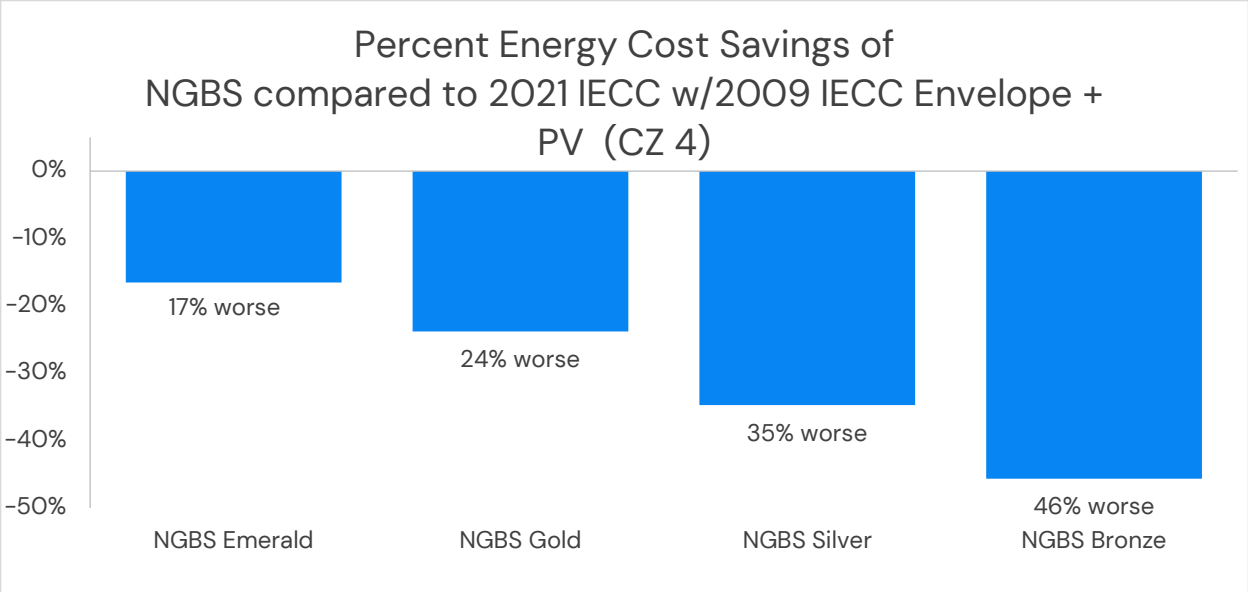


Figure 6: Percent Energy Cost Savings of NGBS compared to 2021 IECC w/ 2009 IECC + PV Envelope in Climate Zone 4

	Annual Energy Cost	% Savings vs 2021 IECC w/2009 IECC Envelope	% Savings vs 2021 IECC w/2009 IECC Envelope + PV
2021 IECC	$2,332	15.8%	-16.5%
2021 IECC w/2009 IECC Envelope	$2,770	NA	-38.4%
2021 IECC w/2009 IECC Envelope + PV	$2,002	27.7%	NA
NGBS Emerald	$2,333	15.8%	-16.5%
NGBS Gold	$2,479	10.5%	-23.8%
NGBS Silver	$2,697	2.6%	-34.7%
NGBS Bronze	$2,916	-5.3%	-45.7%

Table 7: Annual Energy Costs and Percent Savings compared to the 2021 IECC w/2009 IECC Envelope and the 2021 IECC w/2009 Envelope + PV in Climate Zone 4.

As mentioned above, the 2021 IECC performance path does not include on-site renewable energy in the end-uses to determine compliance, so it has no impact on 2021 IECC compliance. As a result, the home summarized in Figure 6, would fail the 2021 IECC performance path by 36.5%, yet still achieve the highest level of NGBS certification.[12] This demonstrates that the inclusion of on-site renewable energy in the NGBS performance path allows significant tradeoffs of energy efficiency measures like insulation, in exchange for on-site renewable energy.

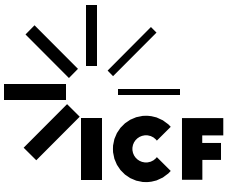
[11] https://pvwatts.nrel.gov/

[12] Note the value of failing the 2021 IECC by 36.5% is not within the tables or charts, it was determined by running a 2021 IECC Compliance Report in Ekotrope.

Conclusions

This analysis evaluated the energy performance of the 2021 IECC, and the 2020 NGBS to determine if the NGBS meets or exceeds energy performance of the 2021 IECC. Key findings from this analysis are:

- **NGBS is not equivalent to 2021 IECC except possibly at Emerald level.** Based on this analysis, only homes achieving the 2020 NGBS Emerald level are equivalent to the 2021 IECC. All homes analyzed at the Bronze, Silver, and Gold levels result in worse performance and higher energy costs when compared to the 2021 IECC. The better performance of the 2021 IECC homes were primarily the result of two factors:
    - The 2020 NGBS Reference Home uses the 2018 IECC as a reference for many of the inputs, so the 2021 IECC achieves savings through measures that were improved relative to the 2018 IECC (e.g., insulation, mechanical ventilation systems, additional efficiency options required in the 2021 IECC Section R408).
    - The 2020 NGBS Performance Path Reference Home uses inputs for lighting, appliances and HVAC equipment that are based on historical values which are worse than what is required by current DOE energy conservation standards, or what is considered standard practice today. Therefore, nearly any new home built today would include equipment that is more efficient than the 2020 NGBS Reference Home and realize some energy cost savings as a result.
- **2021 IECC guarantees a minimum level efficiency due to trade-off limits.** Even if the 2020 NGBS Reference Home were updated to values from the 2021 IECC, there would still be a significant gap between the outcomes of the two standards. Unlike the 2021 IECC, the structure of the 2020 NGBS performance path does not include mandatory insulation levels and allows a significant decrease in core building efficiency in exchange for common improvements to heating, cooling, and water heating equipment and installing on-site renewable energy. This can result in a home with a poor envelope that is significantly worse than the 2021 IECC being able to achieve the highest NGBS level through the addition of on-site renewable energy or incorporating commonly-installed heating, cooling, or water heating equipment that exceeds the federal minimums.



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