



**NGBS  
GREEN™**

# NGBS Green+ Badges HANDBOOK

NET ZERO ENERGY  
RESILIENCE  
SMART HOME  
UNIVERSAL DESIGN  
WELLNESS  
ZERO WATER

JULY 2020

Revised September 2021

This handbook is for projects seeking NGBS Green+ recognition, which is based on the ICC 700-2020 *National Green Building Standard™* (NGBS).

© 2020 Home Innovation Research Labs, Inc. All rights reserved. This document is protected by U.S. copyright law. Use of this document is authorized only for those individuals/organizations participating in Home Innovation's NGBS Green certification and solely for project's seeking NGBS Green certification. Requirements from ICC 700-2020 *National Green Building Standard™* © 2020 National Association of Home Builders used by permission.

# TABLE OF CONTENTS

Program Overview .....	1
NGBS Green+ NET ZERO ENERGY.....	4
NGBS Green+ RESILIENCE .....	7
NGBS Green+ SMART HOME.....	9
NGBS Green+ UNIVERSAL DESIGN .....	13
NGBS Green+ WELLNESS.....	14
NGBS Green+ ZERO WATER .....	27



## PROGRAM OVERVIEW

NGBS Green+ bestows special recognition for NGBS Green homes that go “above and beyond” in certain areas of green practices. With NGBS Green+, builders do not need additional certifications or inspections to highlight their homes’ special features. NGBS Green+ badges provide a streamlined, supplementary, third-party recognition for NGBS Green homes based on their exceptional performance in one (or more) of six categories of green practices:

[NET ZERO ENERGY](#) | [RESILIENCE](#) | [SMART HOME](#) | [UNIVERSAL DESIGN](#) | [WELLNESS](#) | [ZERO WATER](#)

### Benefits

NGBS Green+ badges quickly and clearly spotlight the green features of your homes and apartments to your home buyers and renters. Our NGBS Green+ badges take advantage of people’s tendency to process visuals faster than text. Our visuals are more likely to grab your customers attention and have them immediately focus on why your homes are better than your competitors’. Below are the specialized marketing resources builders and developers earning NGBS Green+ badges are eligible to use to distinguish their homes or apartments from other green certified homes on the market.

- *Badges* – Builders of projects that earn an NGBS Green+ badge(s) can use the accompanying graphic in marketing that project’s unique features or performance.
- *Certificates* – When a home/building achieves an NGBS Green+ badge, the builder will receive a customized NGBS Green certificate that features the badge achievement.
- *Plaques* – Custom award plaques that reflect badge achievement are available for an additional fee if desired.

### Eligibility

NGBS Green+ badges must be sought concurrently with NGBS Green Certification. A home or building must be eligible for, and pursuing certification to, the 2020 National Green Building Standard (NGBS).

Badges are not available for homes pursuing NGBS Green Certification via the Single-Family Certified path (Chapter 12). Except for the NGBS Green+ ZERO WATER option, badges are available to both new construction and remodeling projects.

### Verification & Documentation

The NGBS practices that are included as part of the NGBS Green+ badge criteria must be verified by an accredited NGBS Green Verifier and according to the *Verifiers’ Resource Guide (VRG)*.

The 2020 NGBS Green Scoring Tools include new sections that address design and verification of the NGBS Green+ badges by pulling selected practices and inputs from the main Design and Verification tabs. Download the scoring tools from [www.HomeInnovation.com/GreenScoring](http://www.HomeInnovation.com/GreenScoring).

For an NGBS Green+ badge to be awarded, the final verification report should confirm compliance with the practices that support NGBS Green+ achievement. The NGBS Green+ signature page must be signed by the builder or developer and submitted as part of the final verification packet.

## Process & Fees

Interest in pursuing NGBS Green+ badges can be indicated at the time of project registration or when a verifier submits the rough inspection notification.

Associated fees are assessed per badge for the additional review associated with NGBS Green+ badges. Fees are assessed at the building (not unit) level, as follows:

- \$50 for a single-family home
- \$100 for a multifamily building up to 3 stories
- \$300 for a multifamily building 4 stories and above

These fees are invoiced at the same time as certification fees. Upon request, specialized project-/development-wide pricing will be considered. All homes or buildings within a project/development would need to seek NGBS Green+ recognition. Contact us to request volume pricing ([www.HomeInnovation.com/NGBSGreenContact](http://www.HomeInnovation.com/NGBSGreenContact)).

## Available NGBS Green+ Badges

- **NET ZERO ENERGY:** Net Zero Energy buildings combine energy efficiency and renewable energy generation to consume only as much energy as can be produced onsite through renewable resources. Net Zero Energy homes offer residents independence from energy bills and increased resilience during events that affect the energy infrastructure.
- **RESILIENCE:** Resilient design is the intentional design of buildings and communities to respond to natural and manmade disturbance, have the capacity to adapt to changing conditions, and maintain or regain functionality and vitality in the face of stress or disturbance. To earn the NGBS Green+ RESILIENCE badge, a builder must provide documentation confirming their home/building has been designed and constructed to provide at least 30% enhanced resilience and durability beyond the structural requirements of the IBC or IRC, as applicable, and must show that they have on-site renewable energy and a battery energy storage system.
- **SMART HOME:** Smart home devices offer residents greater control of their home's systems, with the potential for improved comfort and reduced energy and water use. All homes that earn the NGBS Green+ SMART HOME badge must include: (1) automated or voice-activated control of HVAC, lighting, alarm system, or door locks; and (2) programmable communicating thermostat with remote capability. Additional practices regarding the Lighting & Lighting Controls; Energy & Water Consumption Control; Smart Controls for Water Efficiency; and Ventilation and Humidity Control must also be met for badge compliance.
- **UNIVERSAL DESIGN:** Universal design supports the concept of "aging in place," which reduces the need to expend effort and resources to remodel, relocate, or construct a new home. Homes that earn the NGBS Green+ UNIVERSAL DESIGN incorporate a set of common universal design features.
- **WELLNESS:** As a broader concept, the NGBS Green+ WELLNESS badge recognizes homes and buildings that are higher performing across multiple NGBS practice categories that influence human health including Air; Movement; Moisture Management; Humidity Control/Comfort; Nourishment; Light; Sound; Materials; and Access to Nature.

- **ZERO WATER:** The term “Zero Water” signifies that water supplied to a home/building by rainwater capture or reused greywater and/or blackwater sources is at a level that could meet all water usage. Designing and constructing for Zero Water homes/buildings involves careful design with efficient plumbing, fixtures, and landscape and other outdoor features that require limited water. In addition, storage tanks and treatment devices are installed to facilitate the capture and use of rainwater, greywater, and blackwater.

## NGBS GREEN+ NET ZERO ENERGY

### Overview

Net zero energy buildings combine energy efficiency and renewable energy generation to consume only as much energy as can be produced onsite through renewable resources.<sup>1</sup> Net zero energy homes offer residents independence from energy bills and increased resilience during events that affect the energy infrastructure.

Homes demonstrating net zero energy construction can earn the NGBS Green+ NET ZERO ENERGY badge.

### Compliance Criteria

A home or building must demonstrate that it is constructed or renovated to be net zero energy. Badging is based as-built conditions when construction is completed; no post-occupancy benchmarking is required.

The NGBS Green Verifier must provide the following documents with the final verification packet. Energy performance reports should comply with the NGBS Green Energy Modeling Policy within the VRG.

- Energy performance report demonstrating energy performance without on-site renewable energy generation – submit as PDF
- Energy performance report with on-site renewable energy included – submit as PDF
- Energy Efficiency Characteristics Checklist – included within NGBS Green Scoring Tool
- Renewable Energy System Description & Photos – submit as PDF or JPG; details included within NGBS Green Scoring Tool

Any path can be selected in the Energy Efficiency section (Chapter 7 for New Construction / 11.700 for Renovation) to demonstrate energy efficiency for the purposes of NGBS Green Certification.

Minimum energy efficiency level at Silver or higher must be achieved without renewable energy.

Energy performance should be evaluated in accordance with 702.2. Analysis should include improvements in building envelope, air infiltration, heating system efficiencies, cooling system efficiencies, duct sealing, water heating system efficiencies, lighting, and appliances.

<sup>1</sup> U.S. Department of Energy. *A Common Definition of Zero Energy Buildings*.

<https://www.energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings>. Accessed September 13, 2019



#### Why Are Two Different Energy Reports Required?

**1)** The NGBS Reviewers want to understand the amount of energy required for the home and the amount offset by renewable. Our team believes that the intent of the NGBS is to reduce building energy use overall, not just offset it.

**2)** For the 2012 and 2015 NGBS versions, the Energy Performance Path does not reflect renewable energy sources, and, therefore, the respective NGBS templates in REMrate and Ekotrope do not reflect all the elements to be considered as part of the Net Zero Energy evaluation.



The following renewable energy systems are accepted for the purposes of achieving net zero energy:

- On-site generation;
- Local generation, such as community solar or wind;
- Offsite generation, such as through power purchase agreements; and
- Energy attribute certificates & carbon offsets.

### Energy Efficiency Characteristics Checklist

<b>Building Envelope</b>	
<i>Roof R-Value:</i>	
<i>Floor R-Value:</i>	
<i>Wall R-Value:</i>	
<i>Describe Wall Section:</i>	
<i>Window-Wall Ratio:</i>	
<i>Window U-Value:</i>	
<i>Window SHGC:</i>	
<i>Window Description:</i>	
<i>Exterior Shading Devices:</i>	
<i>Air Leakage Test Results:</i>	
<i>Air Sealing Protocol Description:</i>	
<b>Lighting</b>	
<i>Type of Lighting (description):</i>	
<i>Daylighting Features (Y/N, description):</i>	
<i>Occupancy Sensors (Y/N, description):</i>	
<i>Describe Lighting Design &amp; Control Strategy:</i>	
<b>HVAC System Characteristics (Check all included technologies and note efficiency values)</b>	
Gas and Propane Heater	
Oil Furnace	
Gas Boiler	
Oil Boiler	
Radiant and Hydronic Space Heating	
Electric Heat Pump	
Gas Engine-Driven Heat Pump Heating	
Electric Air Conditioner and Heat Pump Cooling	
Gas Engine-Driven Heat Pump Cooling	
Water Source Cooling and Heating	
Ground Source Heat Pump	

<i>Describe Mechanical System:</i>	
<b>Ventilation</b>	
<i>Spot Ventilation Only:</i>	
<i>Building Ventilation Systems:</i>	
Notes:	
<b>Energy Storage</b>	
<i>Battery Storage (Y/N, description):</i>	

### Renewable Energy System Descriptions & Photos

<i>Renewable Energy System Characteristics</i>	<i>Details</i>
Describe systems here. Submit photos of installed on-site systems and appropriate documentation (e.g., solar installer design report, power purchase agreement, or renewable energy credit certificate) of installed system.	
<b>Solar electric (PV):</b> array size and output per capacity nameplate, panel quantity, type and brand, inverter quantity, type and location(s).	
<b>Solar Thermal</b>	
<i>Collector Area (ft<sup>2</sup>):</i>	
<i>Collector Slope (%):</i>	
<i>Tank Volume (gallons):</i>	
<i>Maximum Heating Rate (Btu/hr):</i>	
<b>Wind:</b> (If onsite: note turbine size and output in peak kw, inverter type, brand and location. If off-site, note farm location, overall size, and purchased share of energy expected.)	
<b>Have Renewable Energy Credits been retained?</b> If yes, describe amount (KWh) and plan for recurring purchase, if any. <u>Minimum of two year purchase required up-front.</u>	
<b>Geothermal</b>	
<i>Maximum Power (hp):</i>	
<i>Surface Temperature of Fluid (F):</i>	
<i>Estimated Reservoir Temperature at 6,500 Feet (F):</i>	
<i>Area of Geothermal Field (mi<sup>2</sup>):</i>	
<i>Number of Wells Drilled:</i>	
<i>Efficiency (%):</i>	

## NGBS GREEN+ RESILIENCE

### Overview

Natural disasters have increased in frequency and volatility in recent years due to changing weather patterns and the effect of climate change. Certain areas face higher levels of risk, due to their climate zone and/or proximity to coastal waters or fault lines, as well as other factors.

Resilient design is the intentional design of buildings and communities to respond to natural and manmade disturbances and have the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance.<sup>2</sup>

Homes can be designed and constructed above national building codes to provide additional strength to withstand disasters such as high-seismic, high-wind, heavy snow, and flooding events.<sup>3</sup>

To earn the NGBS Green+ RESILIENCE badge, a builder must demonstrate (via documentation from a licensed design professional) that their home/building has been designed and constructed to provide at least 30% enhanced resilience and durability beyond the structural requirements of the IBC or IRC, as applicable.

Homes equipped with on-site renewable energy systems and battery storage enable them to continue heating and cooling the building during power interruptions.

To earn the NGBS Green+ RESILIENCE badge, a builder must show that they have on-site renewable energy and a battery energy storage system.

### Compliance Criteria

Geographic location and risk of flood, snow, wind, and seismic events will influence a building's ability to earn points for resilient construction.

To earn the badge, the home/building must meet at least 1 practice from each section below and include information about resilient features in the homeowner or multifamily occupant manual.



---

<sup>2</sup> Resilient Design Institute. *Defining Resilient Design*. <https://www.resilientdesign.org/>. Accessed October 10, 2019.

<sup>3</sup> Karl Eckhart. "Home Builders Committed to Resiliency Efforts in Communities Across the Country." *National Association of Counties (blog)*. July 6, 2018. <https://www.naco.org/blog/home-builders-committed-resiliency-efforts-communities-across-country>. Accessed October 10, 2019.

<b>SECTION 1: ENHANCED RESILIENCE</b>		
<i>Requirements:</i>		
<ul style="list-style-type: none"> <li>• Meet one of the below practices.</li> </ul>		
<i>Practice</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
613.5 Enhanced resilience – 30% above base design	Choose 1	
613.6 Enhanced resilience – 40% above base design	Choose 1	
613.7 Enhanced resilience – 50% above base design	Choose 1	
<i>Notes:</i>		

<b>SECTION 2: RENEWABLE ENERGY AND BATTERY ENERGY STORAGE SYSTEMS</b>		
<i>Requirements:</i>		
<ul style="list-style-type: none"> <li>• Meet mandatory practice.</li> </ul>		
<i>Practice</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
706.5(3) On-site renewable energy system and battery energy storage system	Mandatory	Y, required
<i>Notes:</i>		

### Additional Requirements

[ ] Identify resilient construction features and benefits are described in homeowner or multifamily occupant manual.

## NGBS GREEN+ SMART HOME

### Overview

Today's connected technology offers building owners and residents seek visibility into home operation and performance.

A "smart home" is one that is equipped with network-connected products for controlling, automating, and optimizing functions such as temperature, lighting, security, safety, or entertainment. These products can be controlled, either remotely by a phone, tablet, computer, or a separate system within the home itself. At a minimum, a smart home must include a smart security feature that controls access or monitors the property (smart lock or security camera), a smart thermostat, and a reliable Internet connection.<sup>4</sup> Additional smart home features, including lighting and lighting controls, appliances, ventilation, and energy and water monitoring and control tools offer the potential for further customization and control.



Smart technologies are increasingly being sought by home buyers. A 2015 study by Coldwell Banker, U.S.-based real estate company, and CNET, a technology publication, revealed that about 60% of home buyers, particularly Millennials and parents with children, would prefer a home with smart technology. About 72% of Millennials would be willing to pay \$1,500 more for a home that was "smart," and 42% of those would be willing to pay as much as \$3,000 more.<sup>5</sup>

Smart home devices offer residents greater control of their home's systems, with the potential for improved comfort and reduced energy and water use. Smart technology can be used as a tool for achieving energy efficiency and sustainable living goals.

All homes that earn the NGBS Green+ SMART HOME badge must include: (1) automated or voice-activated control of HVAC, lighting, alarm system, or door locks; and (2) programmable communicating thermostat with remote capability. Where irrigation is installed, the irrigation system must be controlled by smart irrigation controllers that are in accordance with the EPA WaterSense performance criteria. Additional practices from the following sections must also be met for badge compliance.

### Lighting & Lighting Controls

When interior, exterior, and common area lighting is equipped with occupancy sensors and dimmers, a home or building has the potential to significantly reduce lighting energy use. When installed, automated solar shading and lighting occupancy controls earn optional points toward the NGBS Green+ SMART HOME badge.

---

<sup>4</sup> Inman. *What's the Definition of a 'Smart Home'?* <https://www.inman.com/2016/05/11/whats-the-definition-of-a-smart-home/>. Accessed September 13, 2019.

<sup>5</sup> Coldwell Banker and CNET. *Smart Home Survey August 15*. [https://www.coldwellbanker.com/content/pdfs/survey\\_final.pdf](https://www.coldwellbanker.com/content/pdfs/survey_final.pdf). Accessed October 10, 2019.

### Energy & Water Consumption Control

Smart appliances and systems include functionality that can offer added convenience and additional savings. Some are equipped with “smart grid” capabilities that can minimize their use at times when the power grid is under high demand.<sup>6</sup> When installed, smart appliances such as refrigerators, clothes dryers, and HVAC systems, earn points toward the NGBS Green+ SMART HOME badge.

Grid-interactive battery storage stores electrical energy during times when renewable energy production exceeds consumption and then returns the energy to the grid at times of lower demand. Automatic demand response systems curtail energy use upon a signal from a utility or energy service provider. Both of these systems earn points toward this badge.

Finally, devices that control and monitor energy and water consumption earn points toward this badge.

### Smart Controls for Water Efficiency

Smart products can monitor and alert homeowners when water use is outside of normal range.

Technology enables homeowners to detect leaks, such as those from a burst pipe, broken supply line, or clogged toilet, and remotely shut-off water. These systems offer the possibility for reducing the extent of property damage during plumbing-related events. Outside the home, irrigation flow sensing devices can monitor water flow and alert residents of unusual activity.

Pools and spas can be equipped with automated motorized pool covers to cover the pool surface when not in use, reducing evaporation and the need for additional water to be supplied.

Where installed, these products earn points toward the NGBS Green+ SMART HOME badge.

### Ventilation and Humidity Control

Smart ventilation adjusts ventilation rates in response to occupancy, outdoor thermal and air quality conditions, direct sensing of contaminants, and operation of other air moving and air cleaning systems.<sup>7</sup> Points are available toward the NGBS Green+ SMART HOME badge when homes are equipped with whole-building ventilation systems with automatic controls and/or remote-sensing humidity monitoring systems.

### Compliance Criteria

To earn the badge:

- Meet all applicable mandatory practices listed below (yellow sections).
- Achieve at least 18 points from available optional practices (green sections).
- Identify smart home features and their potential for conserving energy and water in homeowner or multifamily occupant manual.

---

<sup>6</sup> U.S. Environmental Protection Agency. *Smart Appliances*.

[https://www.energystar.gov/products/smart\\_home\\_tips/smart\\_appliances](https://www.energystar.gov/products/smart_home_tips/smart_appliances). Accessed September 13, 2019.

<sup>7</sup> Air Infiltration and Ventilation Centre. *What is Smart Ventilation?* <https://www.aivc.org/resources/faqs/what-smart-ventilation>. Accessed September 13, 2019.

<b>SECTION 1: LIGHTING &amp; LIGHTING CONTROLS /WINDOW SHADING</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet applicable mandatory practice.</li> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
612.3(9) Automated or voice-activated control of HVAC, lighting, alarm system or door locks	N/A for badge purposes	Mandatory	Y, required
703.7.2 Automated Solar Protection	1	Optional	
705.2.1.1(1 or 2) Interior Lighting Controls	1-2	Optional	
705.2.1.2 Exterior Lighting Controls	1	Optional	
705.2.3 Lighting Outlets	1	Optional	
705.2.1.3(1-2) Multifamily Common Areas	1-5	Optional, only available for Multifamily	
705.2.1.4(1-2) Multifamily Occupancy Controls	2-3	Optional, only available for Multifamily	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 2: ENERGY &amp; WATER CONSUMPTION CONTROL</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet applicable mandatory practice.</li> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
706.1(1) Remote, Programmable Thermostat	N/A for badge purposes	Mandatory	Y, required
706.10 Automatic Demand Response	1	Optional	
706.11 Grid-Interactive Battery Storage	2	Optional	
1004.1(2) Verification System for Post-Occupancy Monitoring	3	Optional	
706.1(2-5) Energy Consumption Control	2 maximum for badge purposes	Optional	
706.3 Smart Appliances and Systems	1-2	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 3: SMART CONTROLS FOR WATER EFFICIENCY</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet applicable mandatory practice.</li> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
802.6.4(1) Smart Irrigation Controller	N/A for badge purposes	Mandatory when irrigation is installed	Met or N/A
802.6.5(5) Irrigation Flow Sensing Device	3	Optional	
802.10.1(1) Automated Motorized Non-Permeable Pool Cover	10	Optional, points only awarded for Single-Family	
803.3(1-2) Automatic Leak Detection and Control Device	2	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 4: VENTILATION &amp; HUMIDITY CONTROL</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
706.12 Smart Ventilation	1	Optional	
905.1 Humidity Monitoring System	2	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

### Additional Requirements

[ ] Identify smart home features and potential for conserving energy or water in homeowner or multifamily occupant manual.

**TOTAL OPTIONAL POINTS ACHIEVED FROM ALL SECTIONS: \_\_\_\_\_**



## NGBS GREEN+ UNIVERSAL DESIGN

### Overview

Universal design is the design of buildings and products to make them accessible/usable to all people with little need for adaptation or modification. When universal design is applied to construction, living environments are better equipped to accommodate residents with mobility and physical challenges.

Universal design supports the concept of “aging in place,” as a home with universal design features offers accommodations supportive of residents in older age.<sup>8</sup> This reduces the need to expend effort and resources to remodel, relocate, or construct a new home.

Homes that earn the NGBS Green+ UNIVERSAL DESIGN badge incorporate a set of common universal design features.

### Compliance Criteria

To earn the badge:

- Meet all applicable mandatory practices (yellow sections).
- Identify universal design features and benefits in homeowner or multifamily occupant manual.



UNIVERSAL DESIGN	
<i>Requirements:</i>	
<ul style="list-style-type: none"> <li>• Meet mandatory practices.</li> </ul>	
<i>Practice</i>	<i>Type</i>
612.3(1) No-step entrance	Mandatory
612.3(2) Accessible route from entrance to visiting room and bathroom	Mandatory
612.3(3) Accessible route from entrance to bedroom	Mandatory
612.3(4) Blocking or equivalent installed for future installation of grab bars	Mandatory
612.3(5) Door handles are levers	Mandatory
612.3(6) Sink, lavatory, and exterior door handles comply with ICC A117.1	Mandatory
612.3(7) Power receptacles placed 15-48" above finished floor	Mandatory
612.3(8) Light switches are rocker-style switches	Mandatory
612.3(9) Wireless or voice-activated control of HVAC, lighting, alarm systems, window treatments, or door locks	Mandatory

<sup>8</sup> National Association of Home Builders. *What is Universal Design?*  
<https://www.nahb.org/consumers/homeownership/homeownership-articles/what-is-universal-design.aspx>. Accessed September 13, 2019.

## NGBS GREEN+ WELLNESS

### Introduction

The NGBS Green+ WELLNESS badge recognizes homes and buildings that are higher performing across multiple areas that influence human health:

- Air
- Movement
- Moisture Management
- Comfort (Humidity Control)
- Nourishment
- Light
- Sound
- Materials
- Access to Nature



### Air

#### Overview

People spend approximately 90% of their time in enclosed spaces, with the majority at home and in workplaces. During this time, inhalation of indoor air pollutants can lead to a variety of poor health and wellbeing outcomes.<sup>(9, 10)</sup> In fact, global health studies identify household air pollution as the third most important factor influencing health.<sup>(11)</sup>

Health effects associated with exposure to indoor air pollutants can be short- or long- term and can range in severity. Less severe symptoms of exposure include headaches, dry throat, eye irritation, and runny nose. More severe outcomes include asthma attacks, infection, carbon monoxide poisoning, and cancer. Exposure to air pollutants has been shown to increase the risk of respiratory, cardiovascular, and heart diseases.<sup>(12, 13)</sup> There is also emerging evidence that air pollution can disrupt human physical and cognitive development.<sup>(14)</sup>

#### Combustion Pollutants

Combustion-related emissions from space heating, cooking, and nearby transportation are often a major and overlooked source of indoor air pollution.<sup>(15)</sup> Heating, cooking, and other combustion activities produce high levels of indoor air pollution that includes a range of health-damaging pollutants, including fine particles, nitrogen dioxide, and carbon monoxide.<sup>(16)</sup> Inhaling elevated levels of carbon monoxide can lead to headaches, visual impairment, reduced cognitive function and ability, and reduced ability to perform complex tasks.<sup>(17)</sup> Carbon monoxide prevents oxygen from being delivered to the body, which can lead to nausea, loss of consciousness, and possibly death.<sup>(18)</sup>

By opting for non-combustion or low-emission combustion heating and cooling systems and appliances, a builder can reduce the potential for combustion pollutants. Where combustion pollutants are present, proper ventilation and air-sealing contribute toward the maintenance of superior indoor air quality.

To earn the NGBS Green+ WELLNESS badge, there are restrictions on the location of combustion equipment and air handling equipment. Natural draft furnaces and boilers may not be located in conditioned space. Air handling equipment may not be installed in garages. Homes and buildings constructed without fireplaces, woodstoves, pellet stoves, and masonry heaters earn points toward this badge.

## Ventilation

Poorly ventilated spaces contribute toward symptoms, such as headaches, fatigue, dizziness, nausea, cough, sneezing, shortness of breath and eye, nose, and throat irritation. Insufficient ventilation can expose residents to many indoor and outdoor sources of air pollution that emit particulate matter and volatile organic compounds (VOCs) that can trigger asthma and eye, nose, and throat irritation.<sup>(19)</sup>

To maintain acceptable air quality for building residents, it is necessary to provide sufficient ventilation.

To earn the NGBS Green+ WELLNESS badge, at least one whole-building ventilation system, such as balanced exhaust and supply fans or energy-recovery ventilator, must be implemented.

To earn points toward this badge, multifamily developers can implement ventilation for common spaces in accordance with ASHRAE 62.1. Smart ventilation systems, whole-building ventilation system with automatic ventilation controls to manage ventilation during extreme weather and peak utility loads, can also earn point toward this badge.

## Non-Smoking Areas

Exposure to tobacco smoke persists as an important cause of ill health for both smokers and those exposed to secondhand smoke. Possible health issues include asthma attacks, respiratory infections, coronary heart disease, stroke, lung cancer, and impaired cognitive development.<sup>(20, 21)</sup> The average life expectancy of a smoker is 10 years less than that of a non-smoker.<sup>(22, 23)</sup>

Secondhand smoke exposes non-smokers to the same contaminants. Emerging evidence also suggests that there are also serious health consequences associated with thirdhand smoke, which is residual chemicals left on indoor surfaces by tobacco smoke. Thirdhand smoke clings to walls, furniture, clothes, bedding, carpets, and other surfaces long after smoking has occurred.<sup>(24)</sup>

The best ways to protect people from secondhand and thirdhand smoke is to implement a smoke-free environment indoors and not permit smoking near building entries, air intakes, and operable windows. To earn this badge, multifamily developers must designate all interior common areas and exterior areas within 25 feet of building entries, outdoor air intakes, and operable windows as non-smoking areas.

## Construction Pollutants

Building construction and renovations can generate airborne particles that can impact the health of residents. Air pollution originating from construction and demolition work can negatively impact health and is associated with increased mortality due to chronic obstructive pulmonary disease.<sup>(25)</sup>

During construction, care can be taken to prevent dust intrusion and to clear the space of dust, chemical vapors, and other debris. Minimizing the introduction of construction-related pollutants, such as dust, chemical vapors, and debris, during construction improves indoor air quality.

To earn points toward this badge, builders can protect HVAC systems during construction by covering HVAC supply registers, return grilles, and rough-ins during construction activities and verify IAQ factors during and post-construction.

## Air Filtration

Exposure to particulate matter is associated with numerous negative health outcomes, including blocked and inflamed airways, and can contribute to a range of respiratory-related conditions that can lead to illness and death.<sup>(26)</sup>

Proper air filtration and maintenance over the life of the filter helps to improve and maintain indoor air quality over time. Where MERV 14 or greater filters are installed, points can be earned toward this badge.

## Movement

### Overview

Global estimates indicate that nearly a quarter of the adult population is physically inactive. Physical activity has emerged as a primary focus of public health due to a rise in premature mortality and chronic diseases attributed to physical inactivity, including type 2 diabetes, cardiovascular disease, depression, stroke, dementia, and some forms of cancer.<sup>(27, 28)</sup>

### Site Selection & Planning

Building location, neighborhood features, and the ability for residents to walk and bicycle to desired locations and mass transit play an integral role in physical activity opportunities and choices.<sup>(29)</sup>

Mixed-use developments that feature restaurants, markets, civic centers, pharmacies, and other amenities, have been associated with higher levels of physical activity and lower body weight and levels of obesity.

Walkable communities with design features that support pedestrian activities are associated with higher moderate-to-vigorous activity levels, lower levels of sedentary behaviors, reduced blood pressure, and decreased risk of diabetes, obesity, and depression.<sup>(30, 31)</sup>

Thoughtful site planning and selection can also enhance opportunities for cycling and increase ridership. Cyclist infrastructure, such as dedicated lanes for bicycle traffic, is known to increase ridership.<sup>(32, 33, 34)</sup>

The NGBS awards points for several site selection factors that support resident movement, including proximity to community resources, mass transit, and bike sharing program. Mixed-use buildings can earn NGBS points for the physical activity opportunities that they offer. The NGBS also awards points for developments that incorporate bicycle rights-of-way, paved paths, or bicycle lanes into their design or are located close to existing bicycle lanes. All of these practices earn points toward this badge.

### Active Buildings & Communities

Proximity to indoor and outdoor amenities that support recreation can increase physical activity. A shorter distance from an individual's home to recreational amenities has been shown to support higher levels of engagement.<sup>(35)</sup>

Given the importance of physical activity, the NGBS Green+ WELLNESS badge requires the achievement of at least one NGBS practice related to walkability, adult exercise, and/or children's play. Points are available for multifamily indoor and outdoor spaces for adult exercise and children's play and development, as well as developments that offer bicycle parking for resident use.

## Moisture Management

Excess moisture and dampness affect about 20% of building in the U.S., Canada, and Europe and can increase the growth of mold and pests, in turn threatening the building's structural integrity and increasing residents' exposure to conditions that encourage respiratory infections and asthma.<sup>(36)</sup> One-fifth of all asthma cases in the U.S. are caused by excess moisture and dampness in buildings and contribute toward over \$3.5 billion annual spending on asthma-related medical expenses.<sup>(37)</sup>

The NGBS Green+ WELLNESS badge requires that moisture control measures be implemented during construction to prevent building materials with high moisture content or mold from being utilized and ensure that insulation is dry prior to enclosure. To minimize the negative effects of bulk liquid water, exterior sources should drain away from the building.<sup>(38)</sup>

To earn points towards this badge, a builder or developer could ensure that exterior doors are covered from the effects of precipitation using a roof overhangs, awnings, or storm door.

## Comfort (Humidity Control)

Humidity can influence the ability of the human body to release heat through evaporation.<sup>(39, 40)</sup> High humidity can also promote the accumulation and growth of microbial pathogens including bacteria, dust mites, and mold, which can lead to odors and cause respiratory irritation and allergies in sensitive individuals.<sup>(41)</sup> Conversely, low humidity can lead to dryness and irritation of the airways, skin, eyes, throat, and mucous membranes.<sup>(42)</sup>

Building situated in climates with broad humidity ranges can maintain humidity within healthy and comfortable levels by adding or removing moisture from the air. The provision of relative humidity levels has multiple benefits for human health through control of pathogen growth, improved air quality, and resident comfort.

To earn the NGBS Green+ WELLNESS badge, homes and building in humid climates need to ensure relative humidity at or below 60% using a dehumidification system or a central HVAC system equipped to operate in dehumidification mode. (This practice is not available for other climate zones).

By installing, a humidity monitoring system, a homes or building can earn point toward this badge.

## Nourishment

### Overview

Poor nutrition is a top contributor to disease, including numerous preventable chronic diseases.<sup>(43)</sup> Fruits and vegetables are critical components of a healthy eating pattern, but most individuals around the world do not consume enough.<sup>(44)</sup> Research shows that individual change toward improved diet is more likely to occur when environmental conditions and influences support those changes.

### Local Food Production

Increasing access to locally grown food is important for food accessibility, sustainability, and community-building.

Individuals who participate in community and home gardening have higher levels of fruit and vegetable consumption and are more likely to meet national recommendations for fruit and vegetable intakes

than people who don't garden. These benefits have been shown to extend beyond the individual gardener, as gardeners' household members would also increase fruit and vegetable intake as well.

Gardens are also associated with social benefits, including social cohesion and community involvement, increased physical activity, on-site educational opportunities, and increased perceptions of community safety.<sup>(45, 46)</sup> Gardening may also benefit mental health by reducing symptoms of anxiety and depression.<sup>(47)</sup>

To earn points, multifamily and mixed-use buildings can offer on-site community gardens for residents.

### Proximity to Markets & Farm Stands

Locating projects close to supermarkets and grocery stores with produce sections and farmers markets can help individuals improve their dietary and lifestyle behaviors by creating an environment that supports better food choices.<sup>(48, 49)</sup>

Multifamily and mixed-use buildings earn points towards this badge when they are located with walking distance of an existing or planned farmers market.

### Light

Lighting environments can help improve mental health, stress reduction, and improved visual acuity.<sup>(50, 51)</sup> Environments that not only satisfy lighting requirements but also offer a customizable environment can contribute toward improved productivity, mood, and well-being.<sup>(52, 53)</sup>

To earn points toward this badge, a builder or developer can incorporate automatic and customizable window shading and lighting control systems.

### Sound

Acoustical comfort contributes to an occupant's overall satisfaction with their environment. Research shows that exposure to noise sources, such as traffic and transportation, hinders human health and well-being in numerous ways.<sup>(54, 55)</sup>

Exterior noise from transportation or industrial sources have been linked to sleep disturbance, hypertension, and reduction of mental arithmetic by school-aged children.<sup>(56, 57)</sup> One sleep study with a sample size of over 4,000 participants found that the risk of myocardial infarction was elevated in men from road traffic noise and in women by air traffic noise.<sup>(58)</sup>

Internally generated noise can also be a major cause of complaint and contributor to overall occupant dissatisfaction. Sounds within an enclosed space from sources such as HVAC equipment, appliances, and other occupants, has been shown to hinder productivity, focus, memory retention, and mental arithmetic in school children, university students, and workplace occupants.<sup>(59, 60)</sup>

Sound is readily transmitted between enclosed spaces if proper acoustical reinforcement is not provided. By increasing the mass of a partition with laminations, insulation, and/or airspace, a team can incorporate a sound barrier into a building's design.

To earn points toward this badge, a builder or developer can offer room-to-room privacy between bedrooms and adjacent living spaces within dwelling units or homes.

## Materials

Building materials and products are an integral part of our lives, and, unlike most consumer goods, have a long use phase. This makes their chemical composition and potential impact on indoor air quality significant.

Volatile organic compounds (VOCs) comprise a large group of chemicals present in indoor environments due to various source materials, including insulation, paints, chemicals, adhesives, furniture and furnishings, composite wood products, and flooring materials.<sup>(61)</sup> VOCs are associated with a wide range of health issues, including respiratory irritation and cancer.<sup>(62)</sup>

Formaldehyde is another important chemical that is widely used to manufacture building materials and numerous household products. Exposure to formaldehyde can cause irritation of skin, eyes, nose, and throat, and high levels of exposure may cause cancer.<sup>(63)</sup>

The selection and installation of low-emission products can reduce the likelihood of VOC and formaldehyde exposure.

To earn the NGBS Green+ WELLNESS badge, homes and buildings must incorporate multiple types of third-party certified low-emission products, such as insulation, wall coverings, cabinets, flooring material, and furniture.

## Access to Nature

Broadly, exposure to plants and other natural elements offers numerous benefits, including:

- decreased levels of diastolic blood pressure, depression and anxiety;
- increased attention capacity;
- improved recovery from stress and illness;
- increased psychological health; and
- increased pain tolerance.<sup>(64, 65, 66)</sup>

Access to nature supports the health of residents by mitigating stressors and positively impacting cognitive and emotional health, focus, productivity, and overall well-being.<sup>(67, 68)</sup>

The NGBS awards points for the inclusion of wildlife gardens, participation in a certified backyard wildlife program, and siting a home or building adjacent to a wildlife corridor. These practices earn points toward this badge.

## Compliance Criteria

To earn the badge:

- Meet all applicable mandatory practices (yellow sections).
- Achieve at least 29 optional practices (green sections).

## Optional Resource

*Enterprise Green Communities Health Action Plan Template* – Utilize this tool to identify critical health aspects affecting the residents of your development and select interventions that best address those needs. <https://www.enterprisecommunity.org/resources/health-action-plan-instruction-and-template>.

<b>SECTION 1: AIR</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet all applicable mandatory practices.</li> <li>• Meet at least 3 optional practices.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
901.1.1 Natural draft furnaces and boilers not located in conditioned space	N/A for badge purposes	Mandatory	Y, required
901.1.5 Vented Natural Gas and Propane Fireplaces	N/A for badge purposes	Mandatory where applicable	Y, required
902.2.1 Building Ventilation Systems	N/A for badge purposes	Mandatory	Y, required
901.14(1-2) Non-Smoking Areas	N/A for badge purposes	Mandatory if multifamily	Met or N/A
901.1.2 Air handling equipment not installed in garage	N/A for badge purposes	Mandatory for single-family with garage	Met or N/A
902.1.6 Ventilation for Multifamily Common Spaces	3	Optional, available for multifamily	
901.2.2 No Fireplaces, Woodstoves, Pellet Stoves, or Masonry Heaters are Installed	6	Optional	
902.4 HVAC System Protection	3	Optional	
904.1 IAQ During Construction	2	Optional	
904.2 IAQ Post-Construction	3	Optional	
706.12 Smart Ventilation	1	Optional	
902.2.4 MERV Filters 14 or Greater	3	Optional where applicable	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b> <b>(Must achieve at least 3 optional practices)</b>			



**SECTION 2: MOVEMENT**

*Requirements:*

- Select at least one item from Group A.
  - *Exception:* single-family homes unable to comply with 501.2(3) or 501.2(4) due to the low surrounding developmental density can meet this requirement if they demonstrate that they are within walking distance (0.5 mile) from a community facility that meet the intent of 505.10(a) or 505.10(b), such as a public park or sports facility.
- Select optional practices from Group B to contribute toward meeting overall point total.

<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
<b>GROUP A</b>			
501.2(3) Pedestrian Activity	N/A for badge purposes	Choose at least 1	
501.2(4) Walkability	N/A for badge purposes	Choose at least 1	
505.10(a) Indoor area for adult exercise and/or children’s play equipment	N/A for badge purposes	Choose at least 1; only available for multifamily	
505.10(b) Courtyard, garden, terrace, or roof space for play/recreation	N/A for badge purposes	Choose at least 1; only available for multifamily	
<b>GROUP B</b>			
501.2(5) Bicycle Use	5	Optional	
501.2(6) Bicycle Parking	2-8	Optional; only available for multifamily	
501.2(1) Pedestrian access to mass transit system	6	Optional	
501.2(8) Access to bike sharing program	5	Optional	
505.4 Mixed-use development	8	Optional; only available for multifamily	

*Notes:*

**TOTAL OPTIONAL POINTS FROM THIS SECTION: \_\_\_\_\_**

<b>SECTION 3: MOISTURE MANAGEMENT</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet mandatory practice.</li> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
602.1.7.1(1, 3) Moisture Control Measures	N/A for badge purposes	Mandatory	Y, required
602.1.12 Roof Overhangs	4	Optional; only available for 1- and 2 story buildings	
602.1.10 Exterior Doors	2-6	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 4: COMFORT</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Meet mandatory practice.</li> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
903.3 Relative humidity	N/A for badge purposes	Mandatory if located in climate zones 1A, 2A, 3A, 4A, and 5A	Y, required
905.1 Humidity monitoring system	2	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 5: NOURISHMENT</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>• Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
505.5(a) Community garden	3-9	Optional; only available for multifamily	
505.5(b) Proximity to market/farm stand	3	Optional; only available for multifamily	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 6: LIGHT</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
703.7.2 Window Shading	1	Optional; only available for Prescriptive Path	
706.1(5) Lighting Control System	1	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 7: SOUND</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
905.4 Sound Barrier	1-3 (1 for single-family; 3 for multifamily)	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			

<b>SECTION 8: MATERIALS</b>			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>Achieve a minimum of 15 points from the following practices.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
612.2 Sustainable Products	3-9	Optional	
901.5 Low/no- formaldehyde cabinets	3-8	Optional	
901.7 Low-emission floor materials	1-8	Optional	
901.8 Low-emission wall coverings	4	Optional	
901.12 Low-VOC furniture and furnishings	2	Optional; only available for multifamily	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION: _____</b>			
<b>(Minimum 15 required)</b>			

SECTION 9: ACCESS TO NATURE			
<i>Requirements:</i>			
<ul style="list-style-type: none"> <li>Select optional practices to contribute toward meeting overall point total.</li> </ul>			
<i>Practice</i>	<i>Points Available</i>	<i>Type</i>	<i>Pursuing (Y/N)</i>
503.6(1) Wildlife gardens	3	Optional	
503.6(2) Certified backyard wildlife	3	Optional	
503.6(3) Wildlife corridor or other preserved area	3	Optional	
<i>Notes:</i>			
<b>TOTAL <u>OPTIONAL</u> POINTS FROM THIS SECTION:</b> _____			

**TOTAL OPTIONAL POINTS ACHIEVED FROM ALL SECTIONS:** \_\_\_\_\_

<sup>9</sup> Klepeis N, Nelson W, Ott W, et al. *The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants*. J Expo Anal Environ Epidemiol. 2001;11(3):231-252. doi:10.1038/sj.jea.7500165.

<sup>10</sup> Joshi S. *The sick building syndrome*. Indian J Occup Environ Med. 2008;12(2):61. doi:10.4103/0019-5278.43262.

<sup>11</sup> Lim SS, Vos T, Flaxman AD, et al. *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010*. Lancet (London, England). 2012;380(9859):2224-2260. doi:10.1016/S0140-6736(12)61766-8.

<sup>12</sup> Sallis JF, Bull F, Guthold R, et al. *Progress in physical activity over the Olympic quadrennium*. Lancet. 2017;388(10051):1325-1336. doi:10.1016/S0140-6736(16)30581-5.

<sup>13</sup> Remington PL, Brownson RC, Wegner M V. *Chronic Disease Epidemiology and Control*. 3rd ed. Washington, DC: American Public Health Association; 2010.

<sup>14</sup> Biswas A, Oh PI, Faulkner GE, et al. *Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults a systematic review and meta-analysis*. Ann Intern Med. 2015;162(2):123-132. doi:10.7326/M14-1651.

<sup>15</sup> Liu J, Mauzerall DL, Chen Q, et al. *Air pollutant emissions from Chinese households: a major and underappreciated ambient pollution source*. Proc Natl Acad Sci U S A. 2016;113(28):7756-7761. doi:10.1073/pnas.1604537113.

<sup>16</sup> World Health Organization. *Household (Indoor) Air Pollution*. WHO.

<sup>17</sup> Centers for Disease Control and Prevention (CDC). *Health Effects Carbon Monoxide Poisoning Exposure and Risk – CDC Tracking Network*. <https://ephtracking.cdc.gov/showCoRisk.action>. Accessed September 11, 2019.

<sup>18</sup> Weaver LK, Hopkins RO, Chan KJ, et al. *Hyperbaric Oxygen for Acute Carbon Monoxide Poisoning*. N Engl J Med. 2002;347(14):1057-1067. doi:10.1056/NEJMoa013121.

<sup>19</sup> Hanssen SO. *HVAC – the importance of clean intake section and dry air filter in cold climate*. Indoor Air. doi:10.1111/j.1600-0668.2004.00288.x.

<sup>20</sup> Vishnevetsky J, Tang D, Chang H-W, et al. *Combined effects of prenatal polycyclic aromatic hydrocarbons and material hardship on child IQ*. Neurotoxicol Teratol. 2015;49:74-80. doi:10.1016/j.ntt.2015.04.002.

<sup>21</sup> McKenzie J., L. Bhatti and ET d’Espaignet. *WHO Tobacco Knowledge Summaries: Tobacco and Dementia*. 2014. [http://apps.who.int/iris/bitstream/10665/128041/1/WHO\\_NMH\\_PND\\_CIC\\_TKS\\_14.1\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/128041/1/WHO_NMH_PND_CIC_TKS_14.1_eng.pdf). Accessed September 10, 2019.

<sup>22</sup> Jha P, Ramasundarahettige C, Landsman V, et al. *21st-Century Hazards of Smoking and Benefits of Cessation in the United States*. N Engl J Med. 2013;368(4):341-350. doi:10.1056/NEJMsa1211128.

<sup>23</sup> National Cancer Institute. *Harms of Cigarette Smoking and Health Benefits of Quitting*. <https://www.cancer.gov/about-cancer/causes-prevention/risk/tobacco/cessation-fact-sheet>. Accessed September 10, 2019.

<sup>24</sup> Tinuoye O, Pell JP, Mackay DF. *Meta-Analysis of the Association Between Secondhand Smoke Exposure and Physician-Diagnosed Childhood Asthma*. Nicotine Tob Res. 2013;15(9):1475-1483. doi:10.1093/ntr/ntt033.

- 
- <sup>25</sup> Bergdahl IA, Torén K, Eriksson K, et al. *Increased mortality in COPD among construction workers exposed to inorganic dust*. *Eur Respir J*. 2004;23(3):402-406. <http://www.ncbi.nlm.nih.gov/pubmed/15065829>. Accessed September 10, 2019.
- <sup>26</sup> World Health Organization RO for E. *Health Effects of Particulate Matter*. 2013. [http://www.euro.who.int/\\_data/assets/pdf\\_file/0006/189051/Health-effects-of-particulate-matter-final-Eng](http://www.euro.who.int/_data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng). Accessed September 10, 2019.
- <sup>27</sup> Centers for Disease Control and Prevention. *Facts about Physical Activity*. <https://www.cdc.gov/physicalactivity/data/facts.htm>. Published 2014. Accessed September 10, 2019.
- <sup>28</sup> World Health Organization. *Physical Activity*. <http://www.who.int/mediacentre/factsheets/fs385/en/>. Published 2015. Accessed September 10, 2019.
- <sup>29</sup> Urban Land Institute. *Intersections: Health and the Built Environment*. Washington, DC: Urban Land Institute; 2013. <http://uli.org/wp-content/uploads/ULI-Documents/Intersections-Health-and-the-Built-Environment.pdf>.
- <sup>30</sup> Renalds A, Smith TH, Hale PJ. A systematic review of built environment and health. *Fam Community Heal*. 2010;33(1):68-78. [doi:10.1097/FCH.0b013e3181c4e2e5](https://doi.org/10.1097/FCH.0b013e3181c4e2e5).
- <sup>31</sup> Zhu X, Yu CY, Lee C, Lu Z, Mann G. A retrospective study on changes in residents' physical activities, social interactions, and neighborhood cohesion after moving to a walkable community. *Prev Med*. 2014;69 (suppl):S93-7. [doi:10.1016/j.ypmed.2014.08.013](https://doi.org/10.1016/j.ypmed.2014.08.013).
- <sup>32</sup> National Association of City Transportation Officials. *Urban Bikeway Design Guide*, 2nd ed. 2014:260. <http://nacto.org/publication/urban-bikeway-design-guide/>.
- <sup>33</sup> Reynolds CC, Harris MA, Teschke K, Crompton PA, Winters M. *The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature*. *Environ Heal*. 2009;8(1):47. [doi:10.1186/1476-069X-8-47](https://doi.org/10.1186/1476-069X-8-47).
- <sup>34</sup> Pucher J, Buehler R. *Safer cycling through improved infrastructure*. *Am J Public Health*. 2016;106(12):2089-2091. [doi:10.2105/AJPH.2016.303507](https://doi.org/10.2105/AJPH.2016.303507).
- <sup>35</sup> Halonen JI, Stenholm S, Kivimäki M, et al. *Is change in availability of sports facilities associated with change in physical activity? A prospective cohort study*. *Prev Med*. 2015;73:10-14. [doi:10.1016/j.ypmed.2015.01.012](https://doi.org/10.1016/j.ypmed.2015.01.012).
- <sup>36</sup> Institute of Medicine. *Damp Indoor Spaces and Health*. Washington, D.C.: National Academies Press; 2004. [doi:10.17226/11011](https://doi.org/10.17226/11011).
- <sup>37</sup> Mudarri D, Fisk WJ. *Public health and economic impact of dampness and mold*. *Indoor Air*. 2007;17(3):226-235. [doi:10.1111/j.1600-0668.2007.00474.x](https://doi.org/10.1111/j.1600-0668.2007.00474.x).
- <sup>38</sup> U.S. Environmental Protection Agency. *Moisture Control Guidance for Building Design, Construction and Maintenance*. 2013. <https://www.epa.gov/sites/production/files/2014-08/documents/moisture-control.pdf>.
- <sup>39</sup> Nematshoua MK, Orosa JA. *Building construction materials effect in tropical wet and cold climates: A case study of office buildings in Cameroon*. *Case Stud Therm Eng*. 2016;7:55-65. [doi:10.1016/j.csite.2016.01.007](https://doi.org/10.1016/j.csite.2016.01.007).
- <sup>40</sup> Petrofsky JS, Berk L, Alshammari F, et al. *The interrelationship between air temperature and humidity as applied locally to the skin: the resultant response on skin temperature and blood flow with age differences*. *Med Sci Monit*. 2012;18(4):CR201-8. [doi:10.12659/MSM.882619](https://doi.org/10.12659/MSM.882619).
- <sup>41</sup> Arundel AV, Sterling EM, Biggin JH, Sterling TD. *Indirect health effects of relative humidity in indoor environments*. *Environ Health Perspect*. 1986;65:351-361. <http://www.ncbi.nlm.nih.gov/pubmed/3709462>. Accessed September 10, 2019.
- <sup>42</sup> Wolkoff P, Kjærgaard SK. *The dichotomy of relative humidity on indoor air quality*. *Environ Int*. 2007;33(6):850-857. [doi:10.1016/j.envint.2007.04.004](https://doi.org/10.1016/j.envint.2007.04.004).
- <sup>43</sup> Gakidou E, Afshin A, Abajobir AA, et al. *Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016*. *Lancet*. 2017;390(10100):1345-1422. [doi:10.1016/S0140-6736\(17\)32366-8](https://doi.org/10.1016/S0140-6736(17)32366-8).
- <sup>44</sup> World Health Organization. *Diet, nutrition and the prevention of chronic diseases-Report of the joint WHO/FAO expert consultation*. 2003. <http://www.who.int/dietphysicalactivity/publications/trs916/intro/en/>.
- <sup>45</sup> Litt JS, Soobader MJ, Turbin MS, Hale JW, Buchenau M, Marshall JA. *The influence of social involvement, neighborhood aesthetics, and community garden participation on fruit and vegetable consumption*. *Am J Public Health*. 2011;101(8):1466-1473. [doi:10.2105/AJPH.2010.300111](https://doi.org/10.2105/AJPH.2010.300111).
- <sup>46</sup> Art M. *Community gardens to fight urban youth crime and stabilize neighborhoods*. *Int J Child Heal Hum Dev*. 2014;7(3):223-236.

- 
- <sup>47</sup> Clatworthy J, Hinds J, M. Camic P. *Gardening as a mental health intervention: a review*. Ment Heal Rev J. 2013;18(4):214-225. doi:10.1108/MHRJ-02-2013-0007.
- <sup>48</sup> U.S. Department of Health and Human Services, U.S. Department of Agriculture. *Dietary Guidelines for Americans, 2015-2020*. 2015. [https://health.gov/dietaryguidelines/2015/resources/2015-2020\\_Dietary\\_Guidelines.pdf](https://health.gov/dietaryguidelines/2015/resources/2015-2020_Dietary_Guidelines.pdf).
- <sup>49</sup> Morland KB, Evenson KR. *Obesity prevalence and the local food environment*. Heal Place. 2009;15(2):491-495. doi:10.1016/j.healthplace.2008.09.004.
- <sup>50</sup> Küller R, Ballal S, Laike T, Mikellides B, Tonello G. *The impact of light and colour on psychological mood: A cross-cultural study of indoor work environments*. Ergonomics. 2006;49(14):1496-1507. doi:10.1080/00140130600858142.
- <sup>51</sup> Gifford R. *Light, decor, arousal, comfort and communication*. J Environ Psychol. 1988;8(3):177-189. doi:10.1016/S0272-4944(88)80008-2.
- <sup>52</sup> Küller R, Ballal S, Laike T, Mikellides B, Tonello G. *The impact of light and colour on psychological mood: A cross-cultural study of indoor work environments*. Ergonomics. 2006;49(14):1496-1507. doi:10.1080/00140130600858142.
- <sup>53</sup> Knez I, Kers C. *Effects of indoor lighting, gender, and age on mood and cognitive performance*. Environ Behav. 2000;32(6):817-831. doi:10.1177/0013916500326005.
- <sup>54</sup> Hänninen O, Knol A. *European Perspective on Environmental Burden of Disease—Estimates for Nine Stressors in Six European Countries*. Natl Inst Heal Welfare Rep. 2011:95.
- <sup>55</sup> Lamb S, Kwok KCS. *A longitudinal investigation of work environment stressors on the performance and wellbeing of office workers*. Appl Ergon. 2016;52:104-111.
- <sup>56</sup> Fyhri A, Aasvang GM. *Noise, sleep and poor health: Modeling the relationship between road traffic noise and cardiovascular problems*. Sci Total Environ. 2010;408(21):4935-4942.
- <sup>57</sup> Bluhm GL, Berglind N, Nordling E, Rosenlund M. *Road traffic noise and hypertension*. Occup Environ Med. 2007;64(2):122-126.
- <sup>58</sup> Babisch W, Beule B, Schust M, Kersten N, Ising H. *Traffic noise and risk of myocardial infarction*. Epidemiology. 2005;16(1):33-40. doi:10.1097/01.ede.0000147104.84424.24.
- <sup>59</sup> Belojević G, Öhrström E, Rylander R. *Effects of noise on mental performance with regard to subjective noise sensitivity*. Int Arch Occup Environ Health. 1992;64(4):293-301.
- <sup>60</sup> Hedge A. *The open-plan office: A Systematic Investigation of Employee Reactions to Their Work Environment*. Environ Behav. 1982;14(5):519-542. doi:10.1177/0013916582145002.
- <sup>61</sup> U.S. Environmental Protection Agency. *National Programs to Assess IEQ Effects of Building Materials and Products*. <https://www.epa.gov/indoor-air-quality-iaq/national-programs-assess-ieq-effects-building-materials-and-products>. Accessed September 10, 2019.
- <sup>62</sup> U.S. Environmental Protection Agency. *Volatile Organic Compounds' Impact on Indoor Air Quality*. <https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality>. Accessed September 10, 2019.
- <sup>63</sup> U.S. Environmental Protection Agency. *Facts About Formaldehyde*. <https://www.epa.gov/formaldehyde/facts-about-formaldehyde>. Accessed September 10, 2019.
- <sup>64</sup> Largo-Wight E, Chen WW, Dodd V, Weiler R. *Healthy Workplaces: The Effects of Nature Contact at Work on Employee Stress and Health*. Public Health Rep. 2011;126:124-131. doi:10.2307/41639273.
- <sup>65</sup> Wolf K, Krueger S, Flora K. *Work and Learning – A Literature Review*. Green Cities Good Heal. 2014. [www.greenhealth.washington.edu](http://www.greenhealth.washington.edu). Accessed September 10, 2019.
- <sup>66</sup> Larsen L, Adams J, Deal B, Kweon B-S, Tyler E. *Plants in the workplace the effects of plant density on productivity, attitudes, and perceptions*. Environ Behav. 1998;30(3):261-281.
- <sup>67</sup> Kant I, Beurskens a JHM, Amelvoort LGPM Van, Swaen GMH. *An epidemiological approach to study fatigue in the working population: the Maastricht Cohort Study*. 2003:32-39.
- <sup>68</sup> Brown DK, Barton JL, Gladwell VF. *Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress*. Environ Sci Technol. 2013;47(11):5562-5569. doi:10.1021/es305019p.

## NGBS GREEN+ ZERO WATER

### Overview

The term “Zero Water” signifies that water supplied by rainwater capture or reused greywater and/or blackwater sources is at a level that could meet all water usage. (The home may still be connected to a septic tank or public water supply to supplement in the case of unusual activity.)

A zero water home/building is designed to offer reduced environmental impact and greater independence to residents. With a zero water design, water use is minimized; water utility bills are eliminated. Designing and constructing for a zero water homes involves careful design with efficient structural plumbing design, efficient fixtures, and landscape and other outdoor features that require limited water. In addition, storage tanks and treatment devices are installed to facilitate the capture and use of rainwater, greywater, and blackwater.

Homes that demonstrate that they were constructed to be zero water can earn the NGBS+ Zero Water badge.

### Compliance Criteria

Only New Construction projects are eligible to earn the NGBS Green+ ZERO WATER badge. Projects must comply with the Water Efficiency chapter via the Performance Path (Water Rating Index).

A home or building must achieve a Water Rating Index (WRI) score of “0.” This is evaluated by a specially-trained NGBS Green Verifier using the Water Rating Index (WRI) Calculator.



**NGBS  
GREEN™**  
**+ZERO WATER**

**This badge is “Zero Water”—not “Net Zero Water” or “Zero Water Ready.”**

“Net Zero Water” refers to a home or building that is designed to use water from alternative sources (e.g., rainwater, greywater, blackwater) at an equal amount as the amount of wastewater discharged from the building and returned to the original water source. The NGBS does not factor in withdrawal or return of water to original water sources but instead provides an efficiency score of a home’s overall water use that factors in the amount of water use that is offset by alternative water sources.

“Zero Water Ready” and similar identifiers imply that the water capture and treatment systems are not yet installed, but the home includes features that support the installation of those systems. For example, piping infrastructure is in place to support greywater collection and treatment systems. For NGBS Green Certification, all home features, including those evaluated as part of the WRI achievement, must be installed and verified prior to certification.









**Home Innovation**  
RESEARCH LABS™