Building Professional Training – Day 1

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Agenda

Day 1: Wednesday, October 19th 10:00 – 1:00 PM

- Intro
- Comparing Green Building Certifications
- EarthCraft Family of Programs
- EarthCraft Workbook
- Building Science Fundamentals

Day 2: Wednesday, October 20th 10:00 – 1:00 PM

- 2018 IECC Update in Virginia
- Building Science and Health
- Efficient HVAC Systems
- Resilience

Housekeeping

- Please mute yourself during the presentation
- The chat is the best way to ask questions throughout
- Cameras on or off are fine.
- If you need tech support, please message the hosts at any time!
- We will be recording

Partners & Sponsors

PARTNERS

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HBA Virginia

Habitat for Humanity Virginia

ENERGY STAR

HOME BUILDING ASSOCIATION OF RICHMOND www.hbar.org

SPONSORS

MITSUBISHI ELECTRIC COOLING & HEATING

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HUBER ENGINEERED WOODS

SANTA-FE DEHUMIDIFIERS

Presenters

Bill Riggs, Technical Advisor

Sean Shanley, Director of Residential Operations

Viridiant & EarthCraft

viridiant

non-profit organization committed to supporting sustainable building processes through education, consultation, and certification

earthcraft

A Program of Southface

family of programs serving as a blueprint for energy and resource-efficient structures including single family, multifamily, renovation, light commercial, and communities

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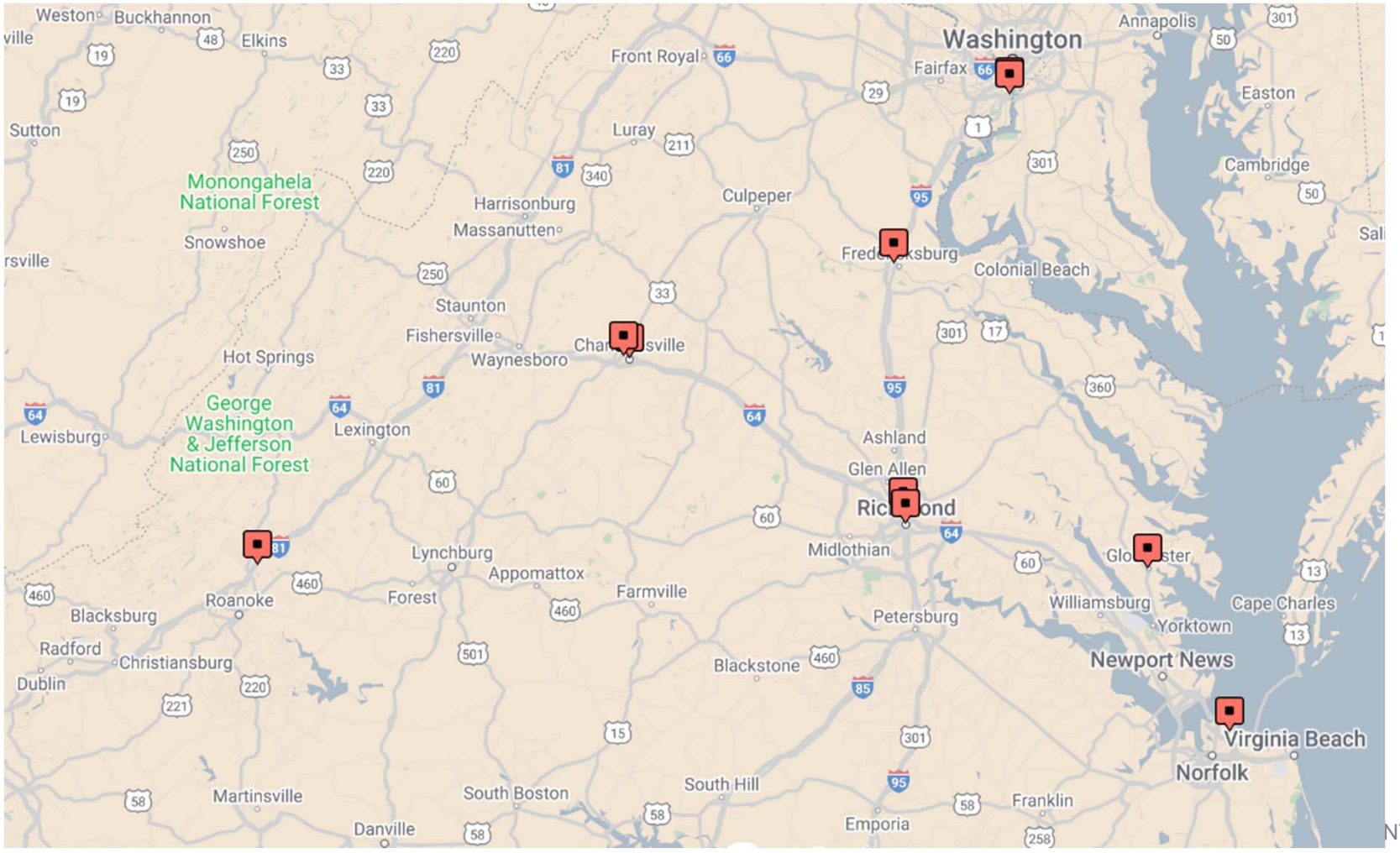


2021 ENERGY SAVINGS

In 2021, Viridiant verified **5,123** homes

154
TOTAL HOMES IN 2021

\+

4,969
TOTAL UNITS IN 2021

EQUATES TO ELIMINATION OF

6.7
GIGAWATT HOURS OF ENERGY

OR

2,806
TONS OF CARBON DIOXIDE

OR

3,101,425	106,350	46,398	6,496	610	510
POUNDS OF COAL BURNED	INCANDESCENT LAMPS SWITCHED TO LEDS	TREE SEEDLINGS GROWN FOR 10 YEARS	BARRELS OF OIL CONSUMED	PASSENGER VEHICLES DRIVEN FOR ONE YEAR	HOMES' ELECTRICITY USE FOR ONE YEAR

Families Served in 2021

SINGLE FAMILY

154
TOTAL HOMES IN 2021

3,485
TOTAL HOMES THROUGH 12/31/2021

MULTIFAMILY

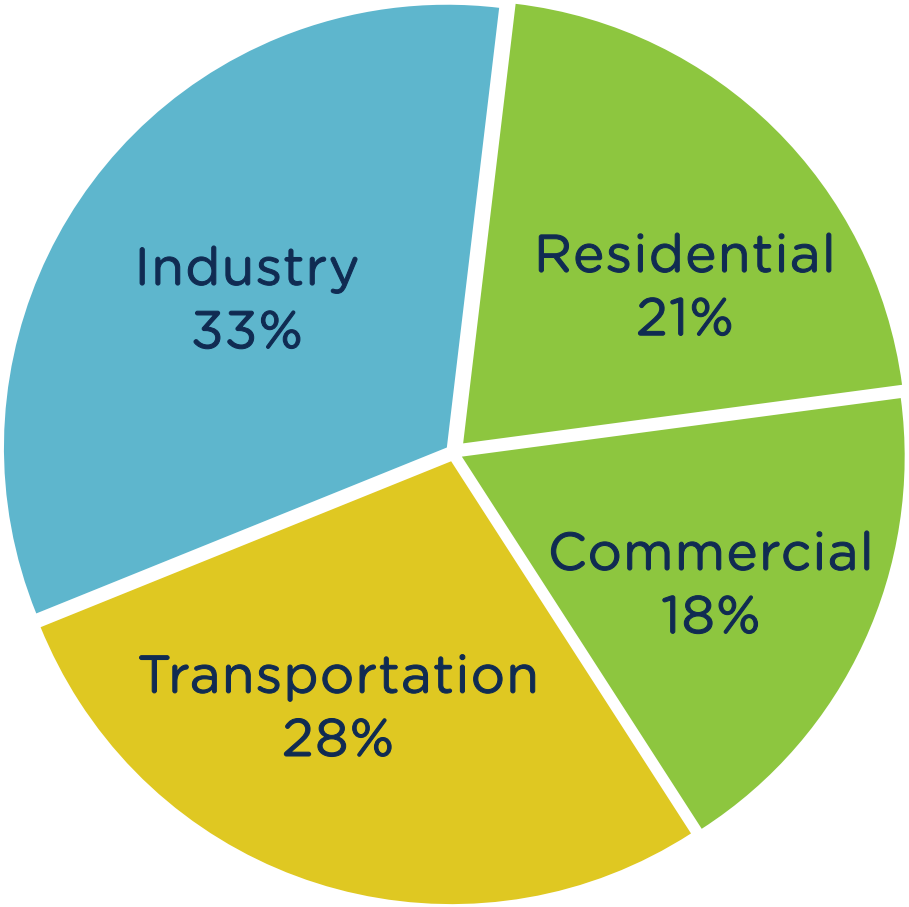
4,969
TOTAL UNITS IN 2021

32,141
TOTAL UNITS THROUGH 12/31/2021

5,123 FAMILIES SERVED IN 2021

35,626 FAMILIES SERVED THROUGH 12/31/2021

US Energy Consumption by Sector



Buildings make up 39% of US energy consumption, representing a huge opportunity for reducing energy consumption

Source: Lawrence Berkley Lab

Comparing Green Building Programs

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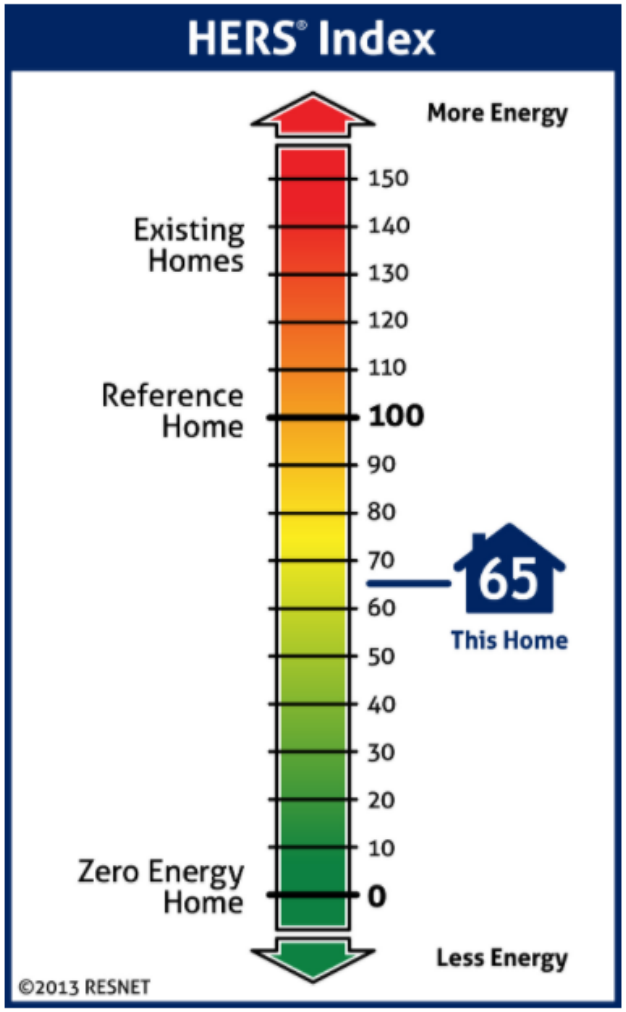
Viridiant Programs & Services

- ENERGY STAR
- HERS Ratings
- EarthCraft
- NGBS
- Enterprise
- LEED for Homes
- Zero Energy Ready Home
- Passive House
- Viridiant Net-Zero
- Mechanical Design
- HUD MAP: SEDI & SEP
- Energy Audits
- Utility Allowances
- Benchmarking
- Performance Testing
- Code Compliance (blower door, duct blaster)

What is a HERS Index?



A certified Home Energy Rater assesses the energy efficiency of a home, assigning it a relative performance score. The lower the number, the more energy efficient the home.The U.S. Department of Energy has determined that a typical resale home scores 130 on the HERS Index while a standard new home is awarded a rating of 100.

- **A home with a HERS Index Score of 70 is 30% more energy efficient than a standard new home**
- **A home with a HERS Index Score of 130 is 30% less energy efficient than a standard new home**

ENERGY STAR: All MF in 1 Program

- All MF buildings under one program
- Currently V1, Revision 2 in VA, V1.1 Revision 2 in DC, MD
- Integrates Low-Rise + High Rise programs
- Released early 2019, mandatory permitted 7/1/2021
- **Requires residential and common spaces comply**
- Requires 2 yrs of post-occupancy benchmarking for 50,000sf or larger

Source: https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_mfhr_bldg_eligibility

Energy Star

Pros

- All building types
- National program
- Focus on Energy
- On-site visits
- Consumer awareness
- 45L Tax Credit ($2,500)

Cons

- Basic certification program
- Not regionally adapted to southeast
- Not a green building program

Energy Star – 45L Tax Credit

- ENERGY STAR Single-Family New Homes certification - $2,500 per single-family home
  - Jan. 1, 2023 – Dec. 31, 2024: National Version 3.1 *
  - Jan. 1, 2025 – Dec. 31, 2032: National Version 3.2 *
  - *Or the regional program requirements applicable to the home
- ENERGY STAR Multifamily New Construction certification - $2,500 per dwelling unit
  - Reduced to $500 for multifamily projects that do not meet prevailing wage requirements.
  - Most recent Version of National Program Requirements **
  - ** Or the regional program requirements applicable to the dwelling unit.
- ENERGY STAR Manufactured New Homes certification - $2,500 per manufactured home
  - Most recent Version of the program requirements
  - Currently Version 2, with Version 2.1 recently proposed.

Energy Star

Housing Type	Rebate Amount
Single-family detached home	$950
Attached home,including townhome, duplex and two-on-two condo	$650

www.domnewhomes.com

Energy Star Structure & Resources

5 Checklists of Prescriptive Measures

- Rater Design Review Checklist
- Rater Field Checklist
- HVAC Design Checklist
- HVAC Commissioning Checklist
- National Water Management System Builder Checklist

Residential Programs Resources Page

- https://www.energystar.gov/partner_resources/residential_new/homes_prog_reqs/national_page

LIHTC: Optional (10 points, chose 1)

New Construction

earthcraft

Enterprise green communities®

NGBS GREEN™
Home Innovation Research Labs

LEED
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Renovation

earthcraft

NGBS GREEN™
Home Innovation Research Labs

Enterprise green communities®

HIEE/Future Points (10 points each, chose 1 or both)

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

PHIUS
Passive House Institute US

EPA Indoor airPLUS
QUALIFIED HOMES

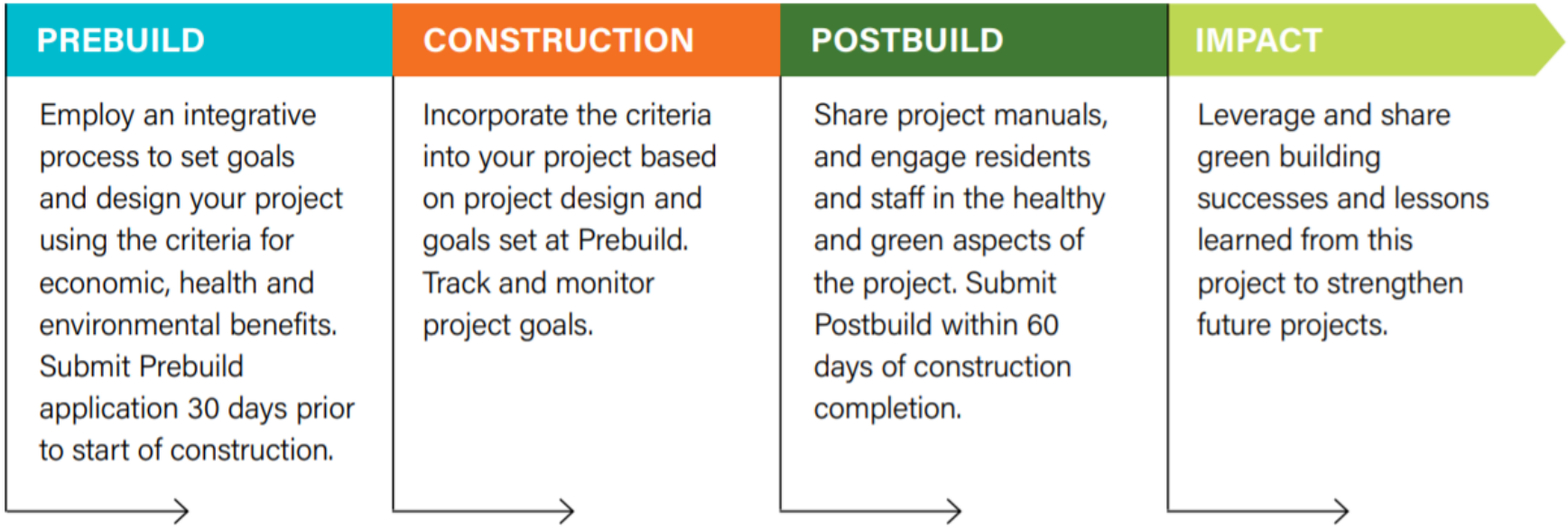
Costs

Registration
Verification
Certification

Enterprise Structure and Resources

Enterprise Green Communities Certification - all projects must achieve compliance with the 'Criteria mandatory measures' based on construction type.

- New Construction projects must also achieve at least 40 optional points
- Substantial and Moderate Rehab projects must also achieve at least 35 optional points.



https://www.greencommunitiesonline.org/sites/default/files/egc_2020_criteria_manual.pdf

Enterprise Structure and Resources

2020 criteria offer two levels of certification:

- *Enterprise Green Communities (EGC) Certification*
- *EGC Certification Plus* – 'developments making the greatest strides on the Path to Zero Energy'

Eligibility

- All buildings that contain affordable housing units.
- Affordable housing = at or below 60 percent AMI for rental / at or below 80 percent AMI for-sale projects.

Two Phases of Certification: PreBuild and PostBuild

- $1,250 at the time of Prebuild application (30 days before start of construction) and;
- $300 at the time of Postbuild application (within 60 days of construction completion)

Enterprise

Pros

- Comprehensive national program
- Affordable housing focused
- More than buildings
- ENERGY STAR Baseline for Energy Component

Cons

- Focused on communities
- Timelines for Pre and Post build applications
- For affordable housing only
- Fees to Enterprise

NGBS Green Certified Structure and Resources

Current Version 5.2.2 - March 10, 2021

- MF/Mixed Use, SF, Remodeling, Land development, Water Rating Index

ICC

- reen

Home Innovation
NGBS GREEN CERTIFIED™

Cer

- to attain any certification level, all applicable mandatory provisions must be correctly implemented.
- NGBS requires the building to include enough green building practices in each of the six categories to meet the category minimums for each NGBS Green certification level.

https://www.homeinnovation.com/-/media/Files/Certification/Green_Building/NGBS-Builders-Resource-Guide.pdf

NGBS Green Certified Structure and Resources

Scoring Workbook – Design, Verification, and Certification

- The six categories of green practices in the NGBS are:
  - Lot & Site Development
  - Resource Efficiency
- 2

Two Required Inspection Points

- once before the drywall is installed; once when the building is complete.
- For multifamily buildings, the verifier will need to inspect every unit as well as the common space.
- Not all certification levels require diagnostic testing

NGBS

Pros

- Recommended by the HBA
- Nationally recognized
- Originally for single family homes
- ANSI approved system
- Good starter program

Cons

- Not all certification levels require diagnostic testing
- Developer pays additional fee to NAHB
- Workbook

LEED

Pros

- Brand recognition
- Mostly design related
- International program

Cons

- Not cost effective for all projects
- Constraints that may not pertain to efficiency
- Documentation requirements
- Registration and certification fees

DOE Zero Energy Ready Home (ZERH)

Current Versior

- For homes perm
- Multifamily Spec

Prescriptive Path

- Performance co tem (HERS) Index Score in the low
- Prescriptive doe
- Provisions of the ady Checklist are Completed

ENERGY STAR fo

- Project must also b

ZERH - Components

Zero Energy Ready Home requires:

- **ENERGY STAR Certified Appliances:***
  refrigerators, dishwashers, clothes washers
- **ENERGY STAR Certified Fans*:**
  bathroom ventilation, ceiling fans
- **ENERGY STAR Certified Lighting:**
  Min. 80% of fixtures or lamps (CFL or LED)
- **Efficient Hot Water Systems:**
  - **A. Efficient Distribution**

    …or…
  - **B. Efficient Water Heater + Fixtures**

*Only where installed by builder

Source: Newport Partners – DOE ZERH Webinar

ZERH

Pros

- Next level program
- Nationally recognized
- Balances efficiency with cost

Cons

- Incorporates non-standard construction practices
  - Electric Water Heaters must be Heat Pump Style/have UEF above 1.5
- Subcontractors maybe not able to execute details

Passive House Institute US

Current Version

- Certification Guidebook v 2.1
- PHIUS+ Single Family v4.1
- PHIUS+ Multifamily v2.2
- Currently PHIUS+ Non-Residential DRAFT v1.0

Pass/Fail Standard

- overall limit on energy use for all purposes
- limits on heating and cooling energy, in both the annual-total and peak-power sense.
- Focus on thermal bridging

Passive House Institute US

DOE Zero Energy Ready Home Baseline

- ENERGY STAR MFNC/V3
- Indoor AirPlus

Rigorous Quality Assurance

- Energy Modeling
- Mid point blower door testing
- Infrared Mapping
- Both Compartmentalization and Whole-Building blower door testing for Multi Unit Buildings
  - ≤0.060 cfm/ft2 envelope @50Pa or +/- 0.6 ACH_{50}
  - Requires extensive coordination
- Commissioning of Mechanical Systems

PHIUS

Pros

- Top notch building performance
- Most energy efficient program
- Extremely stringent field verification

Cons

- More expensive first costs
- Lack of contractors to build to specifications
- Design restraints

Additive Programming

Source: https://www.phius.org/phius-certification-for-buildings-products/project-certification/overview

IECC 2009	IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	PHIUS+	PHIUS+ SourceZero
						Source Zero Renew-able Energy System
					Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV
				SOLAR READY Depends on climate	SOLAR READY **ALWAYS**	SOLAR READY **ALWAYS**
				Eff. Comps. & H2O Distrib	Eff. Comps. & H_2O Distrib	Eff. Comps. & H_2O Distrib
				EPA Indoor airPLUS	EPA Indoor airPLUS	EPA Indoor airPLUS
				Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space
		HVAC QI w/WHV	HVAC QI w/WHV	HVAC QI w/WHV	Micro-load HVAC QI	Micro-load HVAC QI
		Water Management	Water Management	Water Management	Water Management	Water Management
		Independent Verification	Independent Verification	Independent Verification	Independent Verification	Independent Verification
IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Encl./ES Win.	Ultra-Efficient Enclosure	Ultra-Efficient Enclosure
HERS **85-90**	HERS **70-80**	HERS **65-75**	HERS **55-65**	HERS **48-55**	HERS **35-45**	HERS **< 0**

The Impact of Energy Efficient Construction for LIHTC Housing in VA

A partnership between Housing Virginia, Viridiant, and the Virginia Center for Housing Research at Virginia Tech

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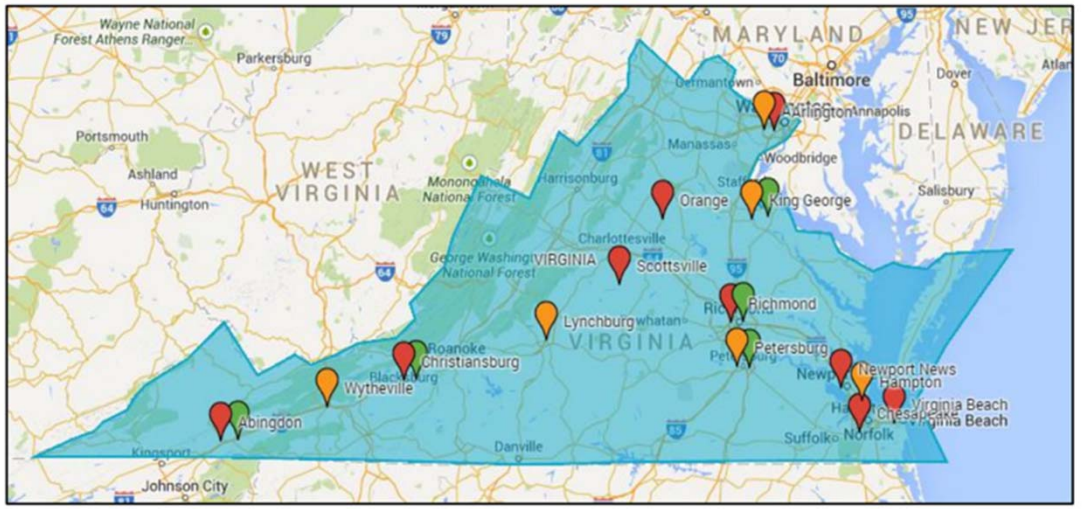
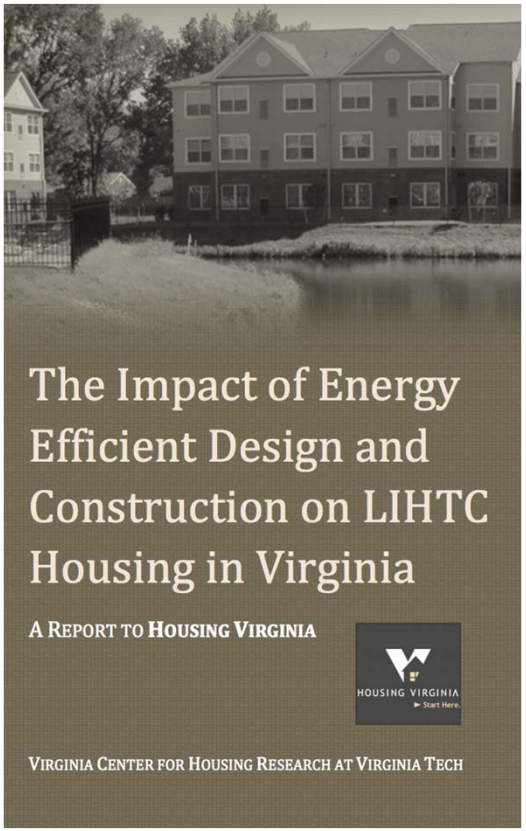
Housing Study

1. Policy Efficacy
2. Quantitative Benefits: Utility Savings for Residents
3. Qualitative Benefits: Thermal Comfort, Education, etc.



Full Report: http://www.vchr.vt.edu/wp-content/uploads/2015/02/Housing-VA-LIHTC-Study-Full-Report.pdf

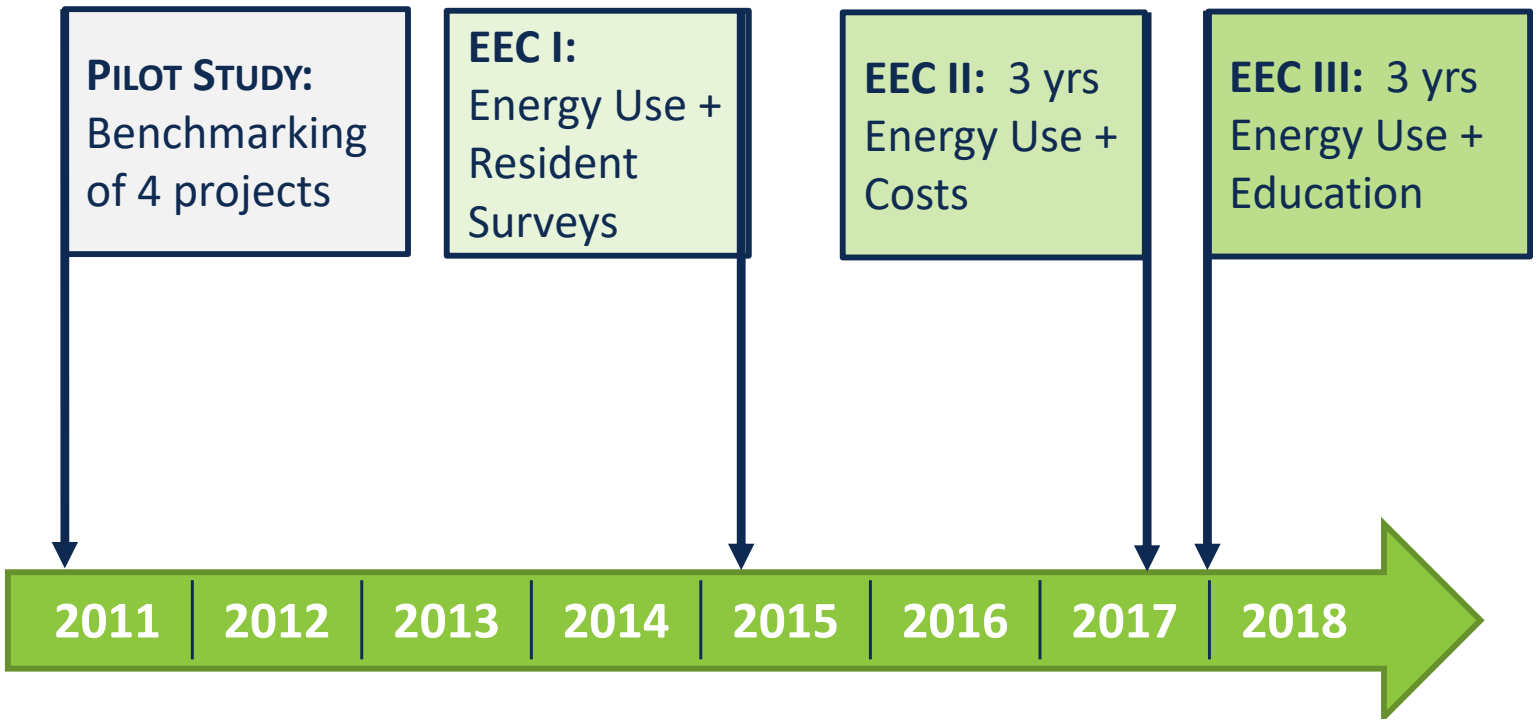
Housing Study - Executive Takeaways



1. VH's goal of promoting affordability via green building is working
2. EarthCraft average savings of $648/year
3. ECMF housing is generally more affordable, comfortable and residents are more satisfied
4. Value in 3rd party verification
5. Disconnect between resident education and owners

Read More: www.viridiant.org/aboutus/research-and-resources/vt-housing-study/

TIMELINE OF THE RESEARCH



Energy Savings and Affordability with EarthCraft[1]

- ✓ Over 3 years, findings continue to indicate a **significant reduction of energy costs for LIHTC residents**. From low-income to extremely low-income housing units, **residents can save between 3.1 and 8.3 percent of total annual housing costs from energy efficiency respectively**.

- ✓ Over 3 years, the average per unit energy use intensity **(EUI) is 55% more efficient than the National average** and **43% more efficient than the Virginia average for multifamily rental housing**.

VCHR

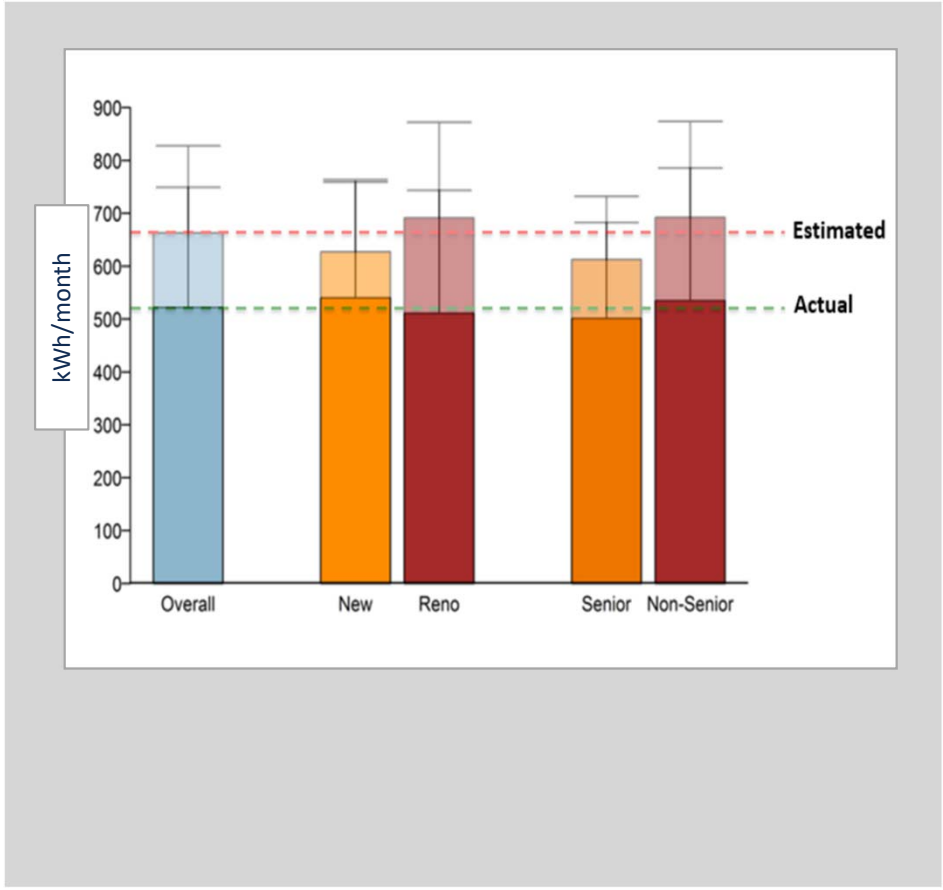
HOUSING VIRGINIA
INFORM | CONNECT | UNLOCK

viridiant

VHDA

[1] McCoy, A. Zhao, D., Agee, P., Mo, Y., & F. Paige. (2017). "Sustaining Energy Efficiency: Longitudinal Evidence of Virginia's Low-Income Housing Tax Credit Properties." A Report by the Virginia Center for Housing Research (VCHR) at Virginia Tech for Housing Virginia. August 29, 2017.

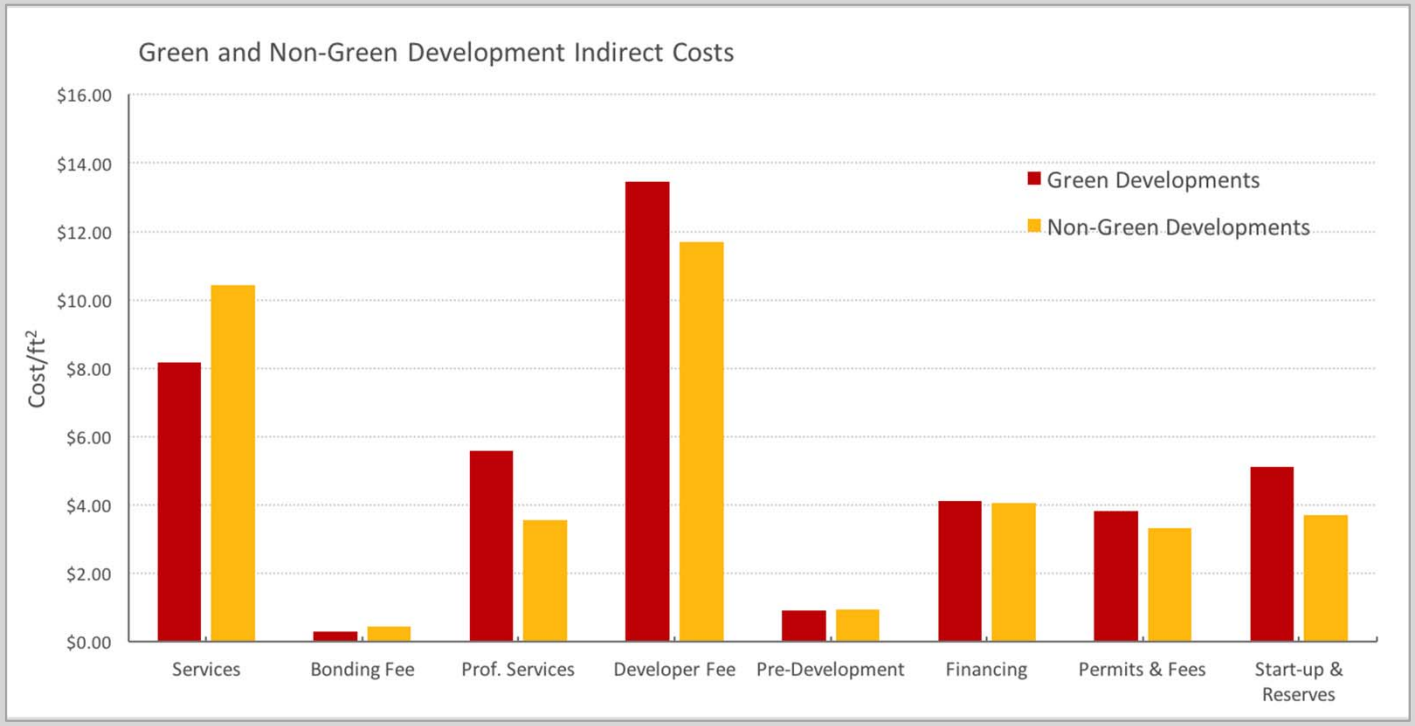
EEC I | FINDINGS



Incentives are working to reduce energy consumption, but the focus needs to be on results

- ✓ Energy usage is 16.6% **less** than estimated and 30% **less** than new standard construction.
- ✓ Based on an energy rate of $.1167/ kWh for the Commonwealth of Virginia in 2015 (http://www.eia.gov/), savings equal **$54 per month** on average.

EEC II | INDIRECT COSTS FINDINGS



EEC II | INDIRECT COSTS FINDINGS

- *The difference in the total cost between green and non-green LIHTC developments is not statistically significant nor does cost statistically correlate to energy usage in the unit.* Builder-developers have been able to provide affordable green housing at less cost per square foot than non-green in this program- *a higher average total cost for* ***non-green*** *developments of 6.2% or $7.15* ***per square foot.***

EarthCraft Overview

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EarthCraft Development & Evolution

Serving builders across the Southeast since 1999, in Virginia since 2006

What is EarthCraft?

EarthCraft homes & buildings are designed to suit the unique climate conditions of the Southeast. EarthCraft projects are energy, water, & resource efficient.

EarthCraft projects have a number of benefits, including:

- Lower utility costs
- Enhanced indoor air quality
- Greater durability
- Increased comfort
- Higher resale value

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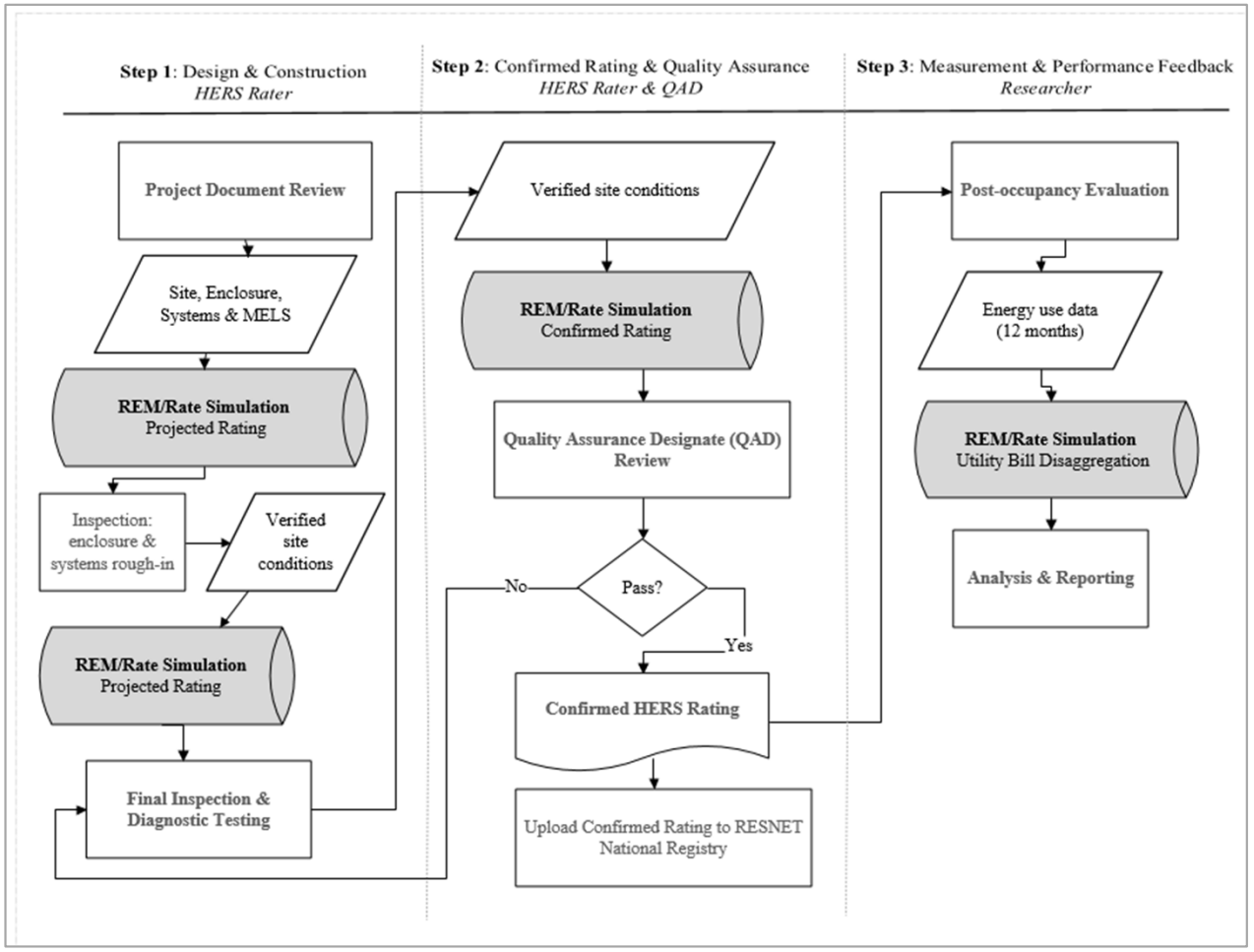
Quality Assurance

OVERVIEW:

- 10 Raters serving MF projects
- Avg. 10 years experience
- 1/7 multifamily sampling rate
- 100% file review
- Standard field QA
- QA on data in WegoWise



EarthCraft Applies to All Building Types

Stony Point Design/Build – Riverside Village

Shelter Alternatives – Net Zero Home

SCG – Residences at Government Center

NNRHA - Jefferson Brookville Rehab

EarthCraft Worksheet

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EarthCraft Worksheet Categories

- Site Planning (SP)
- Construction Waste Management (CW)
- Resource Efficient Design (RE)
- Durability & Moisture Management (DU)
- Indoor Air Quality (IAQ)
- High Performance Building Envelope (BE)
- Energy Efficient Systems (ES)
- Water Efficiency (WE)
- Education & Operations (EO)
- Innovation (IN)

SP CW RE DU IAQ BE ES WE EO IN

EarthCraft House

Single Family Program

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Habitat for Humanity Virginia

Habitat for Humanity® Virginia

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A Program of Southface

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EarthCraft House Program Update 7/1/2018

- A streamlined worksheet, items reduced from 475 to 115
- No points, items are required
- Energy model not required for base certification and base certification cost reduced
- 4 optional badges will replace certification levels:
  - Performance: includes an energy model
  - Comfort: focuses on the HVAC system and ducts
  - Environment: construction waste management, stormwater control, and reduction of material consumption during construction
  - Health: focuses on good indoor air quality and ventilation

ECH Process

Builder Membership

- HBA member
- EC training
- Online application w/$150 annual membership fee

Pre-Construction

- Online project registration
- Submit project info to TA (workbook, construction specs, plans, Manual J load calculations)
- Design Review w/TA

Pre-Drywall

- Framing & air sealing completed
- Mechanical rough-ins and insulation installed
- Schedule Pre-Drywall Inspection with TA

Post-Construction

- Coordinate final inspection and documentation with TA
- TA submits project to Viridiant QAD
- Certification

Builder Membership > Pre-Construction > Pre-Drywall > Post-Construction > Certification

EarthCraft Multifamily

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ECMF Process

Pre-Review

- Online project registration
- Viridiant Spec Sheet
- Drawings
- Review fee

Pre-Construction

- Online Registration
- Submit ECMF workbook, plans, HVAC load calcs
- Design Review Meeting with PM

Construction

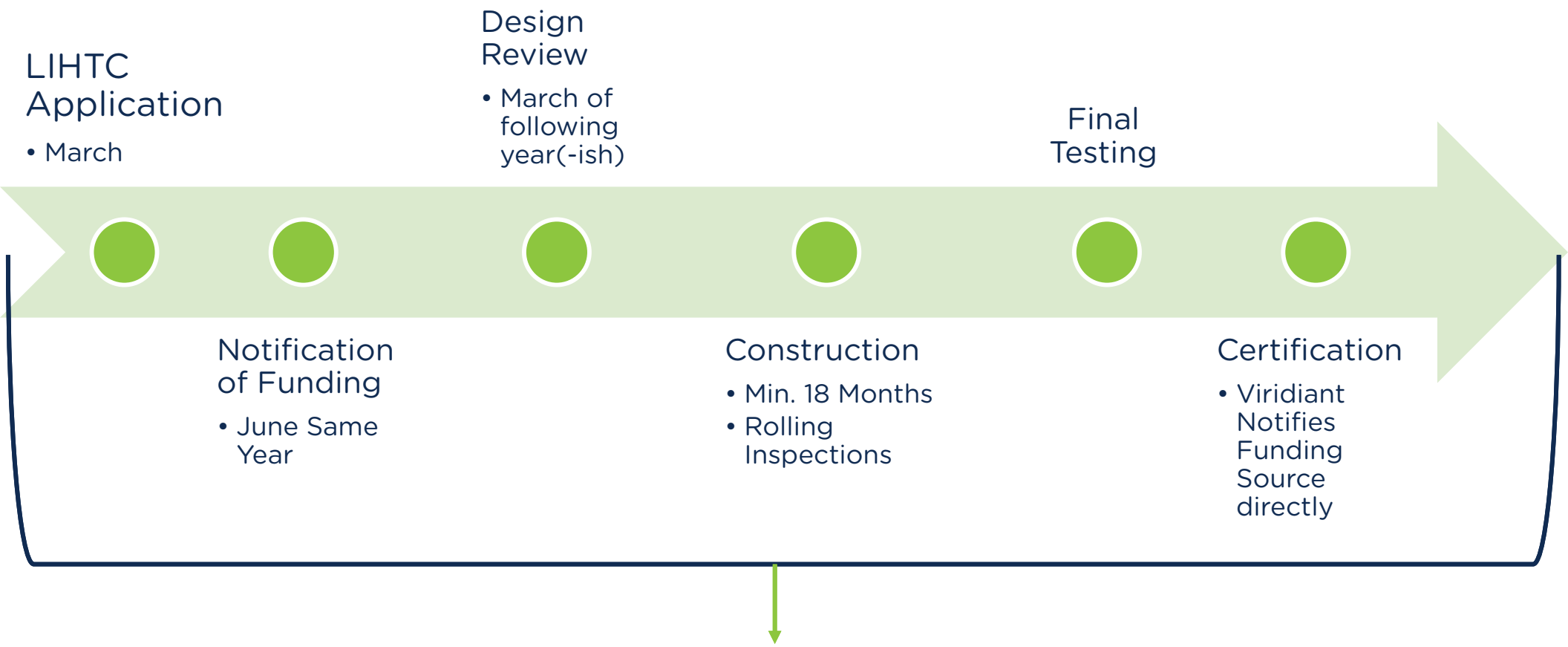
- Kick-Off Meeting with TA
- TA makes regular site visits to verify program items & test units
- Team coordinates documentation with TA

Project Closeout

- Work with TA to ensure units pass final diagnostic testing
- Ta submits documentation to Viridiant
- PM & QAD review
- Certification
- VHDA notified*

Pre-Review | Pre-Construction | Construction | Project Closeout

LIHTC Project Timeline



Avg. 3 years, 2 months, 19 Days

Multifamily Certification Levels – V6.5

Levels	New Construction	Renovation
Certified	100 points HERS ≤ 75	75 points Energy improvement ≥ 20%
Gold	150 points HERS ≤ ENERGY STAR Reference	100 points Energy improvement ≥ 30%
Platinum	200 points HERS ≤ ENERGY STAR Reference	125 points Energy improvement ≥ 40%

ECMF Process

Pre-Review

- Online project registration
- Viridiant Spec Sheet
- Drawings
- Review fee

Pre-Construction

- Online form
- Submit ECMF workbook, plans, HVAC load calcs
- Design Review Meeting with PM

Construction

- Kick-Off Meeting with TA
- TA makes regular site visits to verify program items & test units
- Project Team should coordinate documentation with TA

Project Closeout

- Work with TA to ensure units pass final diagnostic testing
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- PM & QAD review
- Certification
- VHDA notified*

Pre-Review | Pre-Construction | Construction | Project Closeout

ECMF Workbook

EarthCraft Multifamily New Construction Workbook

Project Name:	Pleasantville Estates		
Architect:	John Doe	Building Address:	1234 Pleasant Ave.
Superintendent:		City, State, Zip:	Richmond, VA 23220
Phone:	(804) 225-9843	Technical Advisor:	
E&S Control Contact:		TA Phone #:	
EC Project Manager:		TA Email:	
Permit Date:		Pre-Drywall Inspection Date:	
Design Review Date:		Final Inspection Date:	
ECMF Kick Off Date:			

EarthCraft Program Levels:	Certified	Gold	Platinum
Point Thresholds:	100	150	200

***Choose Level Below

Project Points	Project Score	
	Planned	Actual
SITE PLANNING (SP)	0	0
CONSTRUCTION WASTE MANAGEMENT (CW)	0	0
RESOURCE EFFICIENCY (RE)	0	0
DURABILITY AND MOISTURE MANAGEMENT (DU)	0	0
INDOOR AIR QUALITY (IAQ)	0	0
HIGH PERFORMANCE BUILDING ENVELOPE (BE)	0	0
ENERGY EFFICIENT SYSTEMS (ES)	0	0
WATER EFFICIENCY (WE)	0	0
EDUCATION AND OPERATIONS (EO)	0	0
INNOVATION (IN)	0	0
Totals	**0**	**0**

EarthCraft Multifamily Level: Certified

****CHOOSE DESIRED LEVEL FROM DROP DOWN****

EarthCraft Multifamily (ECMF) is a builder led certification program that utilizes third-party program verrification. In consideration of EarthCraft Multifamily certification, each project will be evaluated based on full compliance with the following:

1. Submission of a field verified worksheet with 100 points (Certified), 150 points (Gold), or 200 points (Platinum) depending on

Cover Sheet | Workbook Instructions | Architect Checklist | Worksheet | Spec Sheet | Final Inspection Diagnostics

Pre-Review | Pre-Construction | Construction | Project Closeout | Certification

ECMF Worksheet

EarthCraft Multifamily New Construction Worksheet	Points	Planned	Status	Documentation
SITE PLANNING (SP)				
SP1: SITE SELECTION				
OPTIONAL AT ALL LEVELS				
SP 1.0 Type of site:	Select all that apply:			Site Plan
1. Brownfield site	3			
2. Previously developed site	1			
3. Infill site	Select one:			
A. >50%	1			
B. >75%	2			
SP 1.1 Dwelling units per acre:	Select one:			Site Plan
1 ≥ 15 dwelling units per acre	1			
2 ≥ 20 dwelling units per acre	2			
3. ≥ 25 dwelling units per acre	3			
SP 2: SITE DESIGN				
OPTIONAL AT ALL LEVELS				
SP 2.0 Connectivity to existing:	Select One:			Site Plan, Location
1. Walking distance to bus line (≤1/4 mile)				
A. Existing	2			
B. Planned	1			
2. Walking distance to rail/rapid transit (≤1/2 mile)	Select One:			
A. Existing	3			
B. Planned	1			
3. Biking distance to bike path (≤1/2 mile)	Select One:			
A. Existing	2			
B. Planned	1			

ECMF Process: Certification

Pre-Review | Pre-Construction | Construction | Project Closeout | Certification

CASE STUDY

WARWICK SRO

The Warwick is an historic, four-story brick façade structure originally constructed in 1883. Fire destroyed most of the original structure in 1960. The first renovation, an adaptive re-use, was performed in 1995. CHP transformed the remaining structure into permanent supportive housing units for formerly homeless individuals using the **EarthCraft Multifamily** program. The Warwick single-room occupancy (SRO) facility contains 88 units. Shared spaces include the lobby, offices for staff, group therapy space, two community resident lounges, computer lab, and laundry facilities.

Warwick SRO Newport News, Virginia
Photo credit: Community Housing Partners

Financial Overview: $9.06M

ANNUAL ENERGY USE
(Source EUI)

Baseline (2011) — 129 kBtu/sq.ft.

Actual (2013) — 67 kBtu/sq.ft.

ENERGY SAVINGS:
48%

ANNUAL ENERGY COST

Baseline (2011) — $105,000

Actual (2013) — $62,000

COST SAVINGS:
$43,000

chp

viridiant

Better Buildings® U.S. DEPARTMENT OF ENERGY

VHDA®

Arlington Water Efficiency Case Study (2009)

AIRE
ARLINGTON INITIATIVE TO REDUCE EMISSIONS

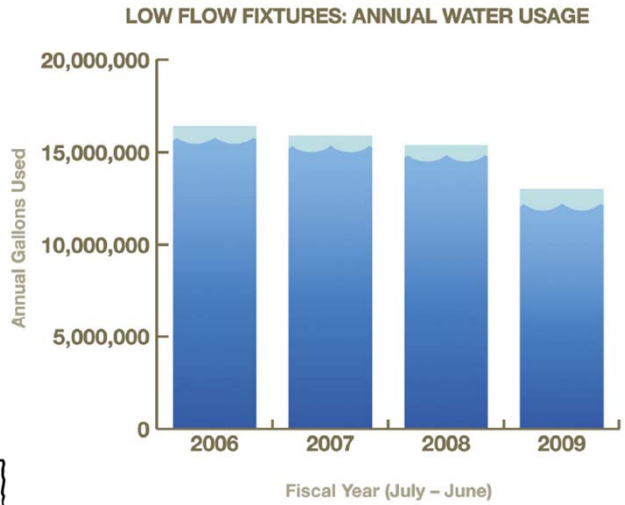
WATER EFFICIENCY SPOTLIGHT
COLUMBIA GROVE APARTMENTS

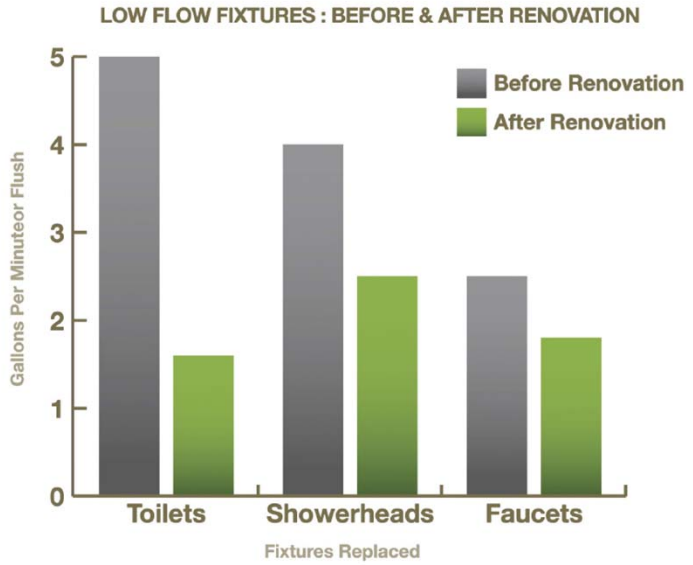
FAST FACT
LOW-FLOW WATER FIXTURES SAVE $24,000 ANNUALLY

DOES WATER EFFICIENCY SAVE MONEY?

Based on the current Arlington County water and sewer rates of $11.20 per 1,000 gallons, this generates over $24,000 in savings annually for APAH.

- $102,000 Labor & fixture costs
- $24,000 Annual savings
- 15% Water use reduction
- 4 Year payback period
- $490 Cost Per Unit
- $140 Annual Savings Per Unit





EARTH CRAFT Multifamily

SP CW RE DU IAQ BE ES WE EO IN

Viridiant Utility Allowance Services

1. **Preliminary UA for EarthCraft projects:** Projects pursuing EarthCraft certification and applying for LIHTC can request a UA during the Pre-Review Process.

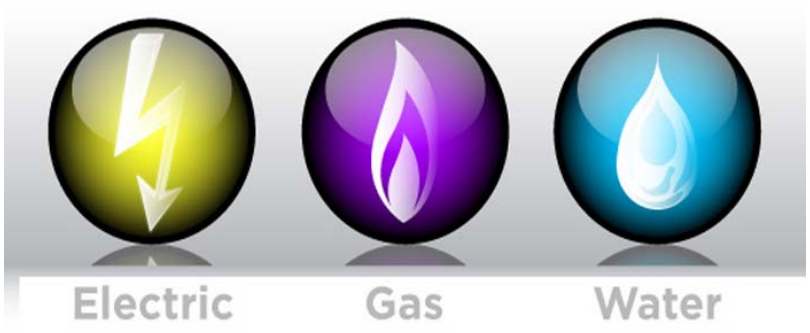
2. **Final UA for EarthCraft projects:** Viridiant can provide UA projections any time after we host the Design Review Meeting and confirm HVAC equipment.

3. **UA for existing non-EarthCraft projects:** An on-site audit will need to be conducted to gather detailed information on the project. Our team will need access to at least three units of each unit type. Energy models will be created to provide UA projections.

4. **UA Renewals:** Viridiant can renew your UA on an annual basis. UA projections might change from year to year based on utility rate adjustments and energy modeling software updates.

Utility Allowance Example 1

- 32 Unit Apartment complex in Virginia. They were able to increase profit on these apartments by **$22,800** per year.
- With 14 years remaining on their loan commitment they realized an additional $319,200 in Net revenue.



	Existing UA Calculation	Viridiant UA Calculation	Savings/Month
1 Bedroom	$164	$111	$53
2 Bedroom	$201	$131	$70

Utility Allowance Example 2

- Replaced existing fixtures with low flow toilets, faucets and showerheads.
- Property had 336 total units.
- The total cost to install and change out the water fixtures was $87,024.
- Savings were $166,656 per year and they realized a ROI in less than 6 months. This project also saved an estimated 4,250,333 gallons per year!

	Existing UA Calculation	Viridiant UA Calculation	Savings/Month
2 Bedroom	$167	$137	$30
3 Bedroom	$215	$157	$58

EarthCraft Light Commercial

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EarthCraft Light Commercial

- Program Developed by Southface Energy Institute and Released in 2008
- Primarily ASHRAE 90.1
- Current Version of the program - V2.1 Released in 2018

EarthCraft Commercial Options

- EarthCraft Sustainable Preservation
  - The program is designed to evaluate and highlight what is inherently sustainable about historic buildings while providing guidance on appropriate alterations to make them more energy and water efficient. Projects will receive technical guidance from green building and preservation experts helping achieve customized solutions for more sustainable historic buildings.

- EarthCraft Fit Out
  - This specific certification option is targeted for restaurants, shops, or smaller office spaces that move into already existing commercial spaces.

ECLC Process Review

Project Eligibility

- Contact Viridiant to talk about your project
- Determine Eligibility based on scope and size of building.

Pre-Construction

- Submit ECLC workbook, drawings, & specs
- Design and Planning Review Meeting with PM
- Pre-Construction Meeting with TA

Construction

- Initial Project Walk-Through and Air Sealing Inspection
- Pre-drywall Inspection
- Final Inspection and Diagnostic Testing

Project Closeout

- Work with TA to submit all documentation
- TA submits documentation to Viridiant
- PM & QAD review
- Certification

Project Eligibility Pre-Construction Construction Project Closeout

Major Renovation Project - Defined

- Partial modifications or complete replacement of mechanical, plumbing, interior partitions and possibly elements of the building envelope.

- Same Requirements and Points Items as NC - may be achieved by using alternative methods depending on project and building condition

Major Renovations

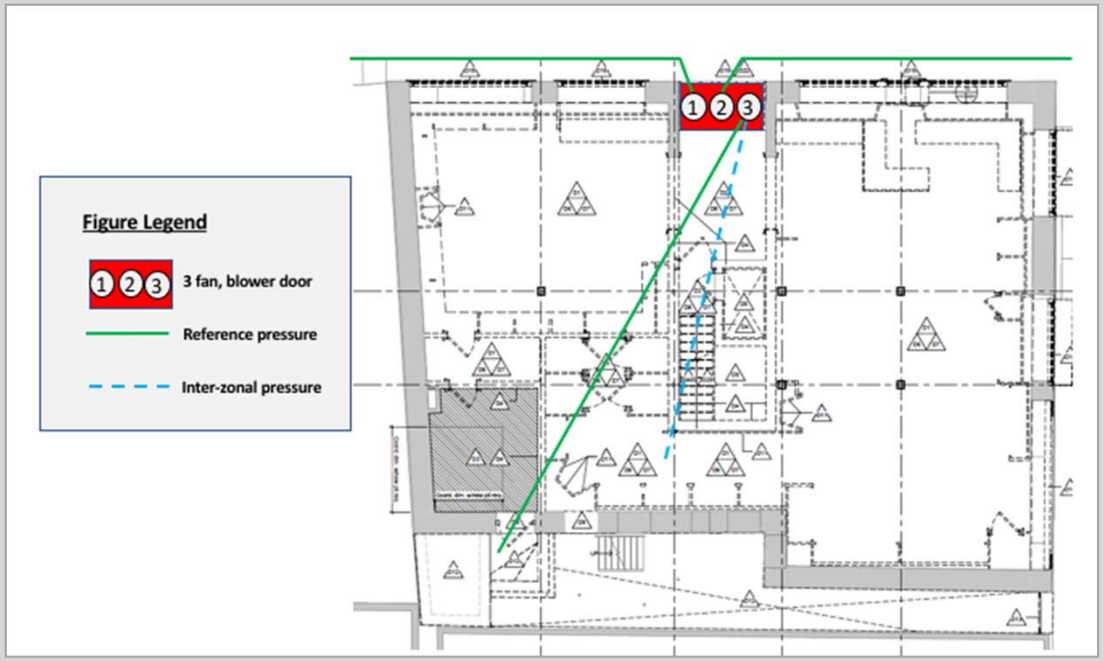
- **Duct System Must be Sealed**

  Seal all seams, joints, collars and connections in forced-air delivery systems using mastic or mastic tape (mastic tape must be UL181-compliant butyl rubber-backed foil tape):

  - Supply and return boots
  - Supply and return plenums
  - Duct-to-plenum connections
  - Y-splits, butt joints and boot connections
  - Outside air intakes
  - Filter housing to plenum/cabinet
  - Air handler condensate, refrigerant line and wire penetrations, and unused holes in the air handling unit cabinet

MAJOR RENOVATIONS Projects are strongly encouraged to implement all criteria on existing duct systems in order to meet IAQ R7: Third Party Test and Balance Report.

Enclosure Testing Planning

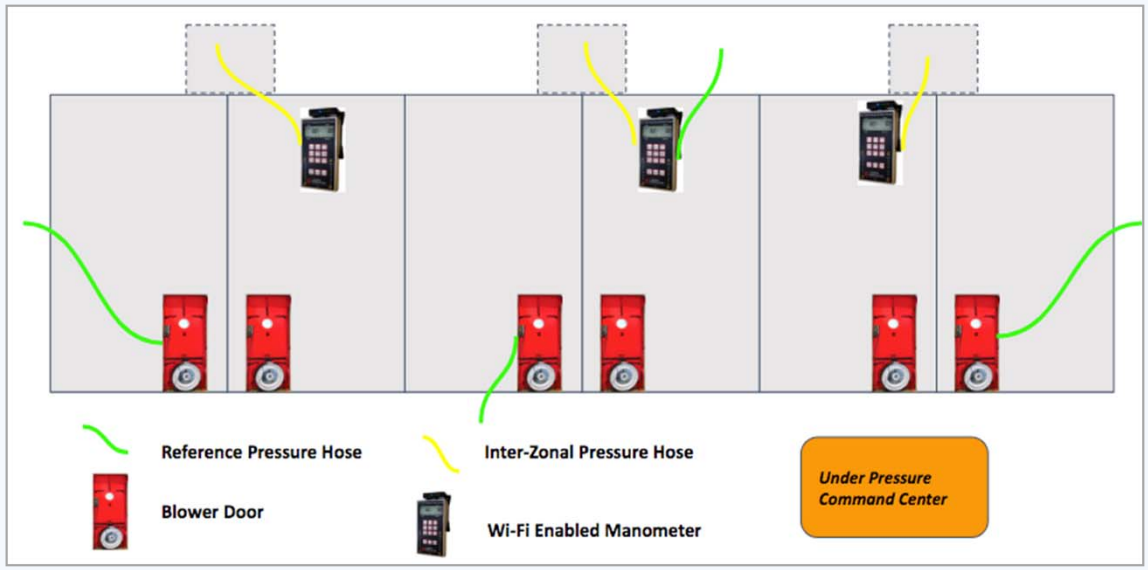


Testing plan for a Commercial Office

Lessons Learned:

- ✓ Someone needs to manage the ventilation system(s)
- ✓ Commercial door assemblies are a pain (e.g., automatic openers and larger openings)
- ✓ Record building conditions before testing
- ✓ Bring extra equipment - (e.g., fans, trash bags, tape)

Enclosure Testing: Have a Plan

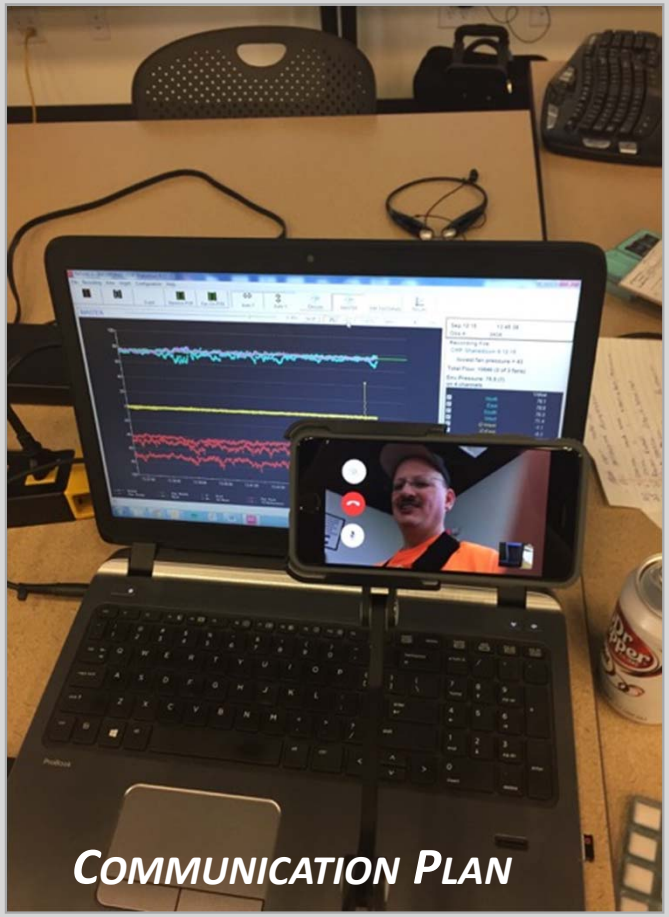


Testing plan for a 6 unit retail center

Lessons Learned:

- ✓ *Have a plan*: pre-test meeting, equipment, team assignments
- ✓ Limit Ingress/Egress for Several Hours
- ✓ 1 fan per circuit
- ✓ Inter-zonal hoses

Commercial Enclosure Testing

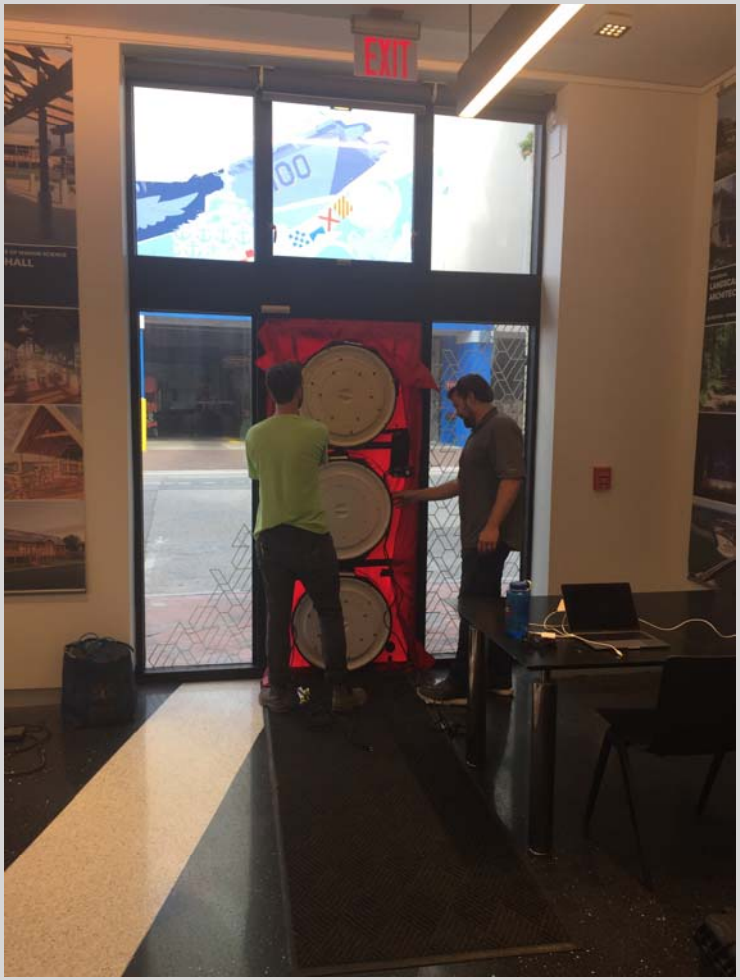


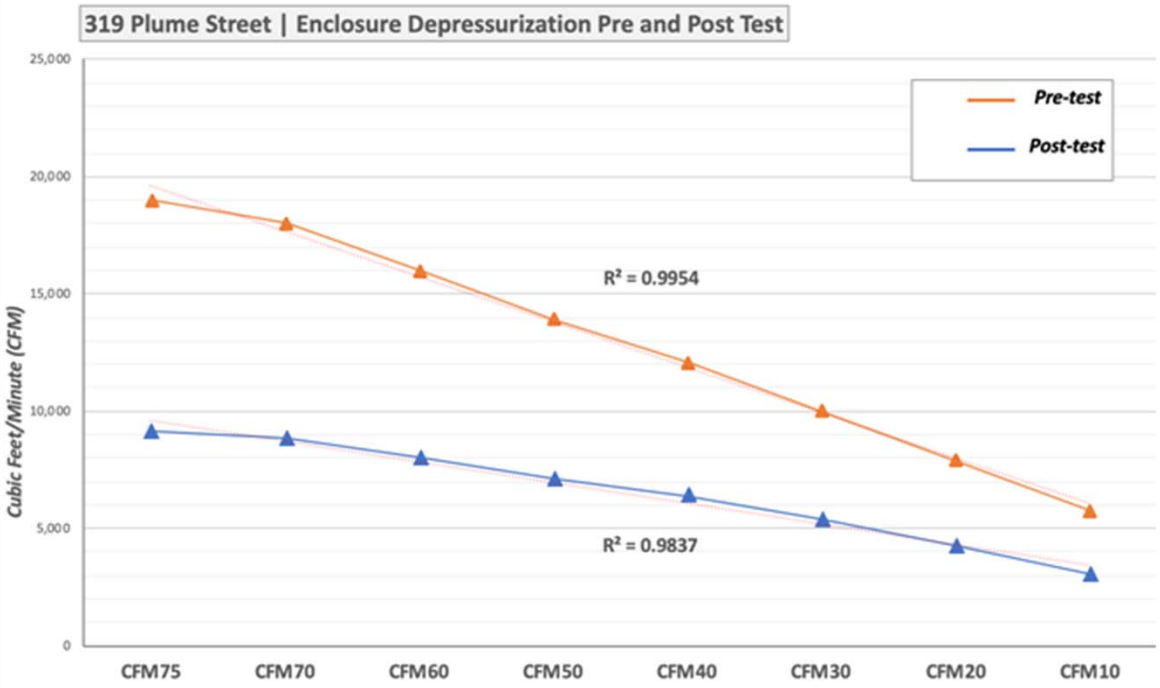
Communication Plan

Multiple Single Fans

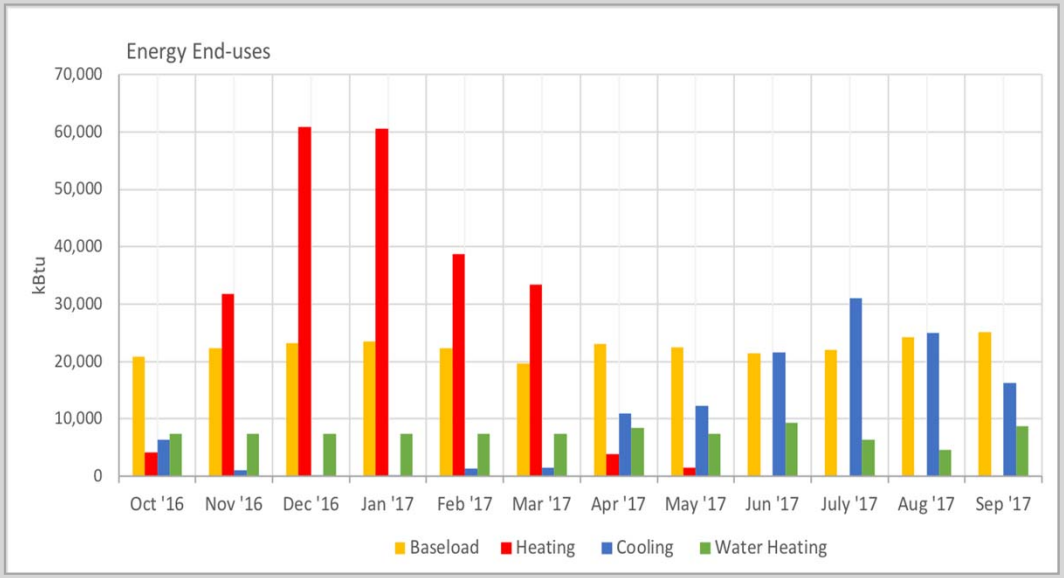
Three Fan

Essex Bvilding: VIA Design Architects





Retrofit Analysis and Investment



What gets measured, gets managed

– Peter Drucker

***Risk** can be managed,*

***uncertainty** cannot be managed*

Table 8. Proposed capital investment EEMs

#	Measure	Quantity	Cost/Unit	Estimated Cost
1.	Encapsulate rooflines with 8" of spray foam (R 30). Install ignition barrier as dictated by fire code	42,000 sq. ft.	$xx	$xxxx
2.	Replace existing heat pump systems with high efficiency heat pump systems; commission systems (test and balance, refrigerant and static pressure tests)	9	$xxx	$xxxx
3.	Water heater replacement: replace 2 atmospherically vented natural gas water heaters with 2 direct vent, high efficiency	2	$xxx	$xxxx
4.	Install 29 kW, net-metered solar PV array	29 kW	$xxx	$xxxx -estimated $4,457/yr in energy savings (approx. 1/3 of annual electricity cost) with 17.89 year payback assuming energy prices stay the same[4].
5.	Replace existing windows with energy star rated vinyl windows	93 windows (approximately 1,827 Ft^2)	$xxx/$Ft^2$	$xxx
6.	Replace existing exterior doors with energy star rated doors	10 exterior doors	$xx/door	$xxxx
			Estimated Capital Investment EEMs Subtotal:	**$xx,xxx**

Greenstone on 5th: Community Housing Partners Case Study

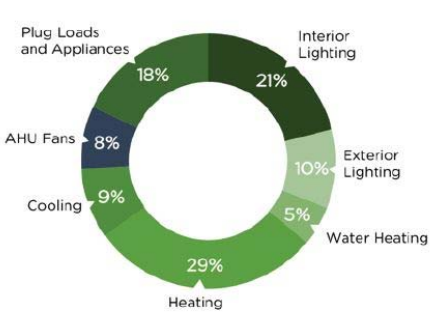
COMMUNITY CENTER:

- ✓ Part of 202 Unit Community, certified under ECLC in 2014
- ✓ After School Programs and Leasing Office
- ✓ 12 KW of Solar PV +/- 20% of Load
- ✓ Heat Pumps, ERV for Fresh Air
- ✓ Performance Data Collected with Circuit-Level Energy Monitors and Temp. Sensors for 1 Yr.

GREENSTONE ON 5TH

FINDINGS

The all-electric Greenstone is currently saving 30% in electricity consumption relative to a code-equivalent building (ASHRAE 90.1-2007), without accounting for the installed rooftop solar photovoltaic (PV) array. Including the rooftop solar PV, Greenstone is saving 80% in electricity consumption relative to a code-equivalent building.



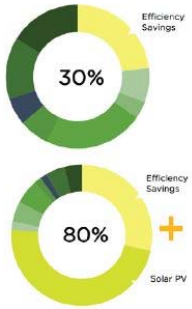


Figure 1 (above). Energy use segemented by end-use and comparisons of efficiency and Solar PV savings added to the energy picture.

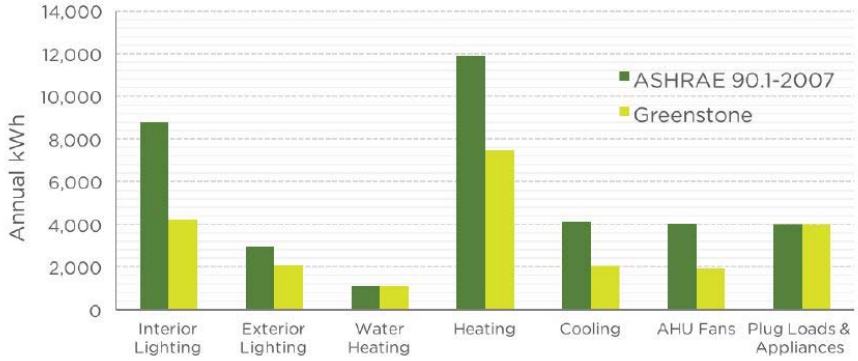


Figure 2 (left). Overall effciency savings are driven by reductions in interior lighting, cooling, air handler fans, heating, & exterior lighting energy use.

MEASURED PERFORMANCE:

- ✓ 30% Better than Comparable Code Built Without Solar
- ✓ 80% Better with Solar Included
- ✓ Monitoring Energy Use Led to Actionable Solutions for Maximizing Performance
- ✓ .19 ELR - .4 = ECLC Current Minimum

MEASURED ENERGY USE IN ECLC BUILDINGS

Essex Bvilding: VIA Design Architects

HISTORIC STRUCTURE:

- ✓ Built in 1910
- ✓ Located in Downtown Norfolk, Light Rail Proximity
- ✓ Sat Vacant for 10 Years
- ✓ Rehabilitated in 2017
- ✓ Test In and Test Out

https://www.viadesignarchitects.com/essex-bvilding.html

Essex Bvilding

VIA Design Architects

Site Planning

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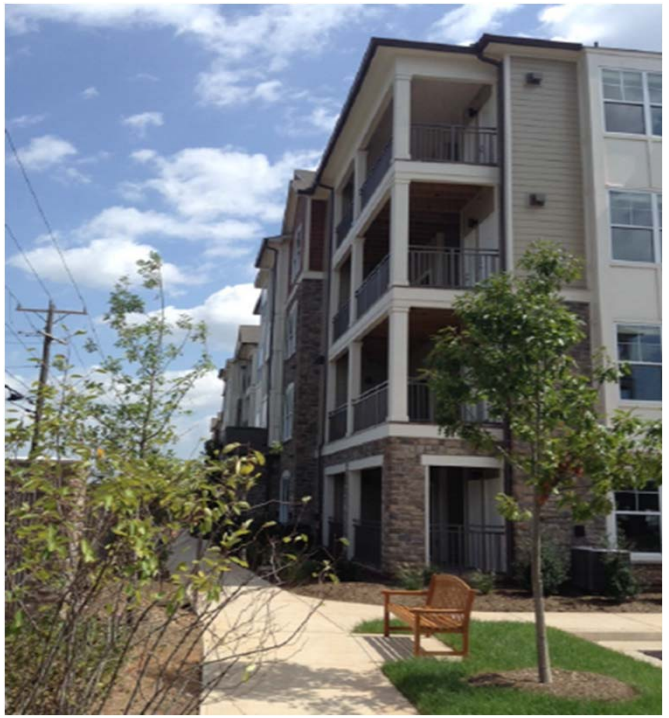
Site Planning Overview

- Improve resident's quality of life & environment
  - Create more walkable, livable communities
  - Improve overall neighborhood air quality
  - Manage storm water drainage
  - Increase property values
  - Prevent water pollution
  - Preserving native vegetation
- Must attend a workshop on erosion and sediment control
- Site assessment identifying all greenspace features
- Erosion & sedimentation control
- Do not install invasive plant species



Erosion control – Run-off Prevention

GOOD vs BAD

Construction Waste Management

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Waste Management

- No construction materials may be burned or buried
- Recycle common wastes such as cardboard, metal, beverage containers, and plastics *(Points item)*
- Donate salvageable material *(Points Item)*
  - *Ex. Habitat Re-Store*

Waste Management

Posted waste management plan

- Wood
- Metal
- Plastics
- Cardboard
- Drywall
- Shingles

Resource Efficient Design

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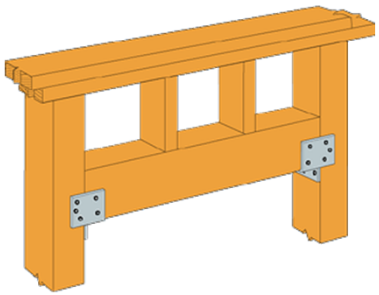
Resource Efficiency Overview

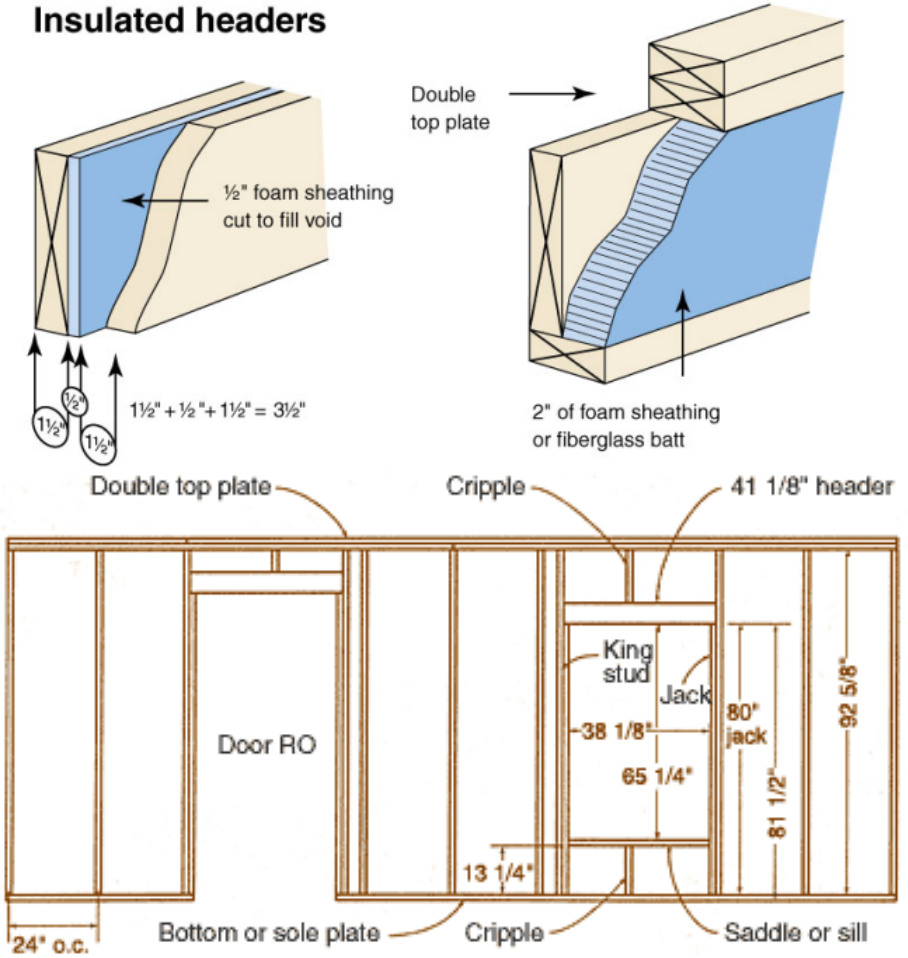
- Design & construction techniques, such as advanced framing
- Manufactured wall panels
- Local, recycled, & natural content products

"4.38 lbs. per square foot is the average waste produced by a SF new construction home"
- NAHB (1992-1997)

Advanced framing can reduce lumber by 15-30 %

- Floor joist spacing
- Wall stud spacing
- No window jack studs
- Non-structural header
- Permitted in Seismic
- Category D2 (must meet bracing requirements)





What Not To Do

Durability & Moisture Management

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Durability & Moisture Management Overview

- EarthCraft projects meet durability & moisture management requirements to ensure they are built soundly to last for generations
- The EarthCraft family of programs were designed to address the climate conditions of the Southeast
  - Homes with good air sealing need to further prepare against moisture intrusion

Perm Ratings of Materials

- Drywall.....30-50
- Housewrap.....5-50
- Semi-gloss latex enamel.....6.6
- Primed & Painted Drywall.....2-3
- Interior plywood.....1.9
- 15 pound asphalt felt.....1-4
- Insulated foam sheathing.....0.4-1.2
- Exterior plywood/OSB.....0.7
- Vapor retarder paint.....0.6-0.9
- Asphalt coated kraft paper.....0.4
- Polyethylene.....0.06

Durability (DU) - Required

- Flashing at wall/roof intersection integrated with wall and roof drainage planes
- Flashing at deck/wall or porch/wall intersection integrated with drainage planes
- 2” clearance between wall siding and roof surface (or per manufacturer recommendation)

Durability (DU) - Required

- Kick-out flashing on roofs sloped along adjoining walls
- Roof valley directs water away from walls, dormers, chimneys, etc.
- Double layer of housewrap behind cementations stucco, stone veneer or synthetic stone veneer on framed walls

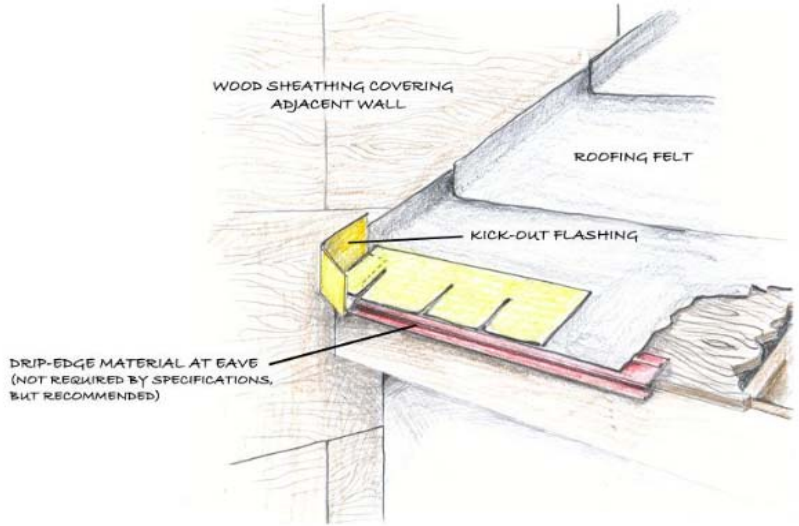

Figure 16: Step 1: Kick-out flashing beginning run of step flashing (Graphic courtesy of US EPA Indoor airPLUS)

Durability (DU) - Required

- Drain tile proximity to footing
- Drainage board for below grade walls
- Vapor Barrier
  - Slabs: above gravel
  - Crawl space: 100%
- Capillary Break
  - Between footing and foundation
  - Slab on grade requires 57 stone with no fines

Indoor Air Quality

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Source Control

- Low VOC Paints, Stains, Finishes, Adhesives
- No added Urea-formaldehyde (UF)
- Ducts Protected during construction

High Performance Building Envelope

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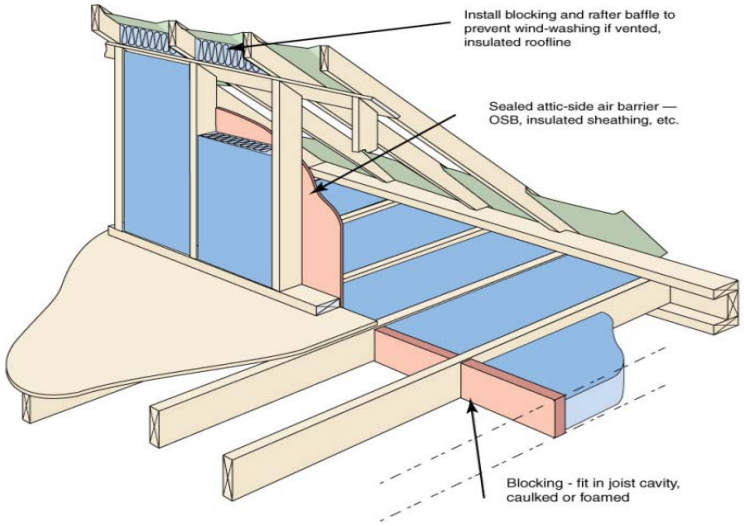
Control Layers - Foundations

Slab On Grade

Source: [illegible]

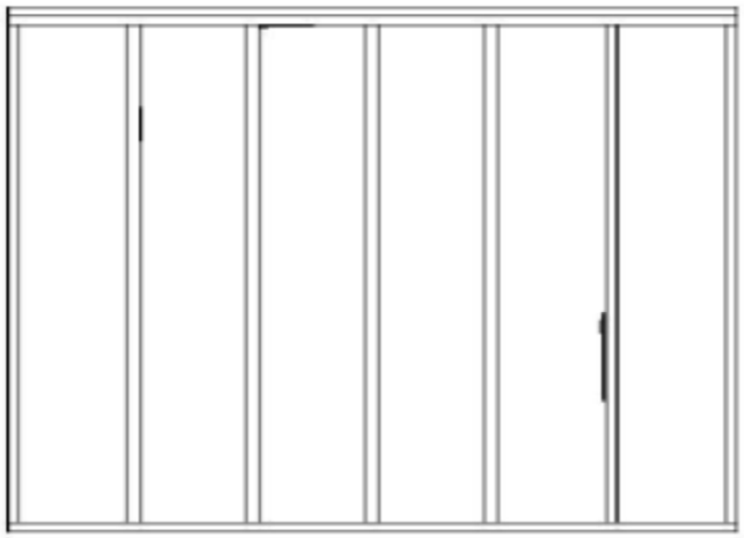
Insulating Attic Kneewalls

- Attic kneewall stud cavities R-19 & sheathed with an **rigid air barrier**
  - OR Attic kneewall with insulated sheathing R-3 or R-5
- Attic kneewalls doors R-19

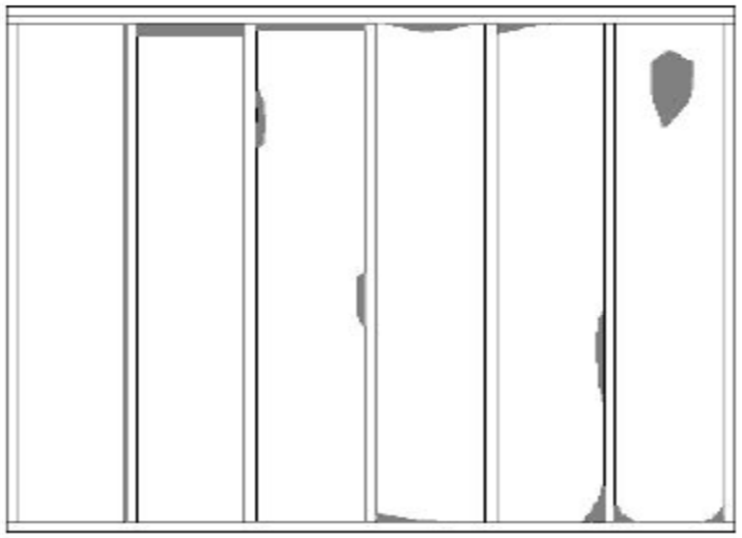


Grade I

- Occasional very small gaps
- Less than 2% compression/incomplete fill



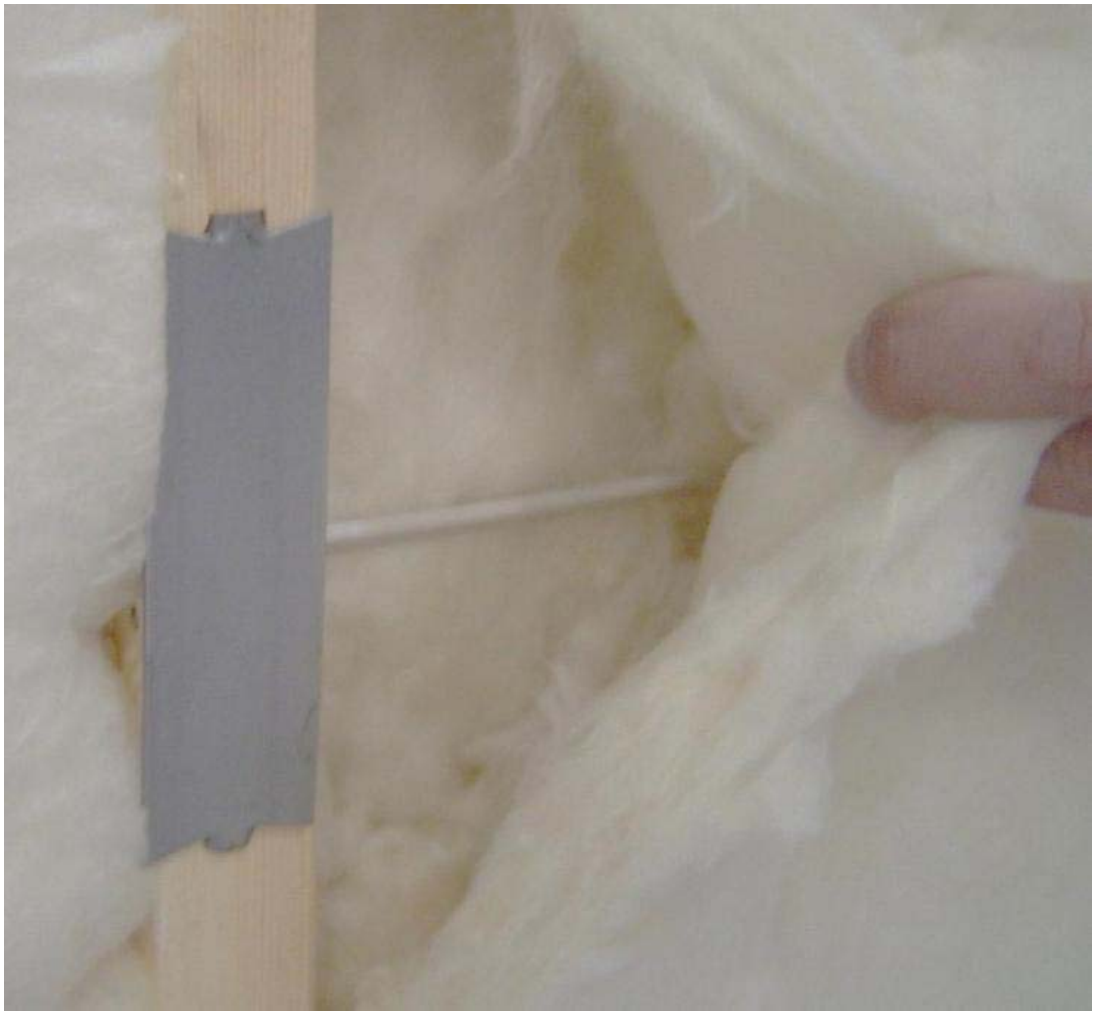
Gaps



Compression

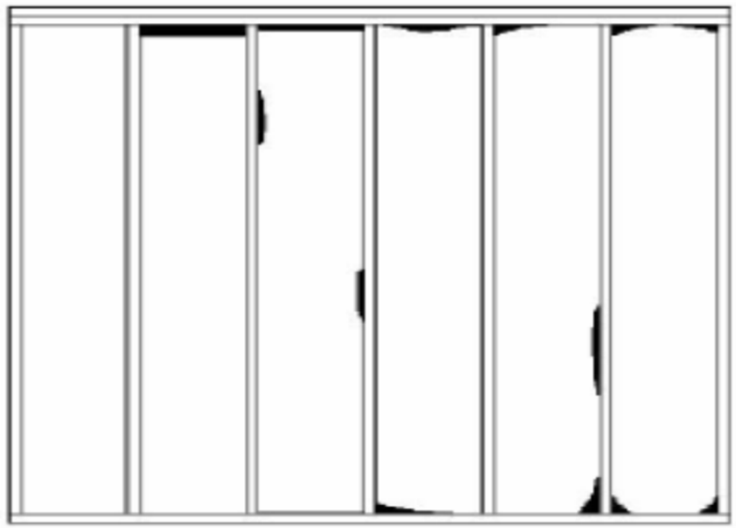
Grade I

Grade I

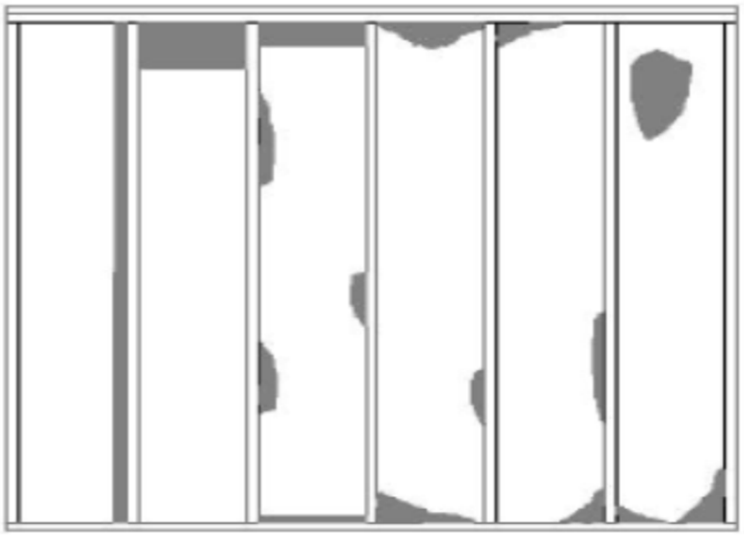


Grade II

- <2% gaps
- <10% compression/incomplete fill



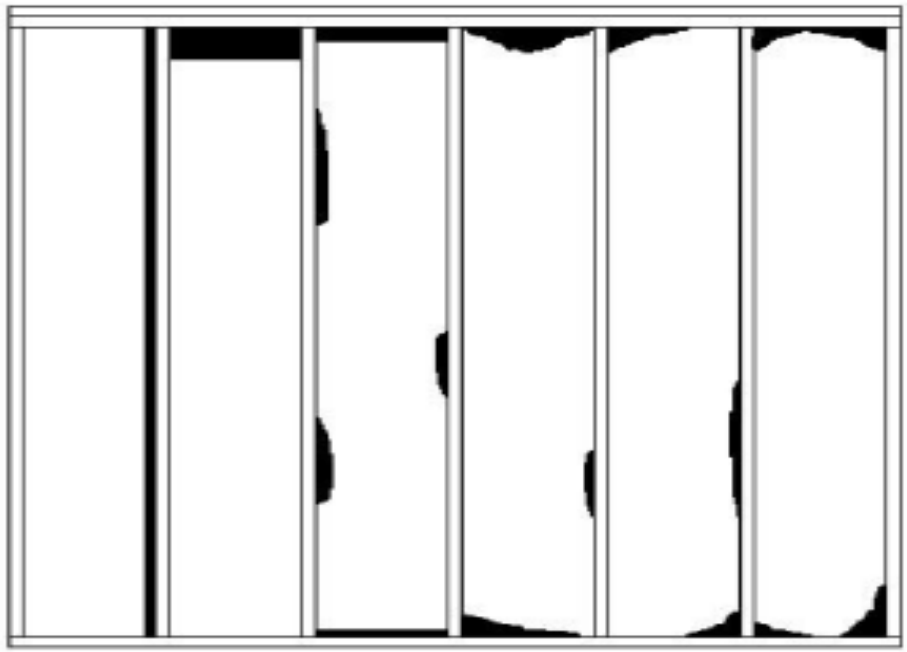
Gaps



Compression

Grade III (not allowed for EarthCraft)

- < 5% gaps
- (greater than 5% = downgraded R-value)



Gaps

Energy Efficient Systems

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Heating and Cooling Minimum Efficiencies (ECMF)

≥ 14 SEER(11 EER)

≥ 8.2 HSPF

- OR -

≥ 90% AFUE

HVAC Design Guidelines

- Size and Select in accordance with ACCA Manual J and S
- Manual J based on actual orientation and location
- Outdoor design temperature 99% design temperatures
- ACHnat selected at 0.35 or “tight” for New Construction, “semi-tight” for renovation
- Indoor: 75^0 cooling; 70^0 heating
- Must use actual window, insulation, and door spec.
- Number of occupants (number of bedrooms plus one)
- Mechanical ventilation
- Room x Room loads
- Realistic internal loads *(1200-2400 Btu sensible)*

Variable Speed and ECM's

Longer Run Times and Variable Capacity

Duct Testing - Thresholds

MF Duct Testing:

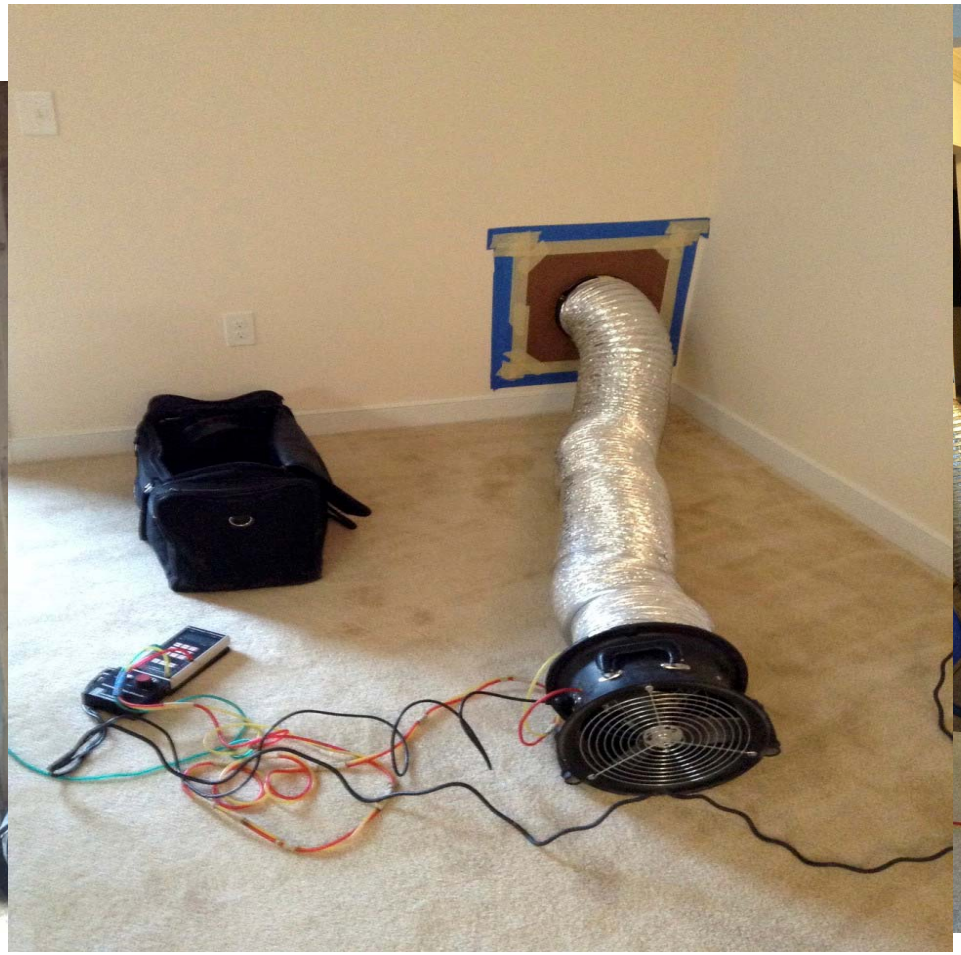
- Leakage to outside ≤ 4%
- Total leakage ≤ 6%

MF RENOVATION DUCT TESTING WILL BE DEPENDENT UPON CERTIFICATION LEVEL & EXISTING CONDITIONS

SF Duct Testing:

- Leakage to outside ≤ 3%
- Total leakage ≤ 6%

Duct Testing



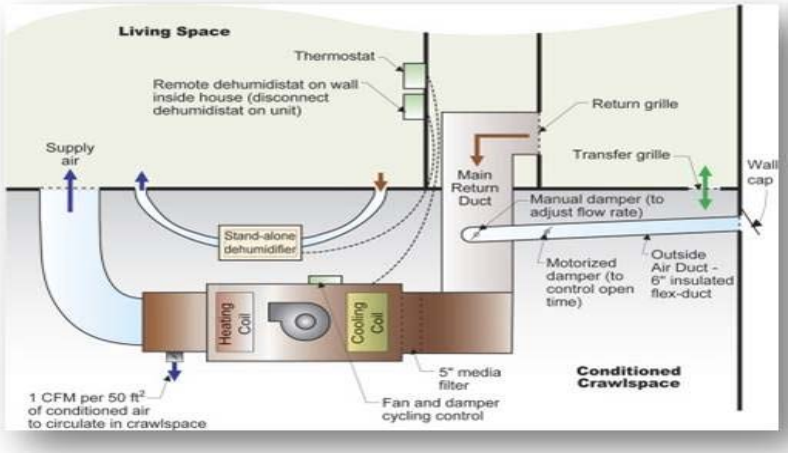
Fresh Air Ventilation Requirement

EarthCraft Requires Fresh Air Ventilation on All Projects

- ASHRAE 62.2 – 2010 for Flow Rate
- Intakes Must Be Ducted to Exterior of Building
- Intakes Must Be At Least 10’ Away from Exhaust Outlets, Vehicle Idling Zones, and May Not be Pulled From Roof
- Intakes Must Be 2’ Above Grade
- All Ventilation Ductwork Must be Insulated and Sealed with Mastic or Mastic Tape

Fresh Air Ventilation

- Design for positive pressure or balanced
- Don’t suck on buildings in our climate zone (negative pressure/exhaust systems)
- Tenant vs. owner paid in Multifamily



Water Heating Minimum Efficiency

Single Family & Multifamily:

Tank Size	Gas EF	Electric EF	Gas UEF	Electric UEF
20 - 55 gal	0.65	0.95	0.61	0.92
55 - 100 gal	0.75	1.97	0.76	2.03
< 2 gal	0.82	0.93	0.81	0.91

Water Efficiency

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Water Efficiency Overview

"Each American uses an average of 100 gallons of water a day at home. We can all use 30% less water by installing water-efficient fixtures & appliances."

– WaterSense

EarthCraft aims to reduce water consumption & water waste by making water efficiency improvements indoors & outdoors

WATER EFFICIENCY (WE)		
WE 1: INDOOR WATER USE		
REQUIRED AT ALL LEVELS		
WE 1.0	Meet National Energy Policy Act low flow standards for all fixtures	
WE 1.1	Detect no leaks at any water-using fixture, appliance or equipment	
WE 1.2	Low-flow fixtures (units and common facilities):	
	1.	WaterSense labeled toilet (≤1.28 avg. gal/flush)
	2.	WaterSense labeled urinal (≤0.5 gal/flush)
	3.	WaterSense lavatory faucet and accessories (≤1.5 gpm at 60 psi)
	4.	WaterSense labeled Showerhead (≤2.0 gpm)

Education & Operations

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Educations & Operations Overview

- Provide project specific manual for owners/tenants and operations/maintenance
  - Worksheet
  - Exhaust fans
  - Mechanicals
  - Sustainable activities
  - Recycling info

Innovation

Going above & beyond

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Innovation Opportunities

- On-site fuel cell system
- Solar/hydro/wind electric system
- Solar-ready design
- Storm water recapture
- Solar common areas
- Housing affordability
  ≥ 20% or 50% of total units
- Post-construction energy monitoring
- Recycled or reclaimed materials
- Modular construction
- Paperless drywall
- Combustion safety
- Passive Solar Design
- Composting & rainwater harvest
- Project specific points

Fundamentals of Building Science

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Definitions

Building Science: the analysis of the physical phenomena affecting buildings. The movement of Heat, Air, and Moisture and how the movement of those elements affect buildings and their components.

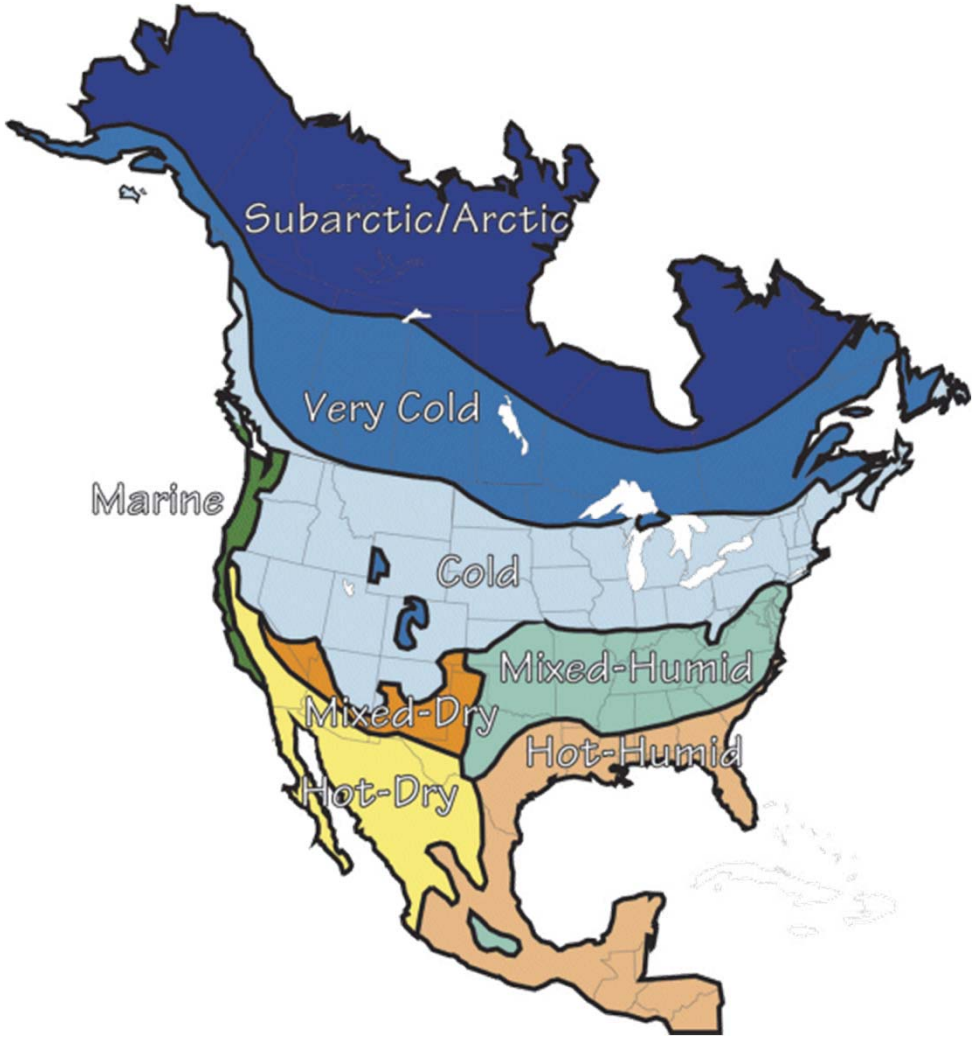
Enclosure: part of any building that physically separates the exterior environment from the interior environment(s); (BSC, 2006)

Infiltration: the flow of outdoor air into a building through cracks and other unintentional openings and through the normal use of exterior doors for entrance and egress; (ASHRAE, 2009)

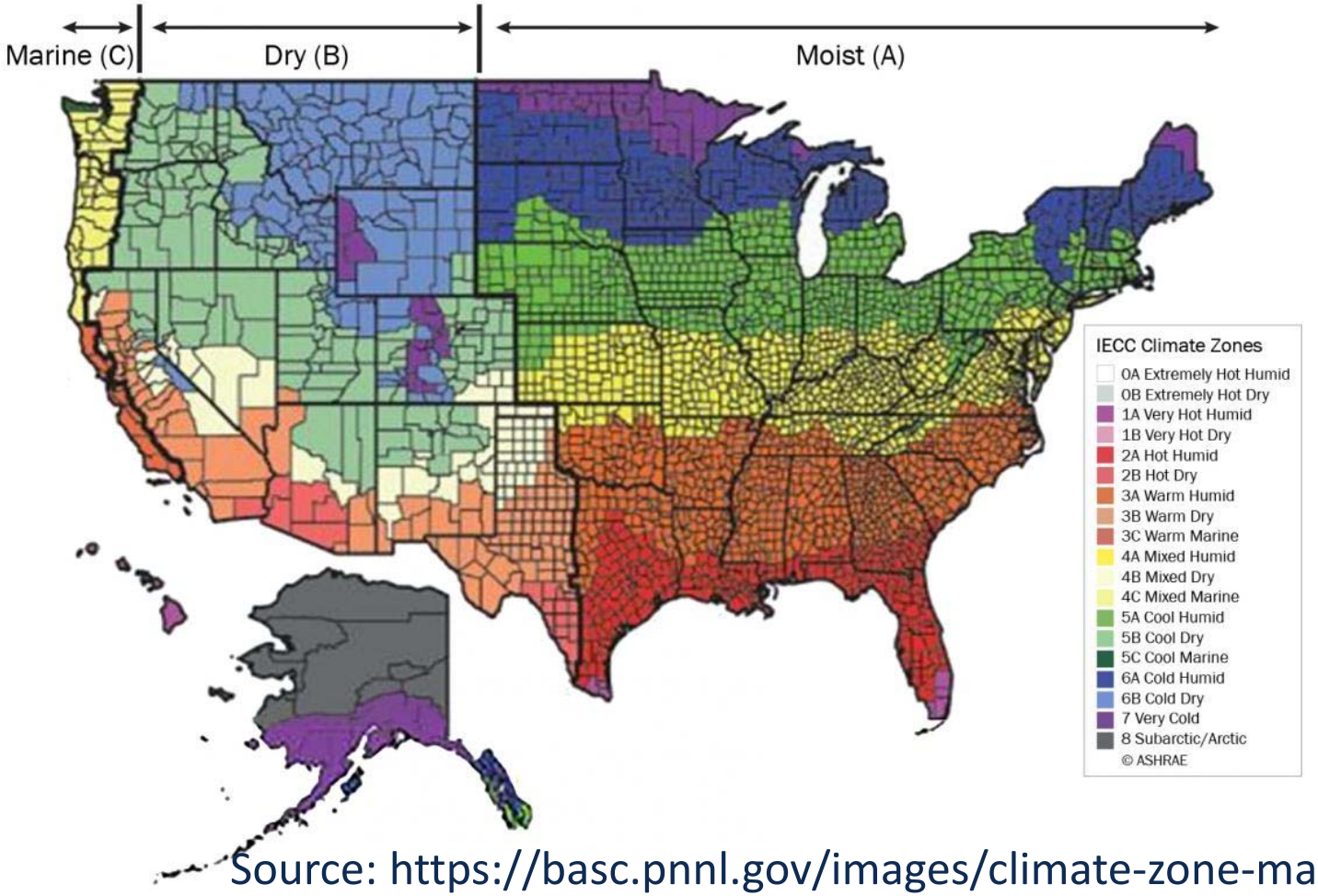
Exfiltration: is leakage of indoor air out of a building through through cracks and other unintentional openings; (ASHRAE, 2009)

Air barrier: a plane that one intends to be the sole, or at least the primary , resistor to airflow; (Straube and Burnett, 2005)

Building & Geography



Virginia – A Complicated Climate



Source: https://basc.pnnl.gov/images/climate-zone-map-iecc-2021

Climate of the Southeast – 30 Year Climate Data

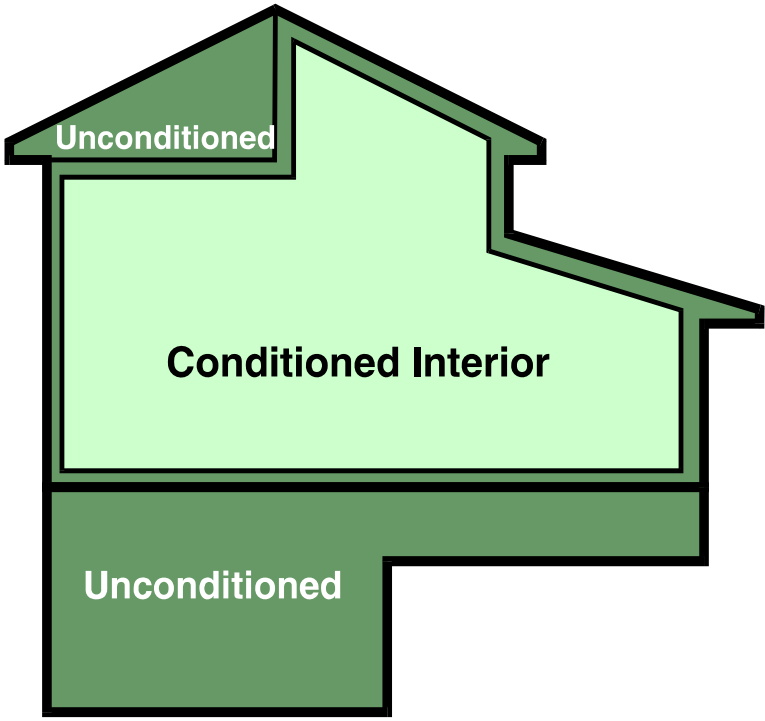
Location	Avg. Annual Relative Humidity (Morn/Aftrn)	Highest Monthly Avg. Relative Humidity (Morn/Aftrn)	Avg. Monthly Temp (Low/High)	Dewpoint
Atlanta, GA	81/55	Aug: 81/55	Aug: 70 / 88.1	64 / 70
Raleigh, NC	83/53	Sep: 90/57	Sept: 61.7 / 82	59 / 65
Richmond, VA	81/53	Sep: 88/56	Sept: 60/81	56 / 64
Washington, DC	80/53	Sep: 81/55	Sept: 62.3 / 79.5	56 / 62

*Relative humidity is expressed as a percentage measure of the amount of moisture in the air compared to the maximum amount of moisture the air can hold at the same temperature and pressure

Sourc: https://www.ncei.noaa.gov/pub/data/ccd-data/relhum18.dat

The House Should Be Viewed as a System

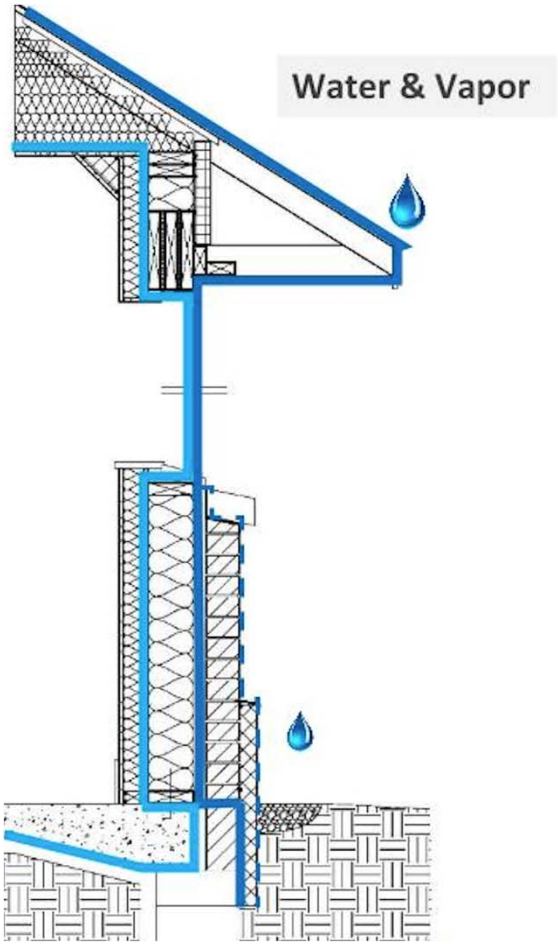
- Building Enclosure
  - Continuous Air Barrier
  - Complete Insulation Coverage
- Moisture Management

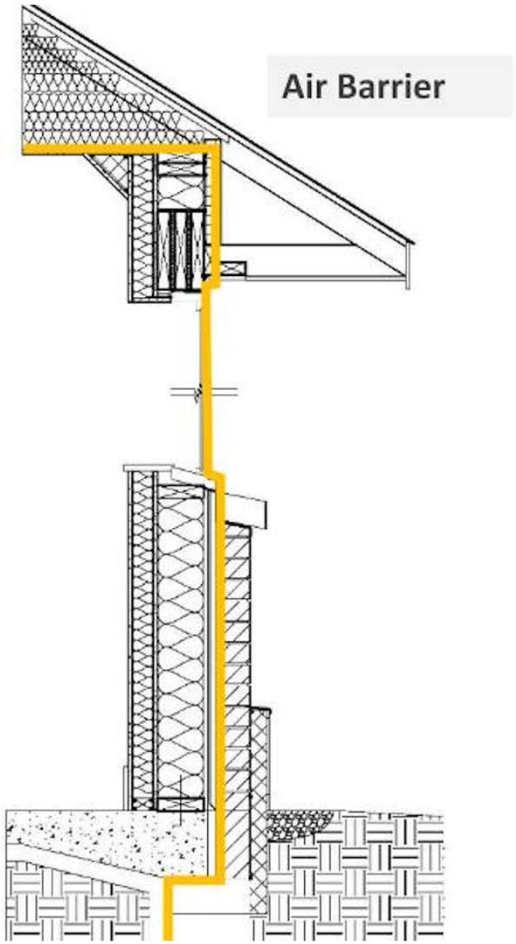


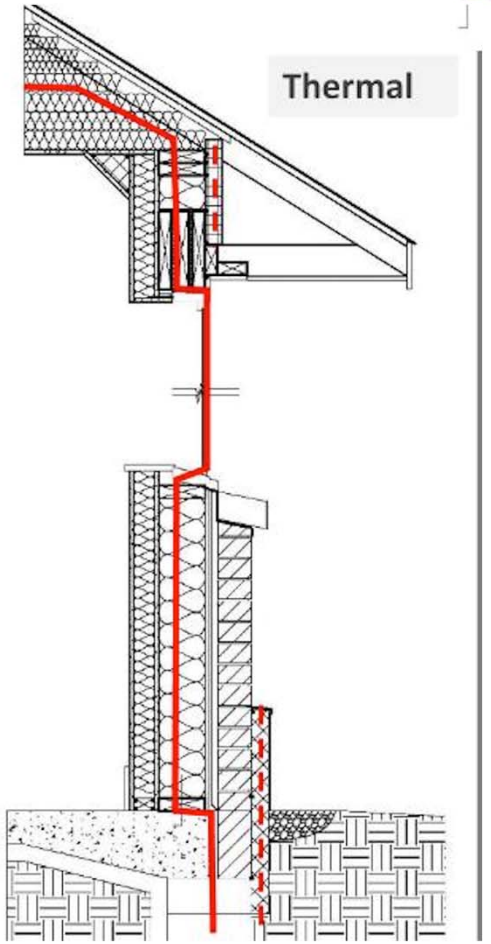
The movement of:

- Heat
- Air
- Moisture

Control Layers Line Test



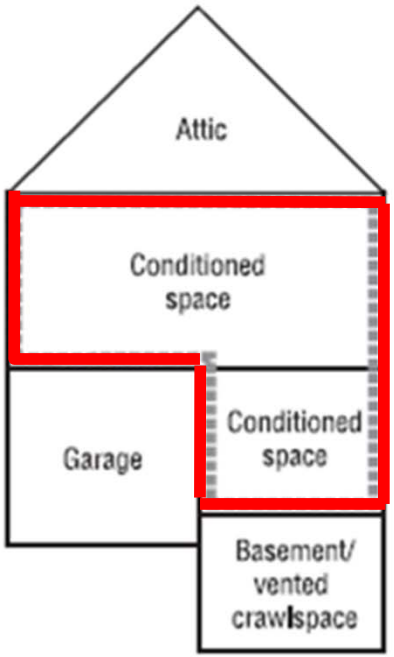




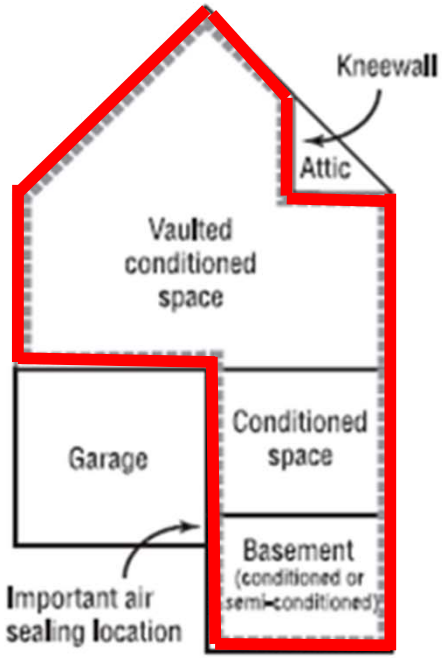
www.epa.gov/iaq/moisture/

Defining Building Thermal Envelope

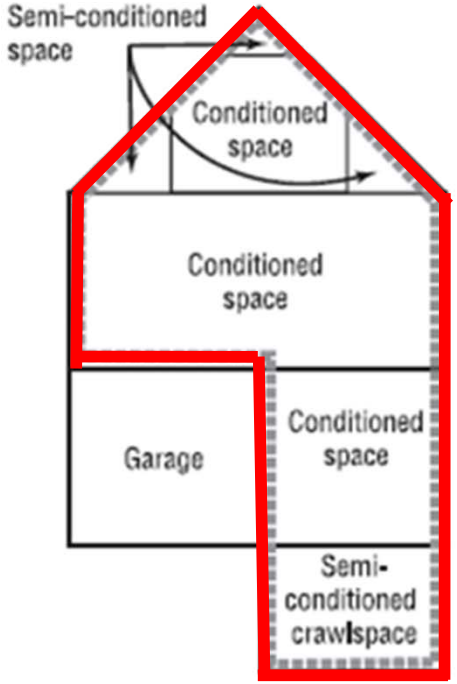
Example 1



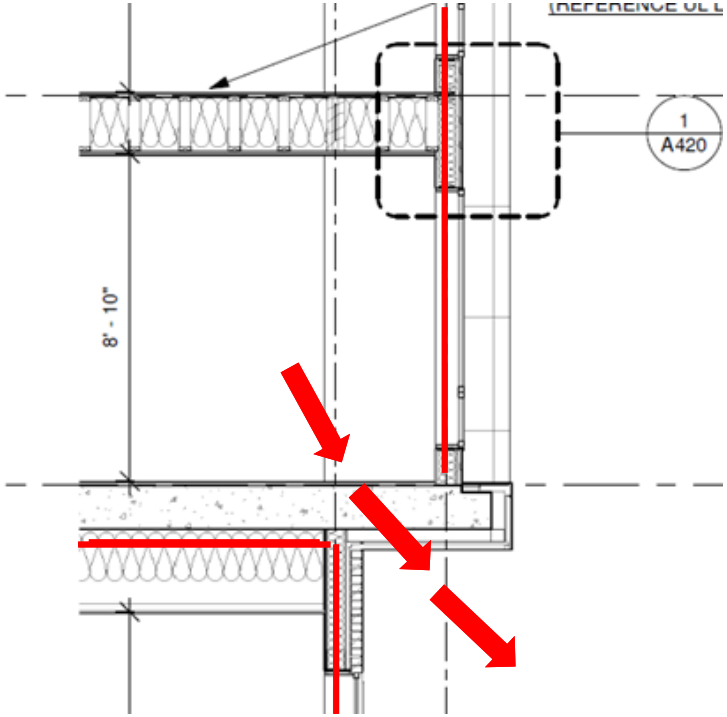
Example 2

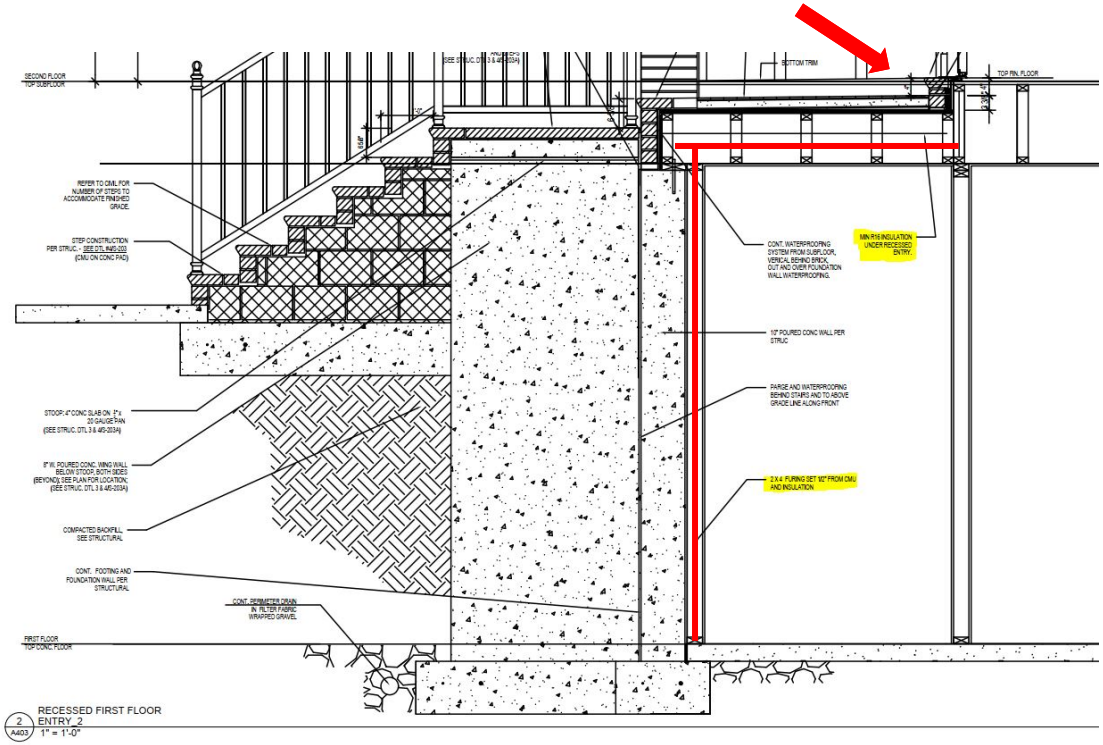


Example 3



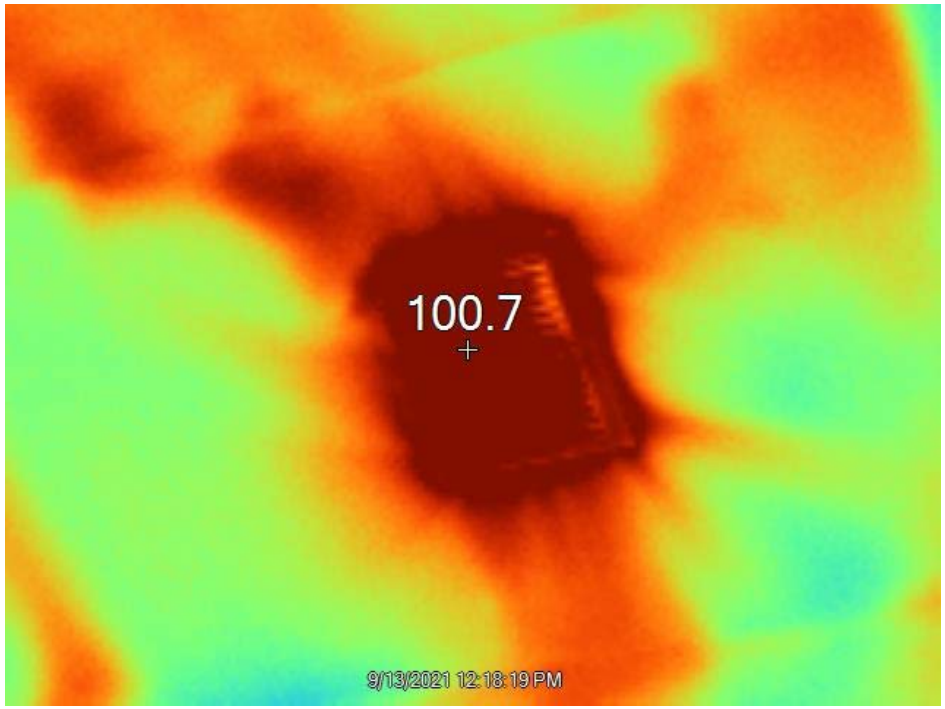
Recent Examples of Line Test

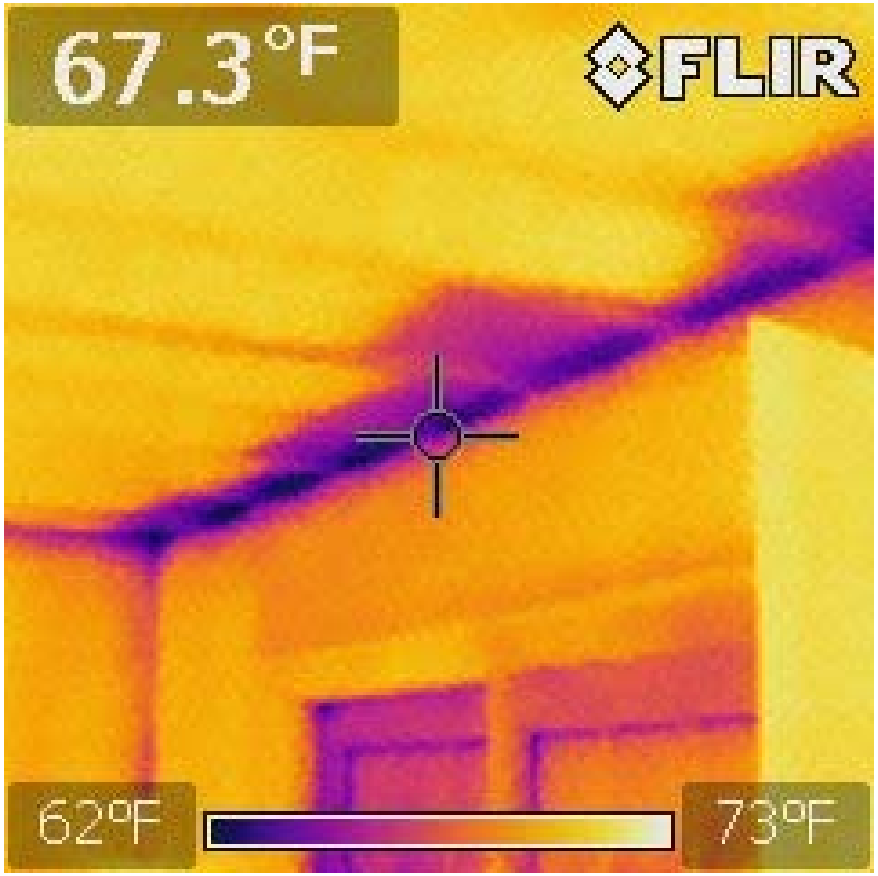




Thermal Control

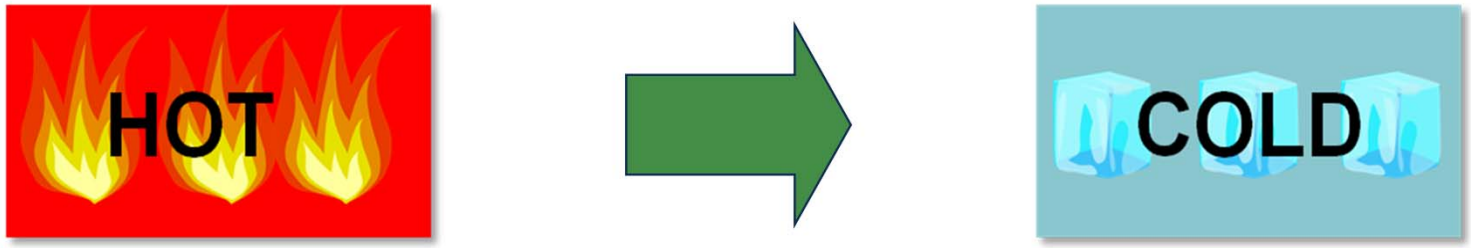
viridiant


100.7
9/13/2021 12:18:19 PM

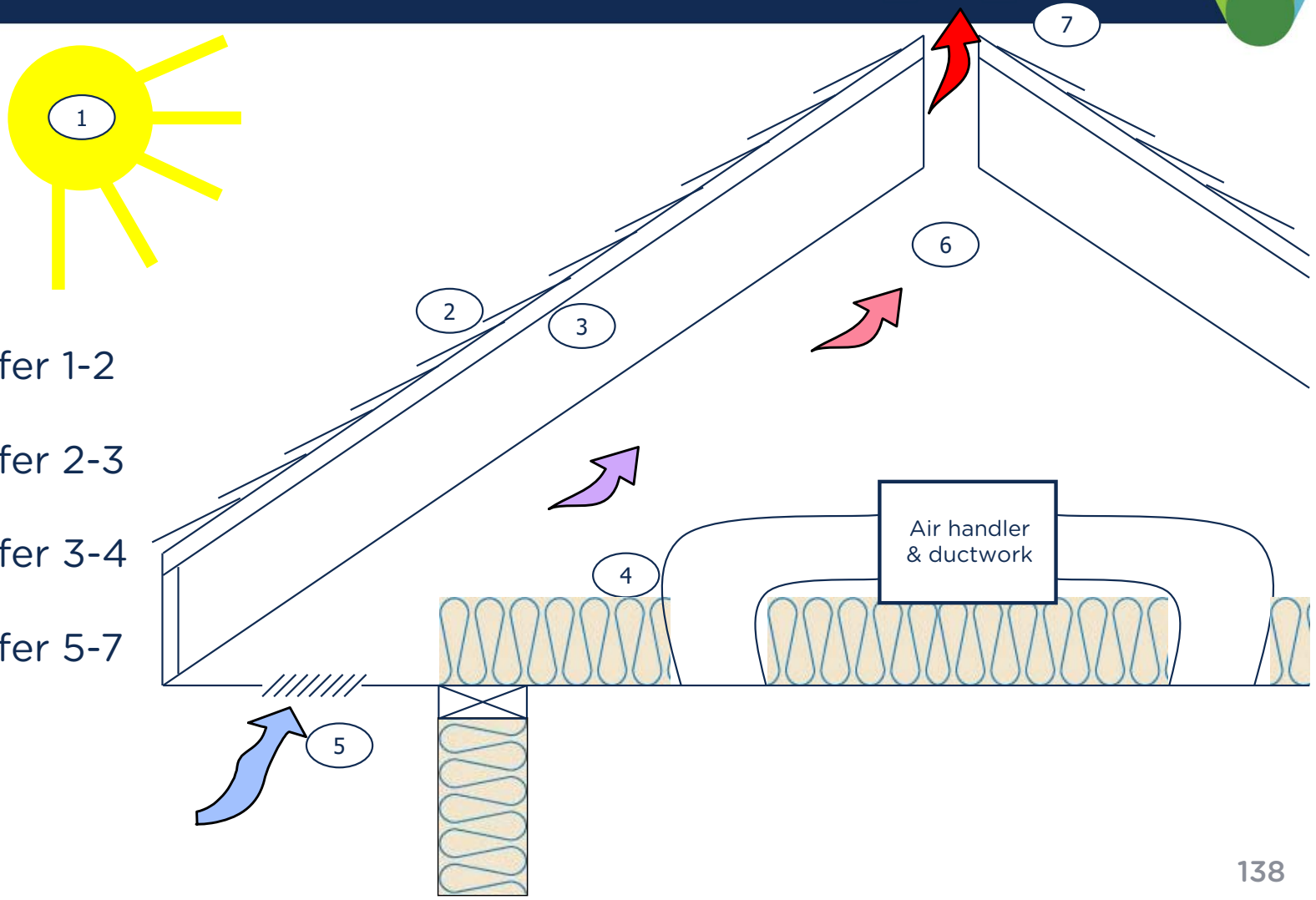

67.3°F
FLIR
62°F
73°F

Heat Flow

- Conduction is heat flowing through a *solid* material
- Convection is the transfer of heat by the movement of gases or liquids *(air)*
- Radiation is the movement of heat energy through space from a hot *surface* to a cold *surface*, and requires no transfer medium (air, water, etc.)



Heat Transfer in Practice - Exercise



Radiation heat transfer 1-2

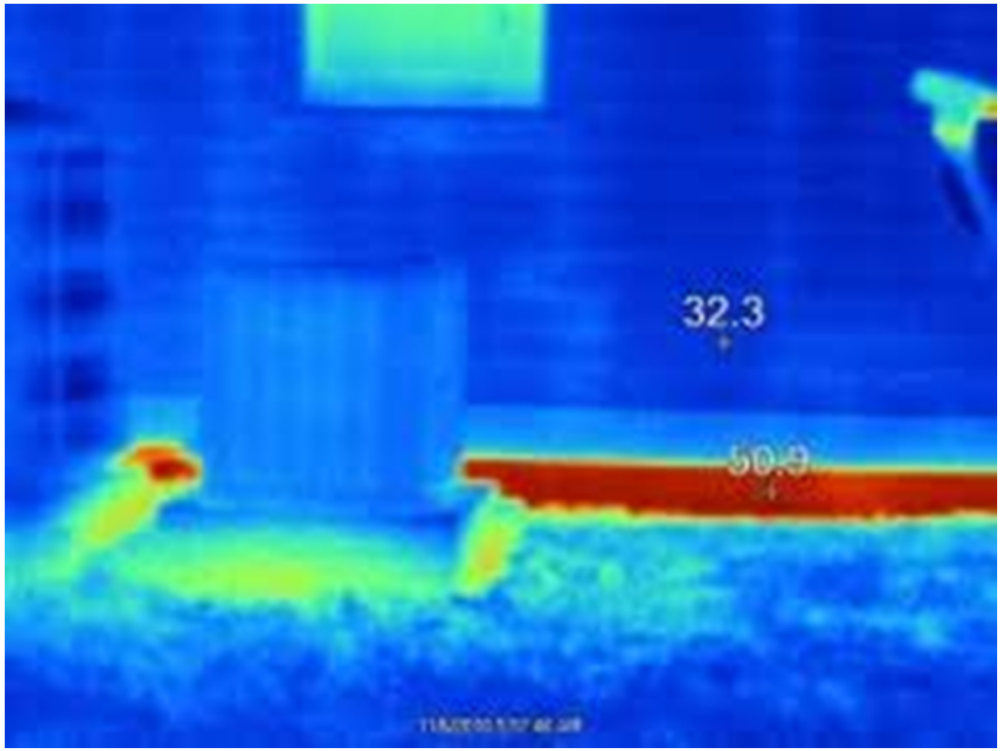
Conduction heat transfer 2-3

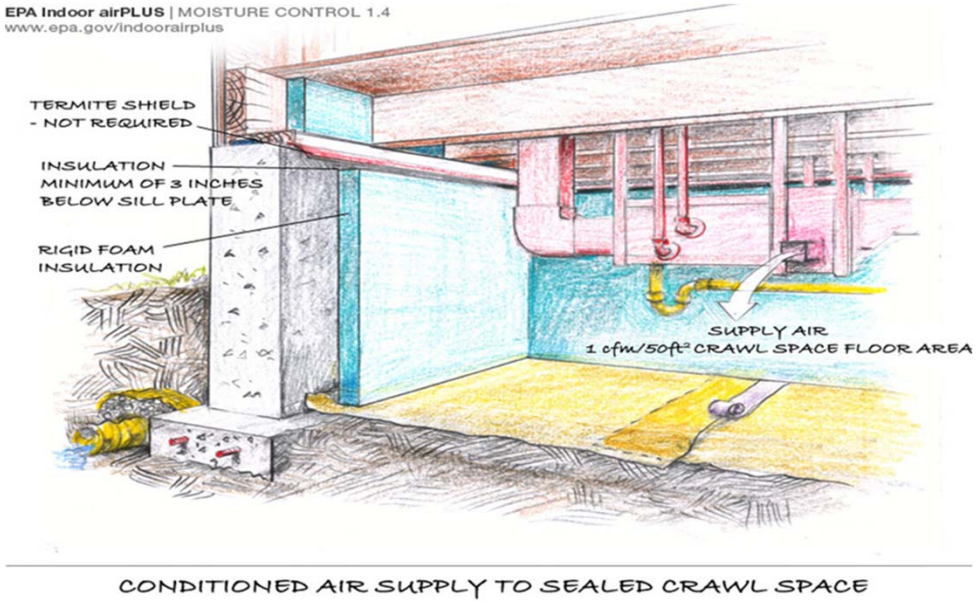
Radiation heat transfer 3-4

Convection heat transfer 5-7

Control Layers - Foundations

Foundations





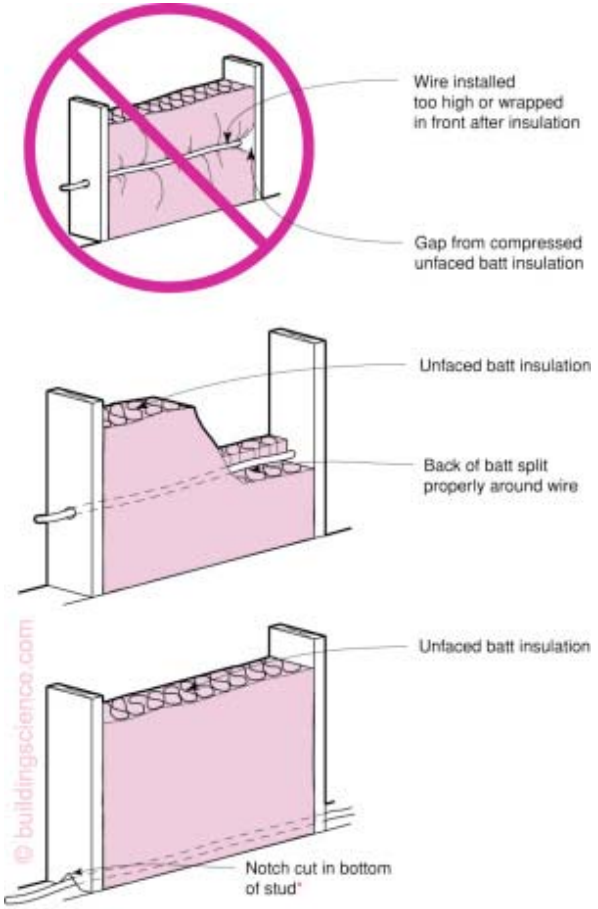
CONDITIONED AIR SUPPLY TO SEALED CRAWL SPACE

Thermal Control Layer – Wall Assembly

- Cavity Insulation

Thermal Control Layer – Wall Assembly

- Cavity Insulation



Alternate Wiring with Batt Insulation Detail

Thermal Control Layer – Wall Assembly

- Cavity Insulation

Retrofit Wall Insulation

Advanced Framing

Can cut lumber needs by 15-30 %

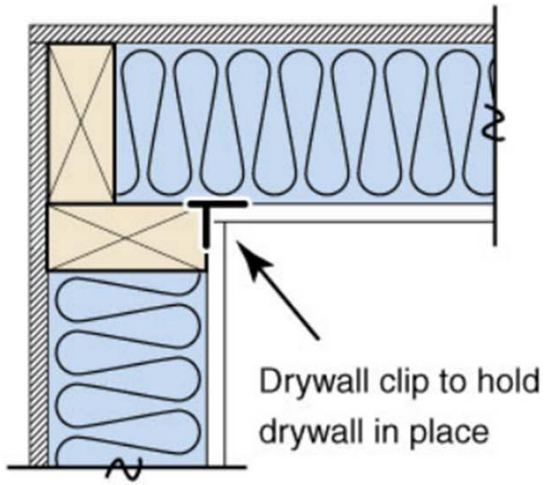


Figure 3: 2-stud corner

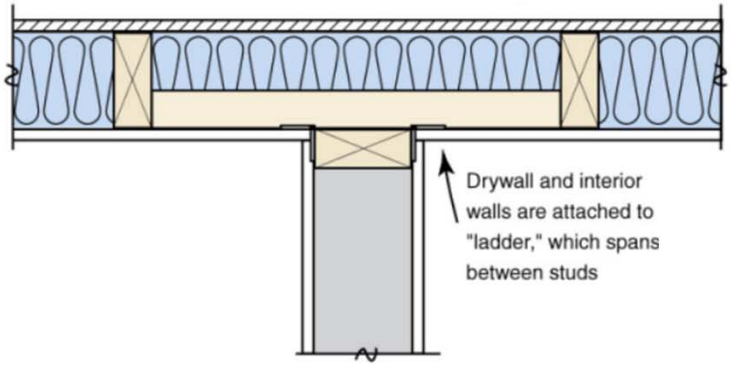


Figure 4: Ladder T-wall

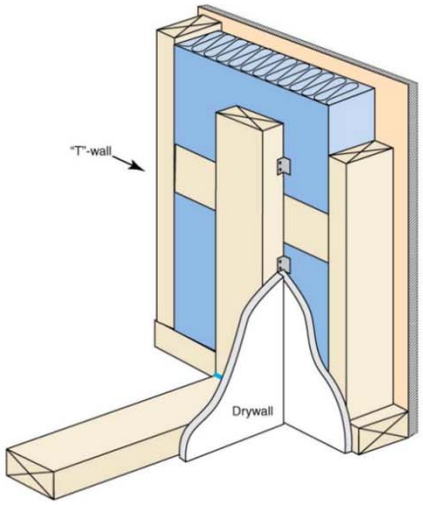
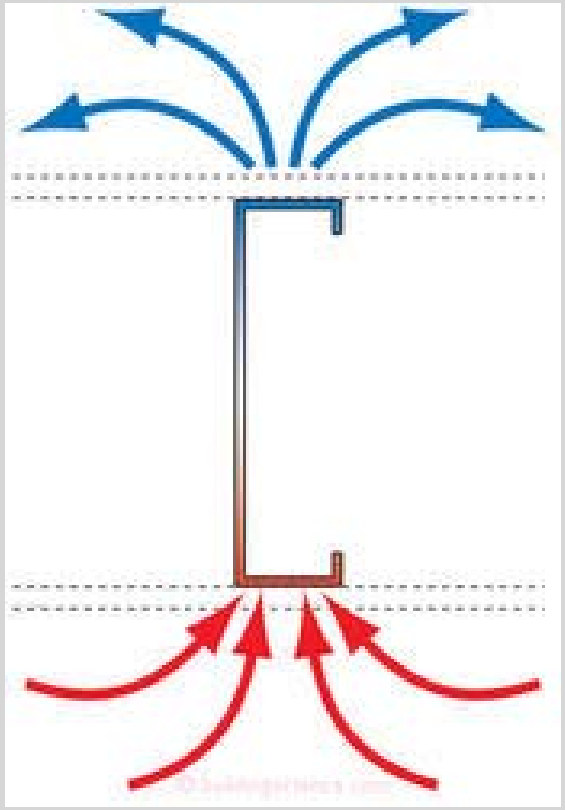


Figure 5: Ladder T-wall

Good Example of Ladder T Framing

Steel Performance



THERMAL BRIDGING SHOWN IN ENERGY MODELING

Control Layers – Wall Assembly

- Continuous Insulation and Integrated Sheathing Products

Thermal Control Layer – Attic/Roof Assembly

- Thermal Control

Thermal Control Layer – Attic/Roof Assembly

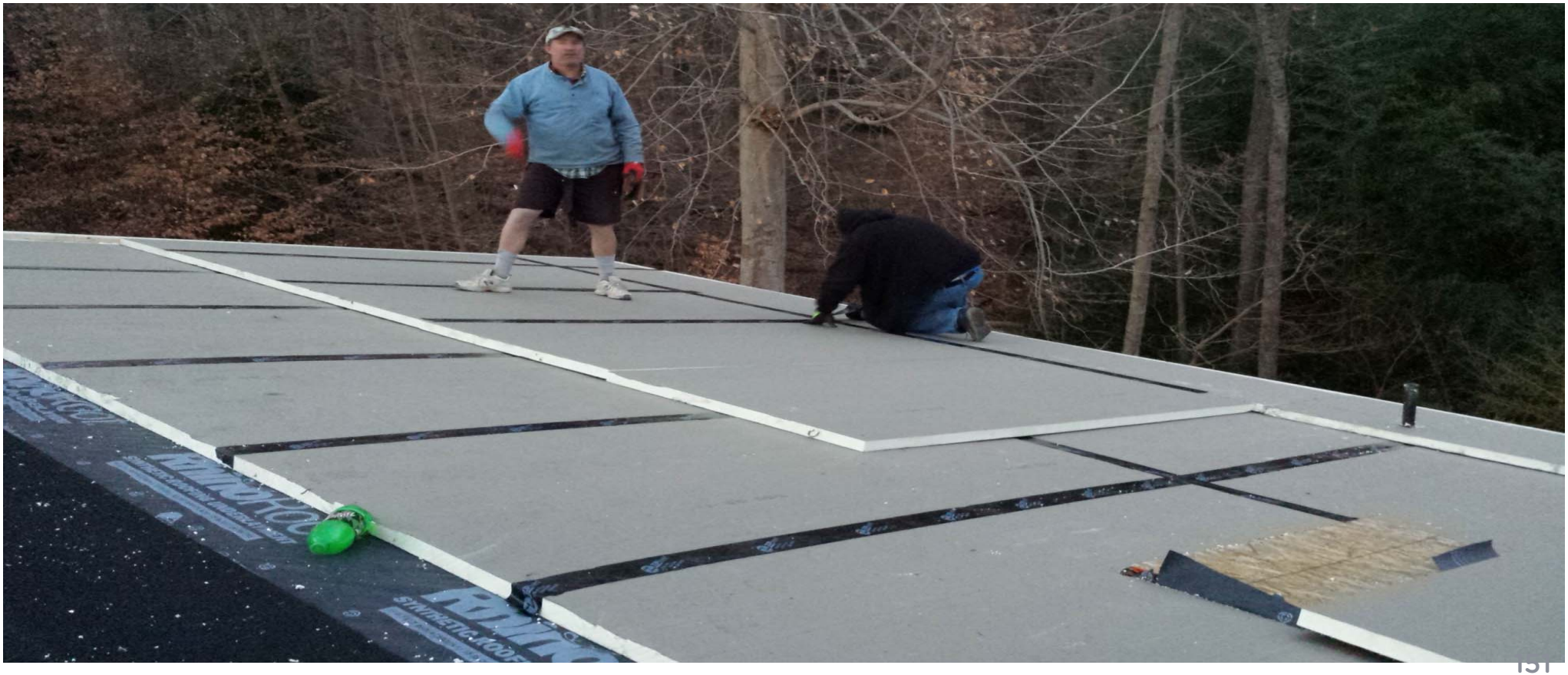
- Closed Cell Spray Foam of Roof Line

Thermal Control Layer – Attic/Roof Assembly

- Closed Cell Spray Foam of Roof Line

Control Layers – Roof Assembly

- Exterior



Control Layers – Roof Assembly

- Exterior

Complete Coverage is Essential

- R-38 installed with 5% gaps and un-insulated areas yields the same heat loss as R-27 with full coverage - a 30% reduction!

- Put differently - 950 sq. ft. Attic with 50 sq. ft. of R-4 and 900 sq. ft. of R-38 = **R-26.5 Weighted UA**