



Nebraska's Residential Energy Code: The 2018 IECC *Advanced Building Efficiency Technologies*

Nebraska Energy Code Training Program
Instructor: Matt Belcher
August 16th, 2022: 9:30 am – 11:00 am CST



Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded
 - Slides and recording will be sent to attendees and added to the MEEA website
- CEUs are provided (ICC and AIA)
- Email canderson@mwalliance.org with questions





Today's Agenda

- Advanced Insulation/Building Envelope
- Phase Change Materials
- Systemic Approach to Building
- Advanced Fenestration
- Advanced HVAC Equipment
- Smart Homes
- Electric Vehicles
- Grid-integrated Efficient Buildings (GEB)

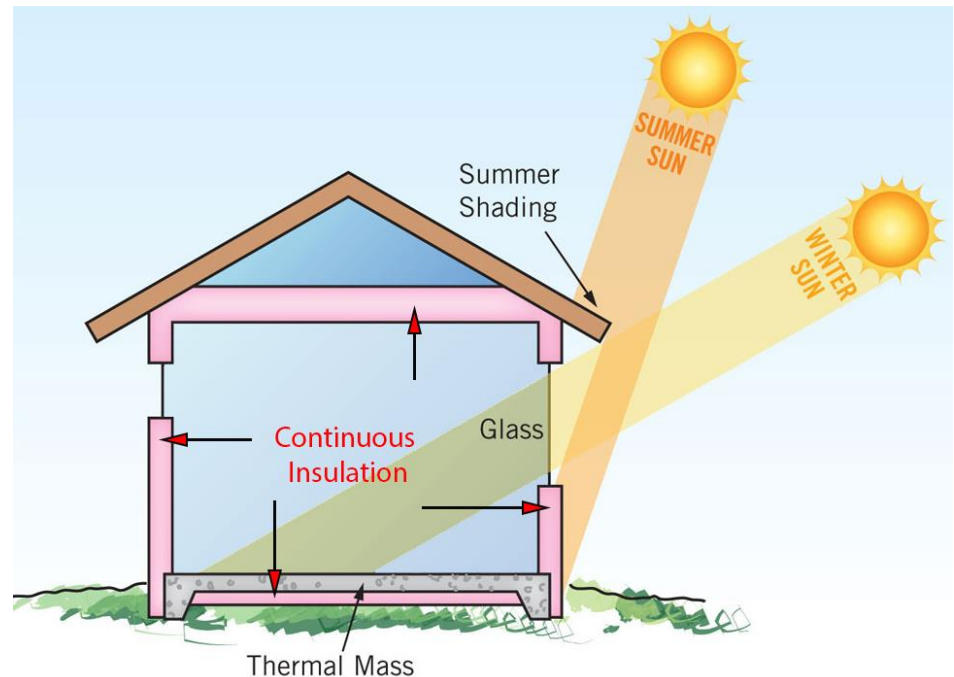
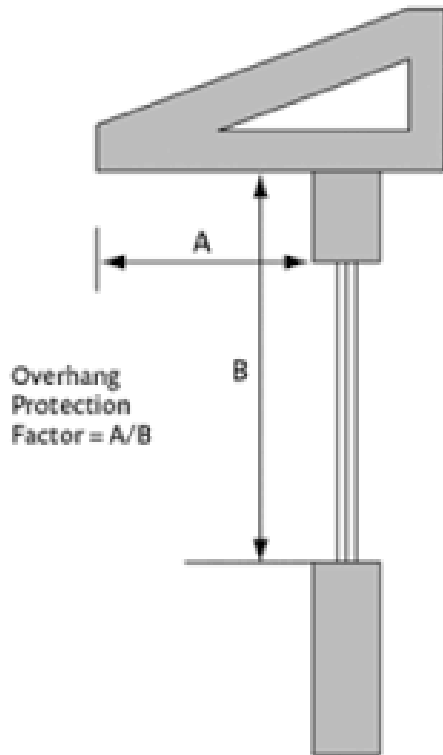


Advanced Building Envelope Components



Building Envelope

- Sometimes you **can** get a free lunch! FREE ENERGY starts with good, thoughtful design!



Building Envelope

Overhangs
Provide Shade
and Protection!



Image: Verdatek Solutions

Advanced Framing

- Everything lines up!
- 2x6 framing @ 24" centers
- **Fewer studs = more insulation = better efficiency**

Corner Framing Stud Configurations

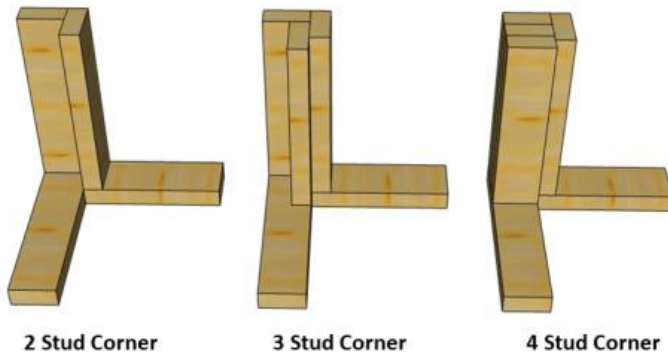
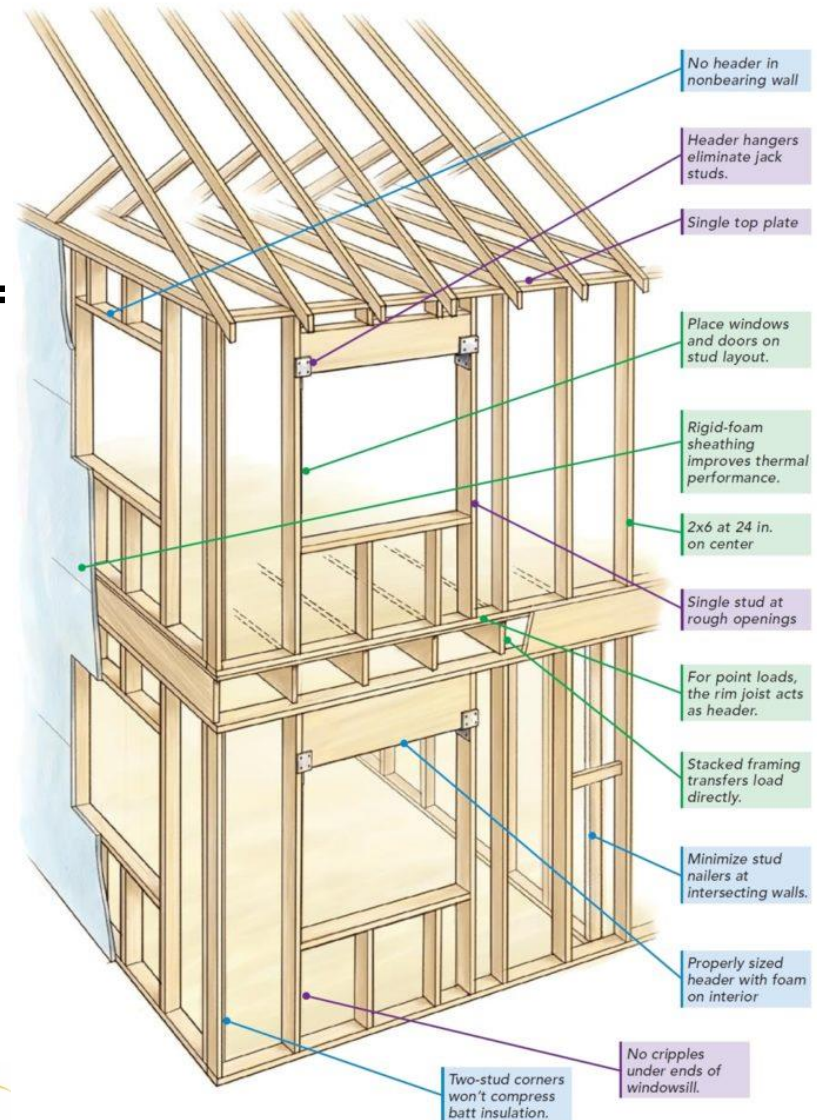


Image: greenbuildingadvosor.com; builderscalculator.com



Continuous Insulation - Typical Framing

- Typical wall with continuous insulation on the exterior
- Be sure to **seal all seams** in continuous insulation
- Stud cavity can accommodate various types of insulation

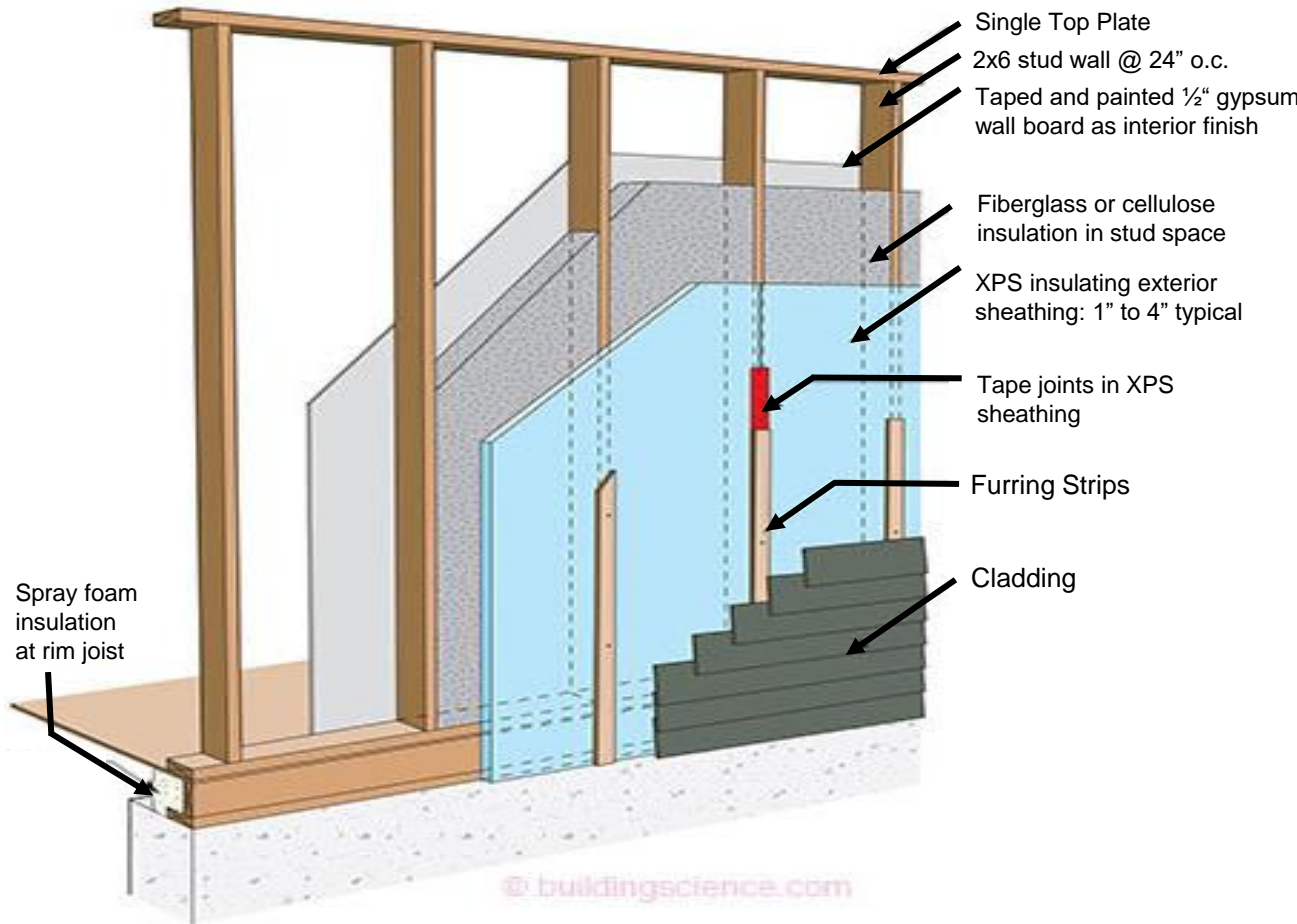
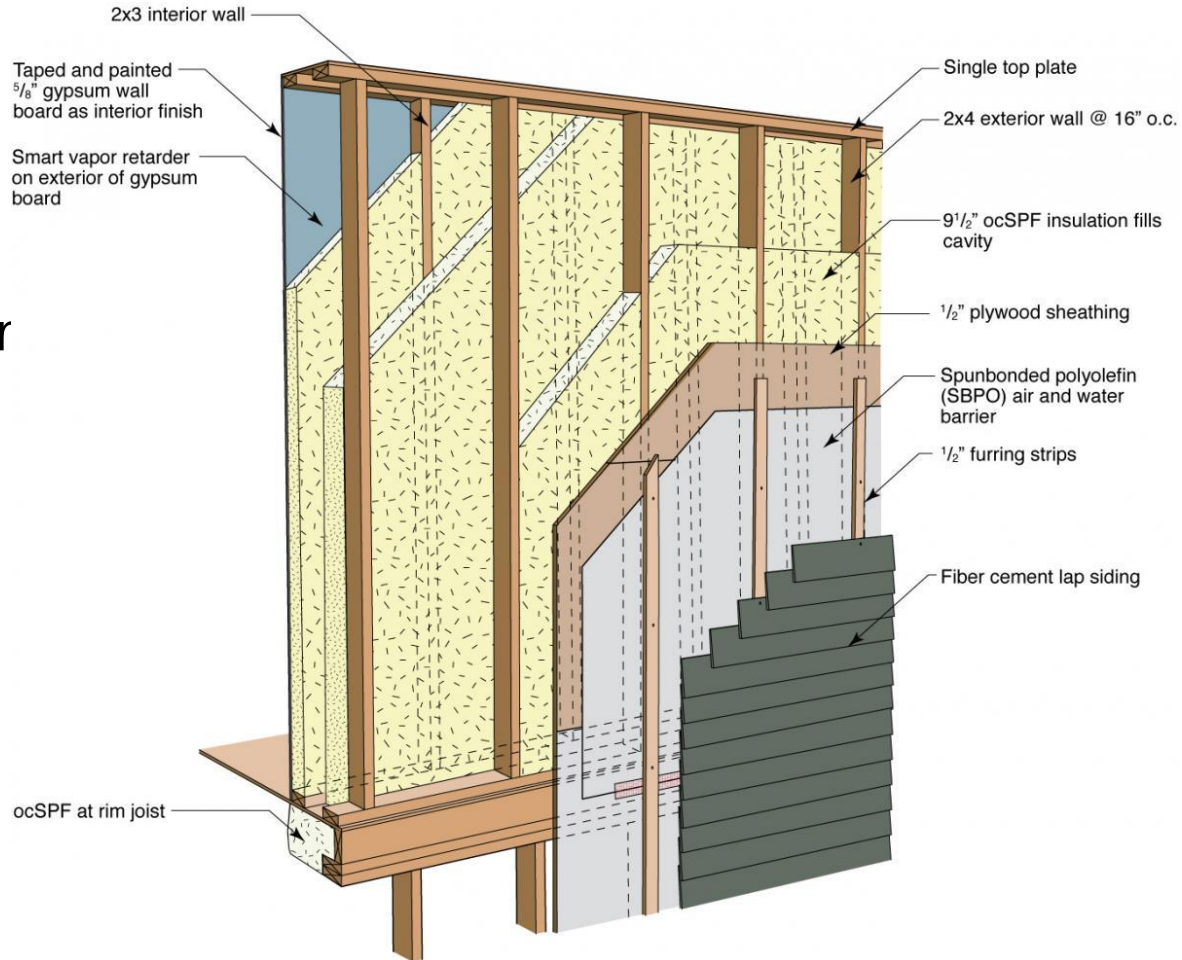


Image: buildingscience.com

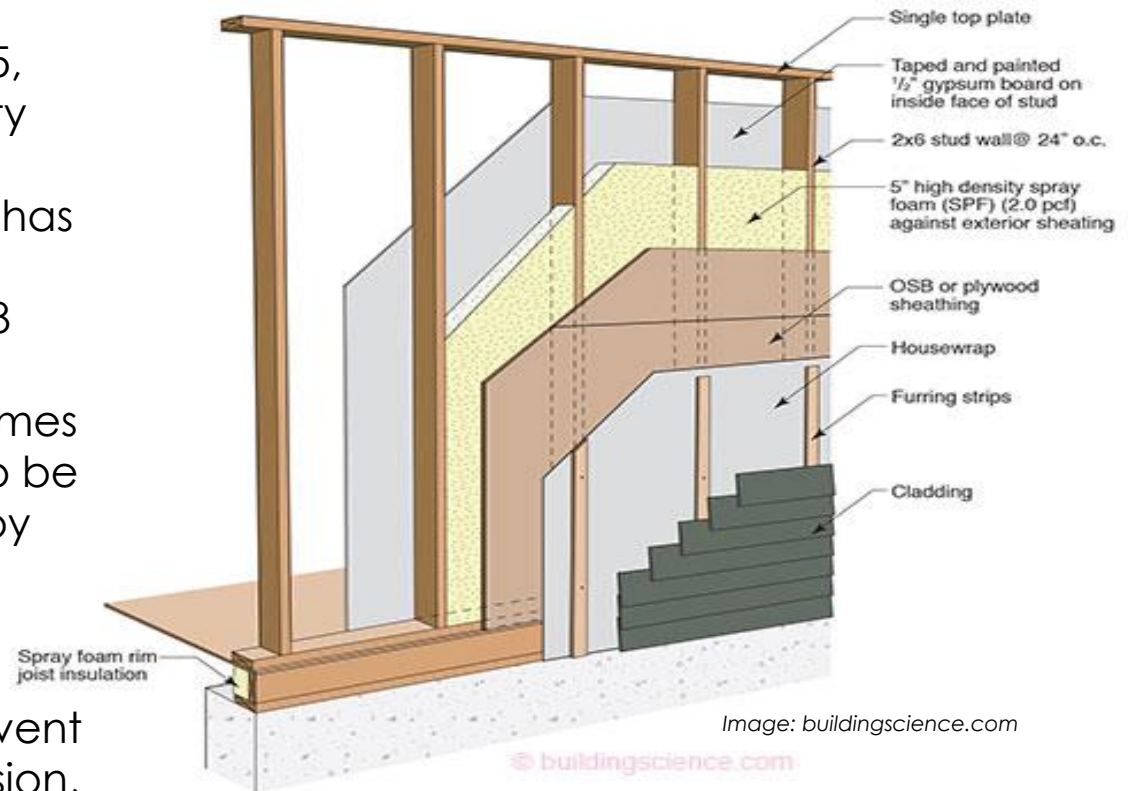
Continuous Insulation - Advanced Framing

- Double stud wall allows for continuous insulation to be placed between interior and exterior studs
- Can accommodate various types of insulation, or even mixed types of insulation



Insulation - Framing with Spray Foam

- High density spray foam has an average R-value between R-5.5 and R-6.5, and has low permeability
- Low density spray foam has an average R-value between R-3.4 and R-3.8
- Spray foam typically comes in two parts that have to be carefully mixed on-site by installer.
- Spray foams must be carefully applied to prevent shrinkage, lack of adhesion, and other problems.



Three Main Types of Rigid Insulation



Image: finehomebuilding.com

Expanded Polystyrene – EPS

- Least expensive
- Most vapor permeable
- R-value: 3.6 to 4.2 per inch

Extruded Polystyrene – XPS

- High compressive strength
- High initial water resistance
- R-value: 5 per inch

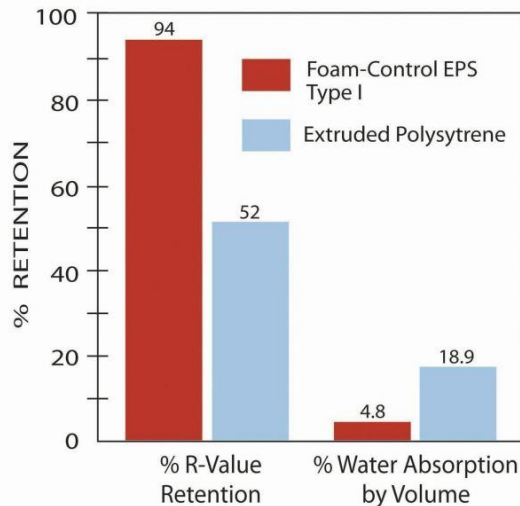
Polyisocyanurate - Polyiso

- No ozone depleting blowing agent
- Absorbs water / requires facing
- R-value: 6 to 6.5 per inch

Comparing EPS and XPS

Standardized tests show XPS has much lower water absorption, but one study of a below grade installation showed a different result. The takeaway – ***carefully research before selecting materials.***

WATER ABSORPTION AND R-VALUE RETENTION¹



Retained thermal resistance and water absorption of insulations subjected to 15 years below grade exposure

3/4" EXPANDED POLYSTYRENE (EPS)

Property	Units	ASTM Test	Type I
Density	pcf, minimum	C303	.90
Thermal Resistance Value (R)	per 3/4" thickness @ 75°F (23.9°C)	C518	2.7
Compressive Resistance 10% Deformation	psi, minimum	D1621	10
Water Vapor Permeance	perm-in; maximum	E96	5.0
Water Absorption	% by volume max	C272	4.0

3/4" STYROFOAM EXTRUDED POLYSTYRENE (XPS)

Property	Units	ASTM Test	Type I
Density	pcf, minimum	C303	1.6
Thermal Resistance Value (R)	per 3/4" thickness @ 75°F (23.9°C)	C518	3.8
Compressive Resistance 10% Deformation	psi, minimum	D1621	25
Water Vapor Permeance	perm-in; maximum	E96	1.1
Water Absorption	% by volume max	C272	.1

Images: guardianexts.com; globenewswire.com

Smart Vapor Retarder

- Vapor retarders are meant to keep things from getting wet, but once an assembly (inevitably) gets wet they can also slow drying.
- Smart vapor retarders become more permeable as moisture levels/humidity rises – allowing faster drying
- Some can change permeability from 0.13 perms to 13.2 perms!
- *Fun Fact: The kraft paper facing on batt insulation is a kind of smart vapor retarder, but with a much smaller variability – from ~0.3 perms to ~3.0 perms*



Image: buildwithbmc.com



Phase Change Materials

- Phase Change Materials (PCMs)
- Ability to store heat gains then release stored energy at appropriate time
- PCMs can
 - Reduce energy usage
 - Increase in thermal comfort
 - Smooth out temperature fluctuations throughout the day and night
 - Help reduce and/or shift in peak loads

Phase Change Materials

- Store thermal energy via the latent heat of phase transitions
- Buffers thermal swings in buildings
- Stores solar thermal energy for short-term or seasonal applications

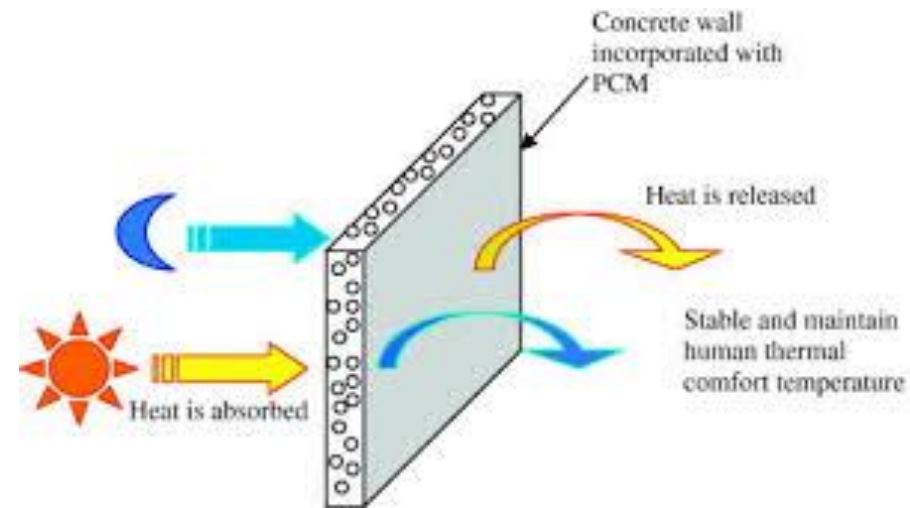


Image: sciencedirect.com

Systems Built Housing and Components: Reimagining the Process

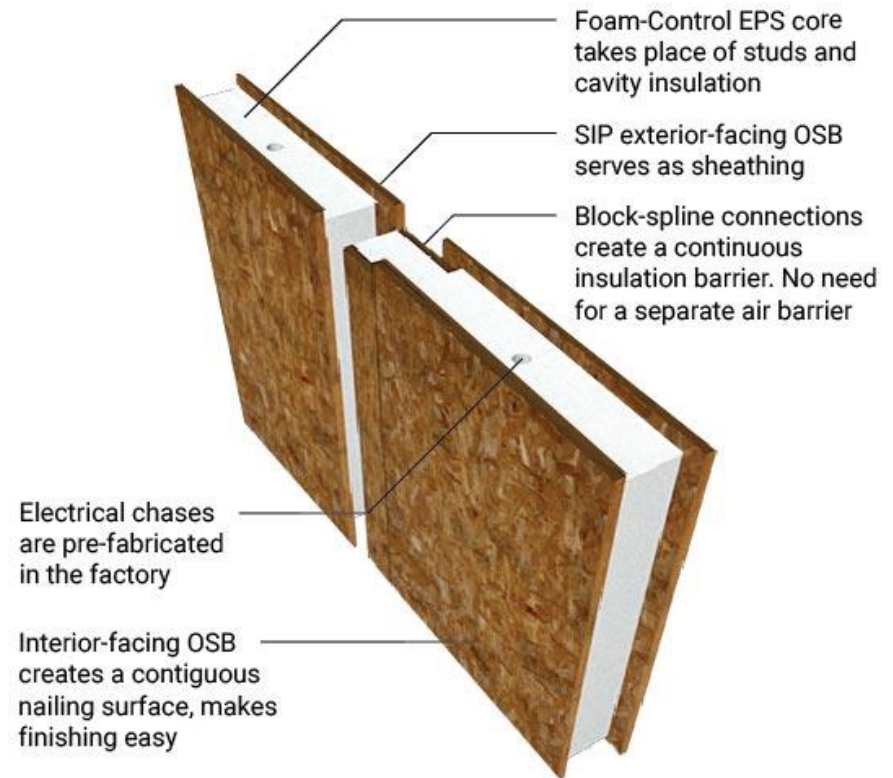
- Time!
- Engineered/"Manufactured" Off Site Construction
- Local Labor/Trades/Material Suppliers
- Local Trade School Engagement
- Potential of Utilizing Local Facilities
 - Allows for expansion of market
 - Local lenders/Appraisers
- Prefab/Modular Largest growth segment in housing market

RECONSTRUCT REMAKE
RECYCLE REJUVENATE
REVAMP REDESIGN RENOVATE
REIMAGINE
RETHINK REUSE RECREATE
REFURBISH RESTORE RENEW
REMODEL REDOREVISE

Image:thelovelyside.com

Structural Insulated Panels (SIPS)

- Fabricated offsite
- Engineered
- Quick erection/assembly
- Thermal barrier
- Structurally Resilient



Panelized, Systemic Construction



Images: sips.org

Time = Money!
Enclosed and Insulated < Week

Precast Basement Insulated Panels

Pros:

- Precast Offsite
- 5000 PSI Concrete
- Gravel Footings
- Insulation Bonded to Panel
- Sealed Mechanically fastened Joints
- Quick Erection/ Assembly

Cons:

- \$\$
- Shipping/Handling



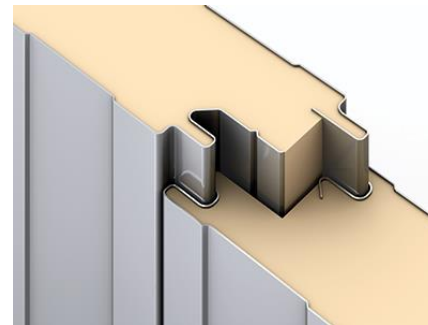
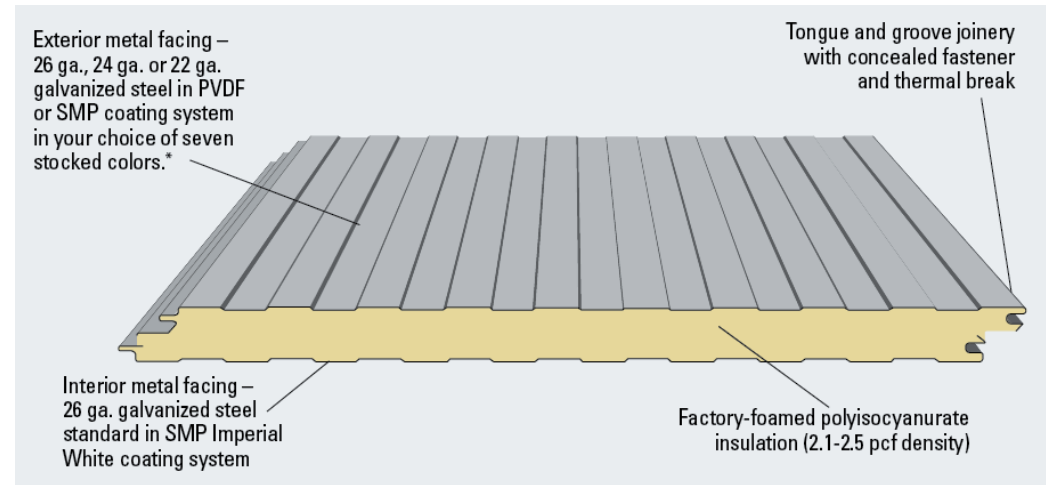
Steel Insulated Panels

Pros:

- Lightweight
- Structural Resiliency
- Fire Rated
- Mated with steel joists, trusses creates rated assembly
- Resistant to weather/moisture

Cons:

- Cost?
- Modifications
- Workforce



Modular/Volumetric

- Highest Growth Segment of the Housing Market
- Non-Chassis based
- Can be custom built
- Built indoors/climate controlled
- Higher quality control
- Inspected by ICC or other third party
- Very Cost Competitive



Image: nashuabuilders.com

Modular/Volumetric

- Gaining single family market share
- *REALLY* gaining multi-family market share



Image: bonestructure.ca; columnandbeam.com



Advanced Fenestration



WHAT MAKES A WINDOW ENERGY-EFFICIENT?

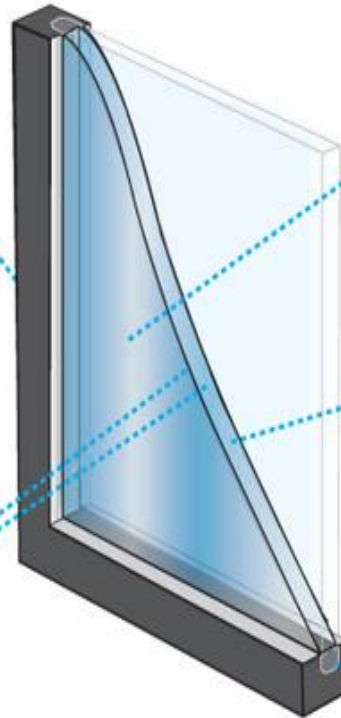


LEARN MORE AT
energystar.gov

Today, manufacturers use an [array of technologies](#) to make ENERGY STAR qualified windows.

QUALITY FRAME MATERIALS

A variety of durable, low-maintenance framing materials reduce heat transfer and help insulate better.



LOW-E GLASS

Special coatings reflect infrared light, keeping heat inside in winter and outside in summer. They also reflect damaging ultraviolet light, which helps protect interior furnishings from fading.

GAS FILLS

Some energy-efficient windows have argon, krypton, or other gases between the panes. These odorless, colorless, non-toxic gases insulate better than regular air.

MULTIPLE PANES

Two panes of glass, with an air- or gas-filled space in the middle, insulate much better than a single pane of glass. Some ENERGY STAR qualified windows include three or more panes for even greater energy-efficiency, increased impact resistance, and sound insulation.

WARM EDGE SPACERS

A spacer keeps a window's glass panes the correct distance apart. Non-metallic and metal/non-metal hybrid spacers also insulate pane edges, reducing heat transfer through the window.

Cutting Edge Windows: Thin Triple Pane and Vacuum Insulated Glazing

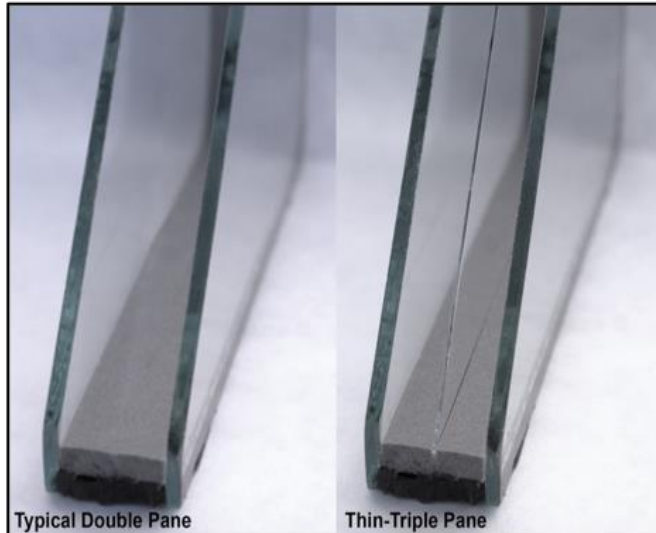


Image: eta.lbl.gov

Thin Triple Pane

- Lighter than standard triple pane
- Adds strong, thin, non-structural center pane
- As high as R-8 (standard double pane is R-2 to R-4)

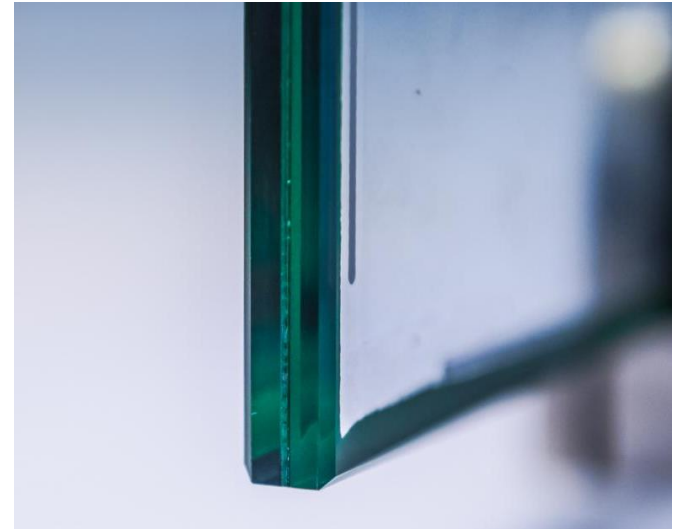


Image: agc-glass.eu

Vacuum Insulated Glazing

- Very thin vacuum gap – 1/10 mm!
- Clear structural spacers maintain gap
- Thinner than standard double pane
- Could be as high as R-14

Window Technologies – Dynamic Glazing

Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, solar heat gain coefficient (SHGC), or visible transmittance (VT)



Image: dwmag.com



Questions so far?

Please feel free to unmute or put questions/comments in the chat!



Advanced Mechanical Systems



High Performance HVAC

- High Efficiency Furnace
 - 98 AFUE
 - Variable Speed Motors
- Heat Pumps
 - As much as **400% efficient**
 - Cold Climate Heat Pumps
 - Mini-Splits
 - Geothermal Heat Pump



Image: 604goodguy.com



Image: catamountsolar.com



Images: oldhouseonline.com

High Performance Air Conditioning

- Condensing Unit
 - Variable speed
- Performance Levels
 - 13 SEER required by code **(1/23)**
 - 14.5 SEER = EnergyStar
 - Units over **20 SEER** are available
 - Tighter envelope increases efficiency
- Advancements in Technology
 - National Renewable Energy Lab (NREL) is developing an air conditioner with integral phase change materials!



Images: bobmims.com

High Performance Water Heating



Image: tankleswaterheaterhub.com

Tankless Water Heater

- Gas or electric
- 24% to 34% more efficient in low use homes (<41 gal/day)
- 8% - 14% more efficient in high use homes (~86 gal/day)
- Higher initial cost but offset by longer life and lower maintenance



Image: energy .gov

Heat Pump Water Heater

- Typical efficiency factor (EF) of 2.0-3.0
 - Typical gas fired EF is 0.5-0.7
- Can be efficiently combined with geothermal heat pump system
- Install in tempered space (40°-90°F)
- Fairly new to the market



Smart homes



System Technologies and Management

- Rapid growth
 - According to some estimates there will be 63 million smart homes in US by 2022
- Mainstream use
 - 86% of millennials would pay more for a smart home
- Lower costs
 - System management
 - Appliances
- Competition!!



Image: home.howstuffworks.com

Appliance Technologies

- Increased Efficiencies
- Maintenance Benefits
- Connected Devices

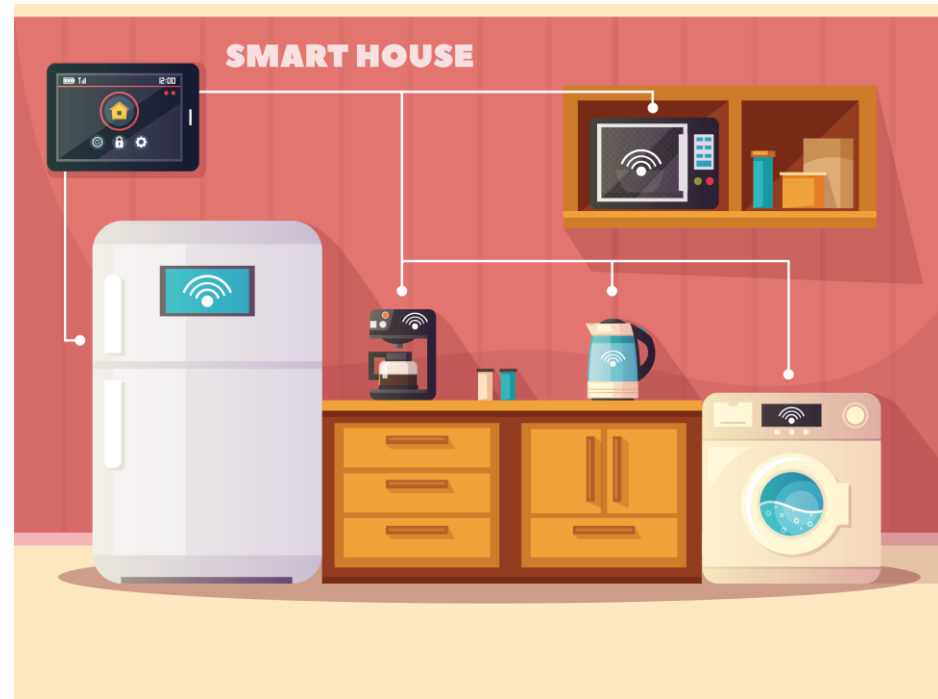


Image: southwestapplianceinc.com

EV Ready and EV Capable

- EVs are growing fast and quickly becoming cost competitive
 - Estimated to be cost comparable by 2023
- EV Ready:
 - Capacity on the electrical panel for at least a 40 amp, 240V dedicated branch circuit.
 - Conduit pre-installed
 - Level 2-ready outlet installed



Image: Verdatek Solutions

EV Ready and EV Capable

- EV Chargers
 - Level 1 EVSE – Charging through 120V AC plug
 - Adds 2-5 miles of range per hour of charging
 - No special equipment, but does require dedicated branch circuit
 - Level 2 EVSE – Charging through 240 V AC plug
 - Adds 10-60 miles of range per hour of charging
 - Requires special charging equipment and dedicated electrical circuit of 20-100 amps
 - More expensive than Level 1
- EVs can also serve as a home battery in the future



Images: tesla.com; wsj.com

Solar

- Solar-ready homes: Same design considerations as a home with solar. Panels to be added later
- Solar installation:
 - Best perform on south facing roofs, with 15-40 degree slope
 - Ensure roofing materials can support panels and a racking structure
 - Electrical panel installed to handle the load, and wiring to connect to solar panels



Image: Homedepot.com

Solar Thermal Water Heater

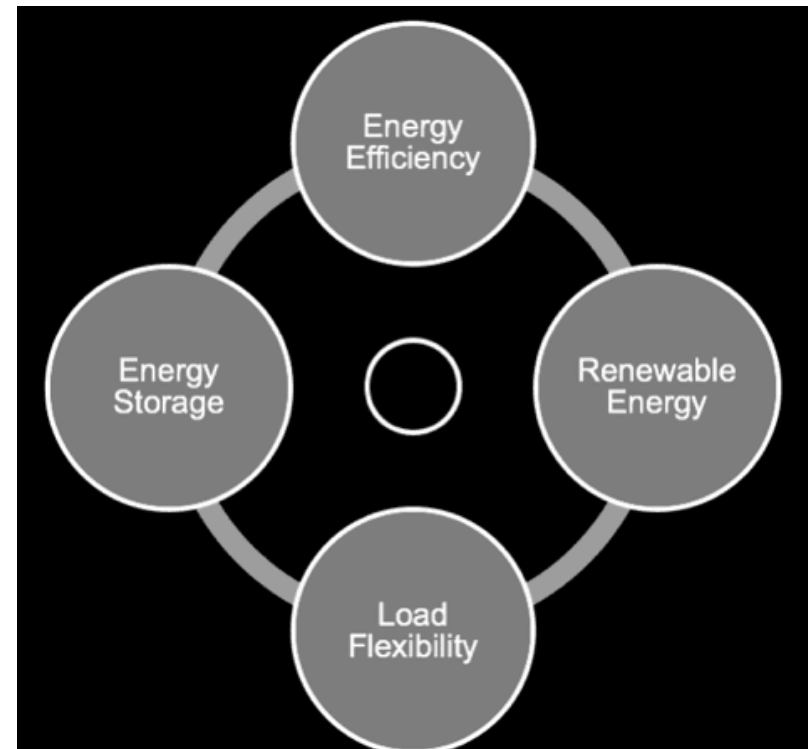
- Systems include storage tanks and solar collectors
- Active Systems: have circulating pumps
- Passive Systems: no circulating pumps
- May require back-up system



Image: Verdatek Solutions

Energy/Battery Storage

- Growing part of Energy design
 - AC, DC and hybrid converter systems
 - 2.5 kW to 10kW
- Benefits
 - Pair with solar
 - Energy and peak savings
- Next Step towards micro grids



Microgrids

- A small, decentralized group of electricity sources and loads
- Normally operates connected to with the traditional grid
- Can "island mode" and function autonomously
 - Resilience benefits
- Saves energy because of the reduced transmission losses
- Saves even more energy, depending on the microgrid's storage capability, power source and other factors.

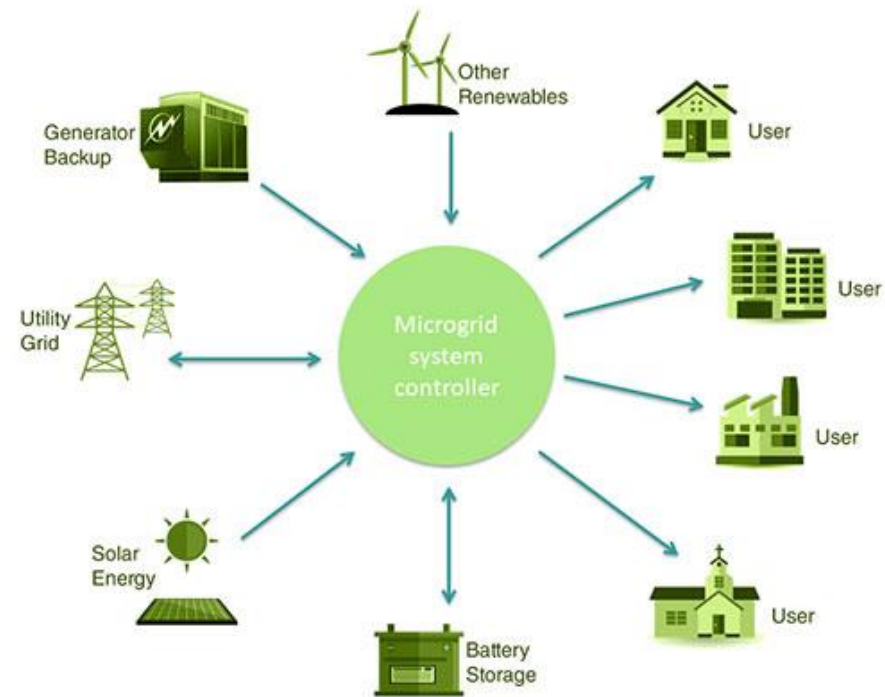


Image: strategicmicrogrid.com

Grid-integrated Efficient Building - GEB



EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure



CONNECTED

Two-way communication with flexible technologies, the grid, and occupants



SMART

Analytics supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences



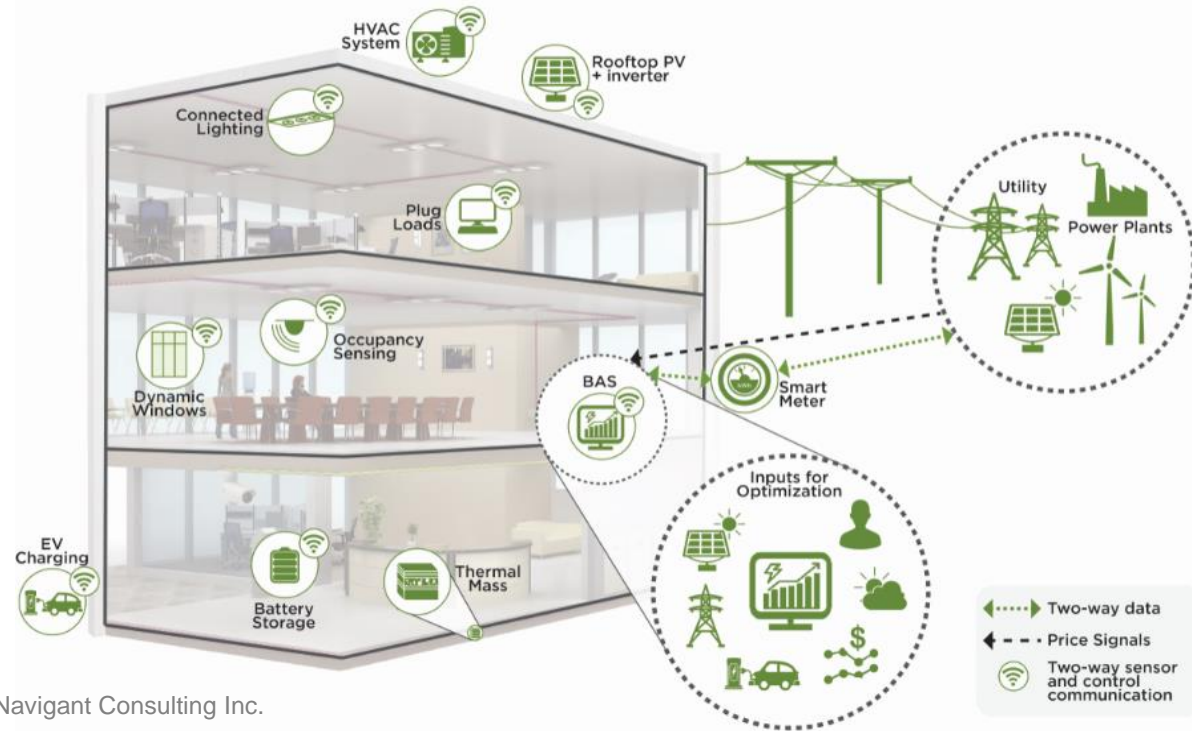
FLEXIBLE

Flexible loads and distributed generation/storage can be used to reduce, shift, or modulate energy use

Image: energy.gov

Grid-integrated Efficient Building - GEB

- Highly efficient building
- Smart technology
- Two-way communication with the grid



© Navigant Consulting Inc.

Image: energy.gov

Smart Neighborhoods: The Whole is More Efficient than the Parts

Alabama Power Smart Neighborhood

- 62 connected homes with state-of-the-art HVAC, neighborhood micro-grid, solar, battery storage.
- Up to 60% lower energy consumption
- smartneighbor.com



Georgia Power Smart Neighborhood

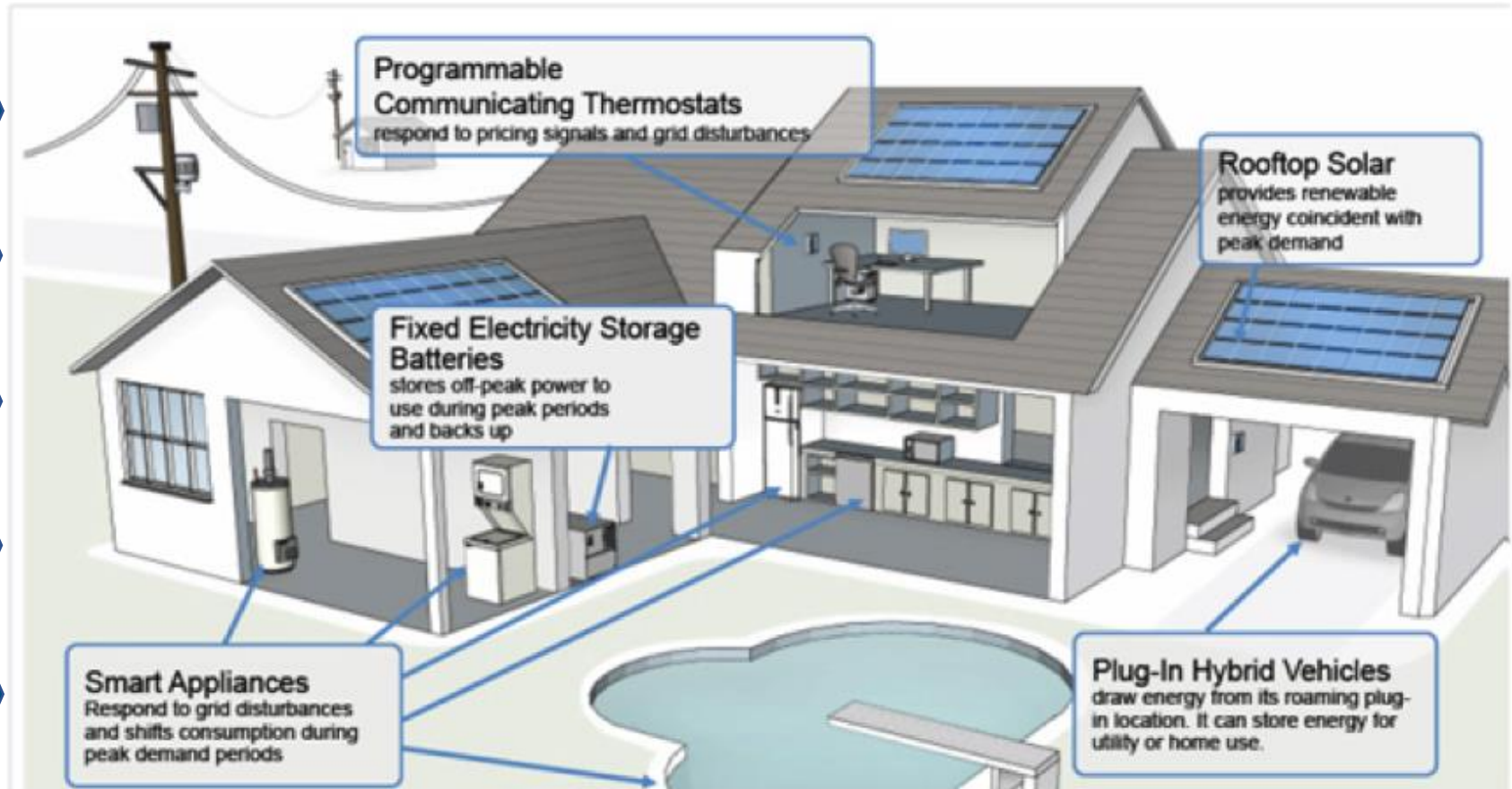
- 46 connected townhomes, HERS score in the 30's, advanced HVAC, solar, in-home battery storage.
- Up to 70% lower energy consumption
- georgiapower.com/residential/save-money-and-energy/smart-neighborhood.html



Images: alabamane.wscenter.com;
highrises.com



The Low Impact, Energy Efficient, Resilient, Healthy, Cost Effective, Comfortable, Grid Interactive, Place we call Home!





Key Takeaways

- Many of these “advanced” technologies and practices have actually been in use for a number of years.
- As newer technologies and components come along, they are easier to incorporate
- They all require the “basics” to be done properly!
- They are all systems part of a larger system!

Questions?

- Submit a question in the chat or unmute yourself to ask a question





Thank you!

Questions?

Matt Belcher, Verdatek Solutions

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314-749-4189 Cell



Continuing Education Credits

- Participants of this session are eligible for continuing education credits from ICC and AIA
- You will receive a certificate from Corie, canderson@mwalliance.org



Thank you!

Live and online trainings in September:

August 31st; Site Visit/Training
National Electrical Contractors Association –
Nebraska Chapter
Partnership Room
8960 L Street, Suite 100, Omaha NE

September 1st Online Training 1-2:30PM
Live Training 3-5 PM
Nebraska Energy Office, Lincoln Ne

More Info:

canderson@mwalliance.org

matt@verda-solutions.com



Thank you!

Live and online trainings in September:

September 13th-14th ASHRAE 90.1

September 15th Nebraska Energy Code
Collaborative Meeting, 9:30-11:30AM
Nebraska Energy Office, Lincoln Ne

More Info:

canderson@mwalliance.org

matt@verda-solutions.com



Thank you!

Live and online trainings in October

October 5th, 11AM-12:30PM- Commercial Energy
Code: Advanced Mechanical Systems
Online

Duct & Envelope Testing
“Train the Trainer”
October 11th-14th
and 24th-25th

More Info:

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