



# Nebraska's Residential Energy Code: Advanced Energy Components and Technologies

*Matt Belcher*

*December 14, 2021*



# 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
- CEU's will be available upon request (ICC and AIA)
  - Information will be emailed to participants following the training
- Email [nwestfall@mwalliance.org](mailto:nwestfall@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)



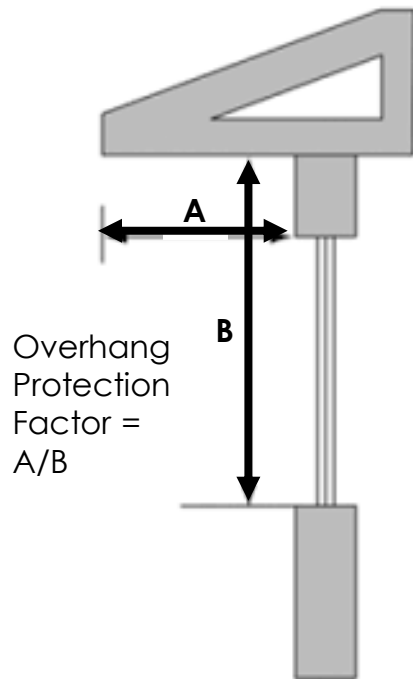


# Advanced Building Envelope Components

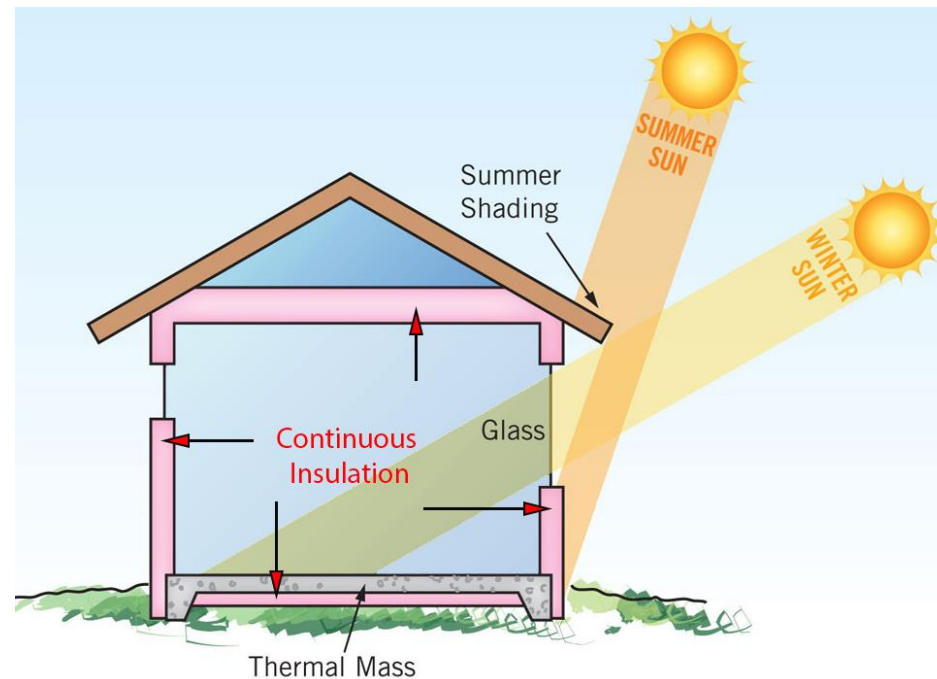


# Building Envelope

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



Projection Factor



Solar Angle



# 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

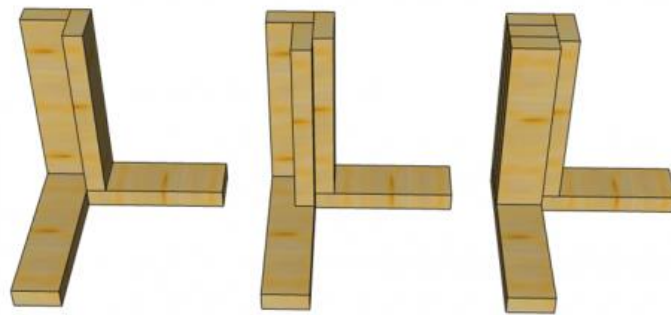
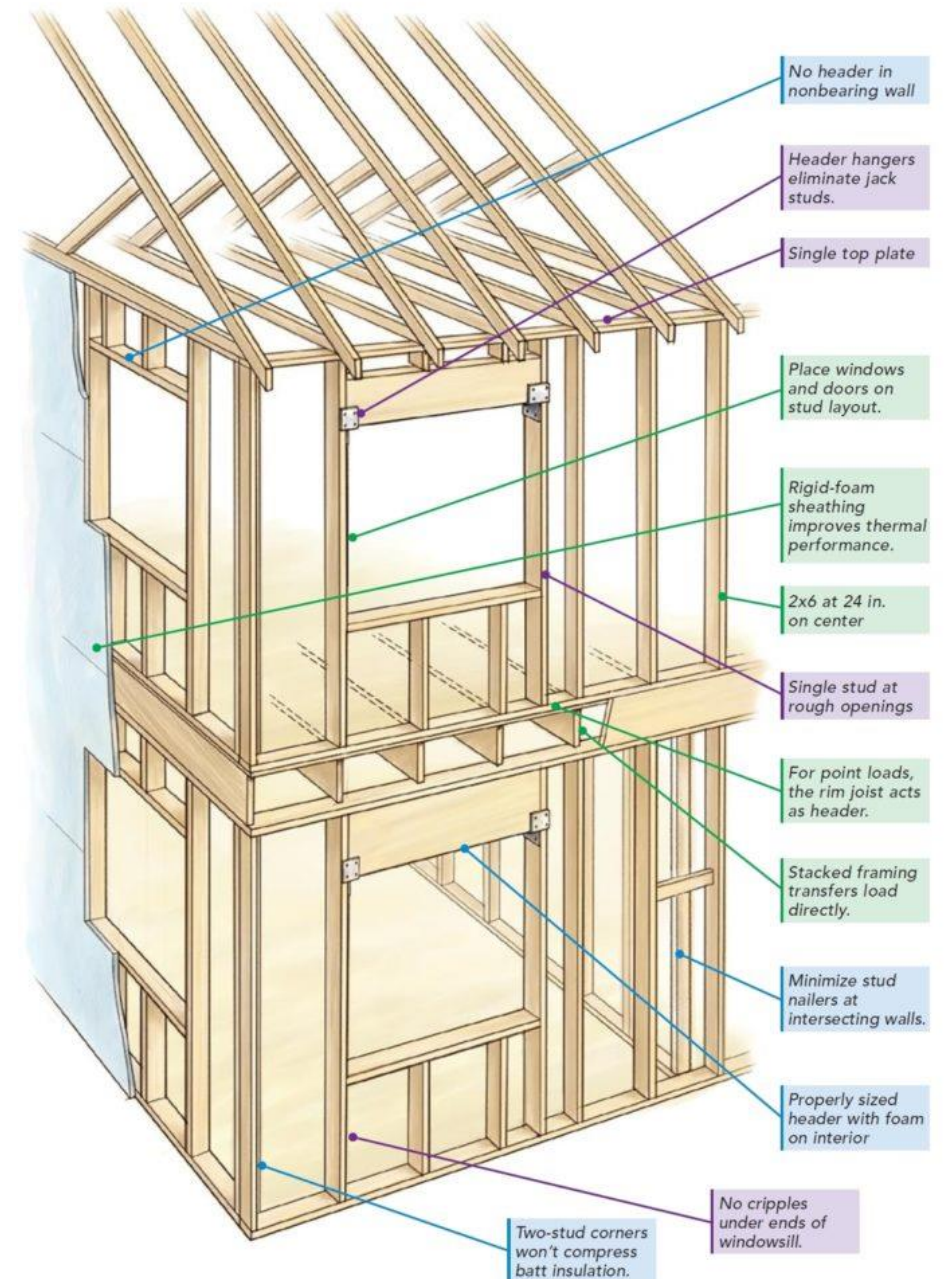


Image: [greenbuildingadvisor.com](http://greenbuildingadvisor.com); [builderscalculator.com](http://builderscalculator.com)



# 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

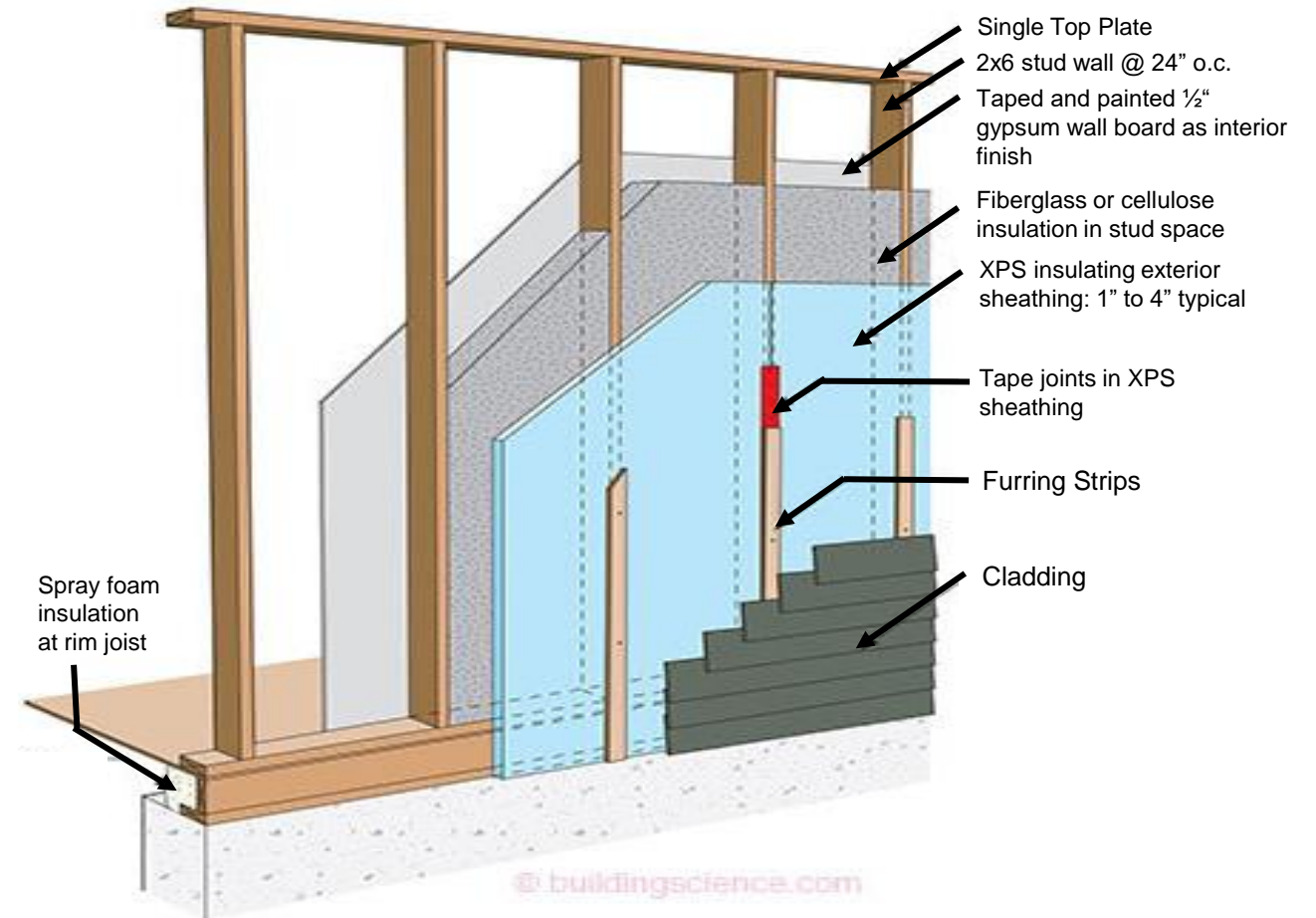


Image: buildingscience.com



# 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

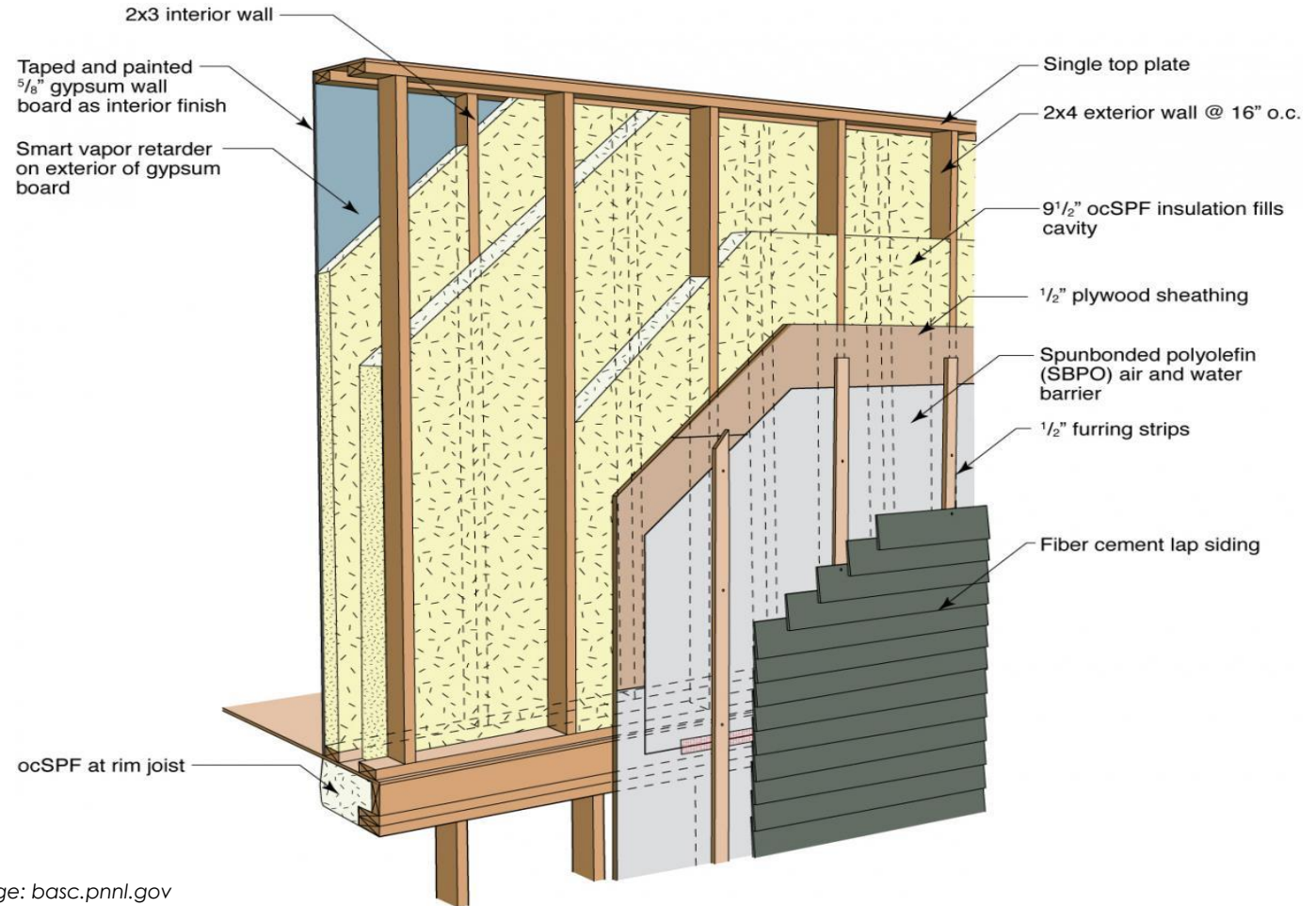


Image: [basc.pnnl.gov](http://basc.pnnl.gov)

# 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 have to be carefully applied to prevent shrinkage, lack of adhesion, and other problems.

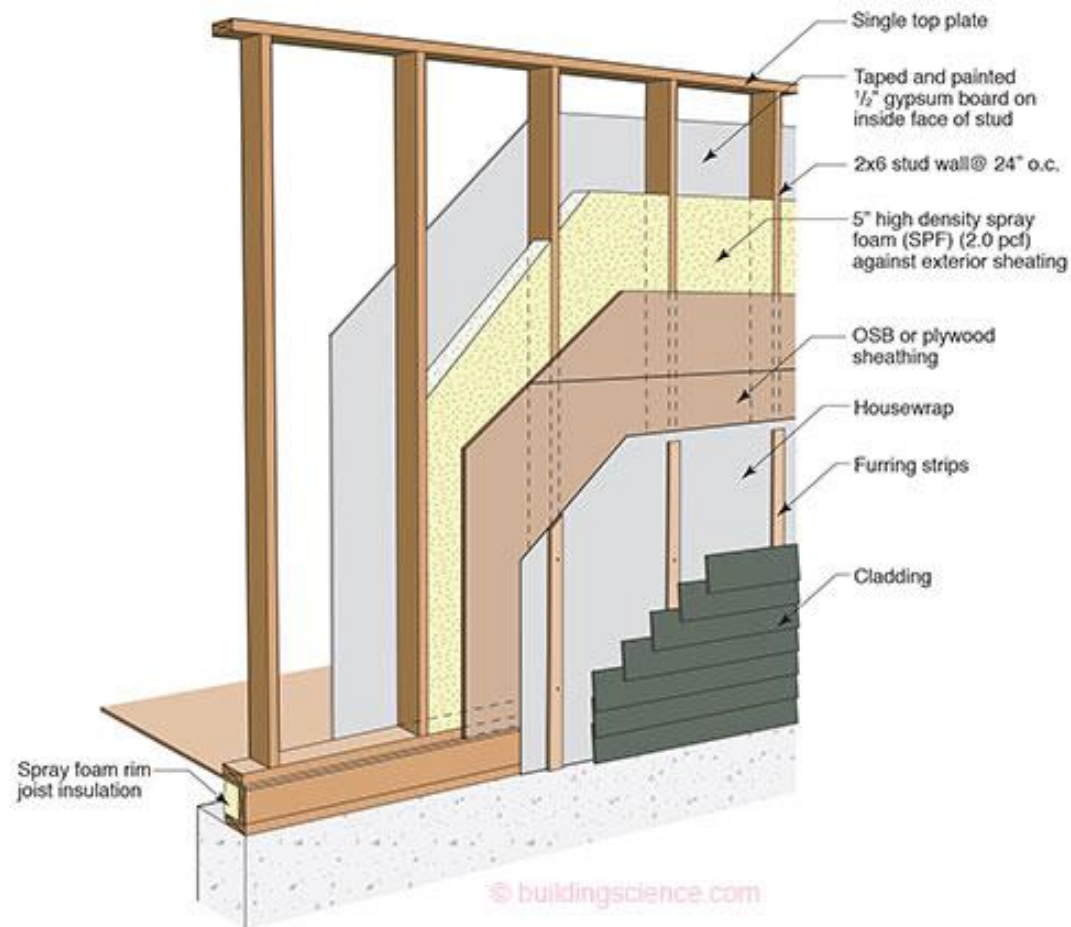


Image: [buildingscience.com](http://buildingscience.com)

# 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

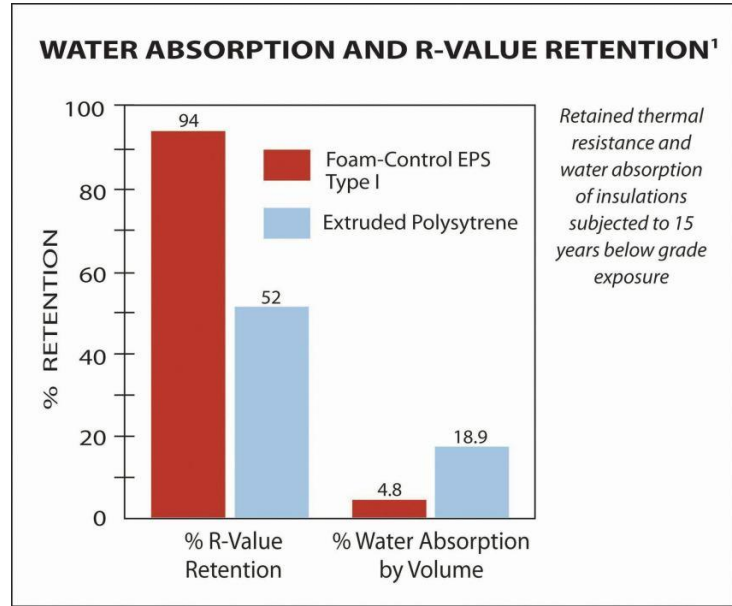
- High compressive strength
- High initial water resistance
- R-value: 5 per inch

## 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.**



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

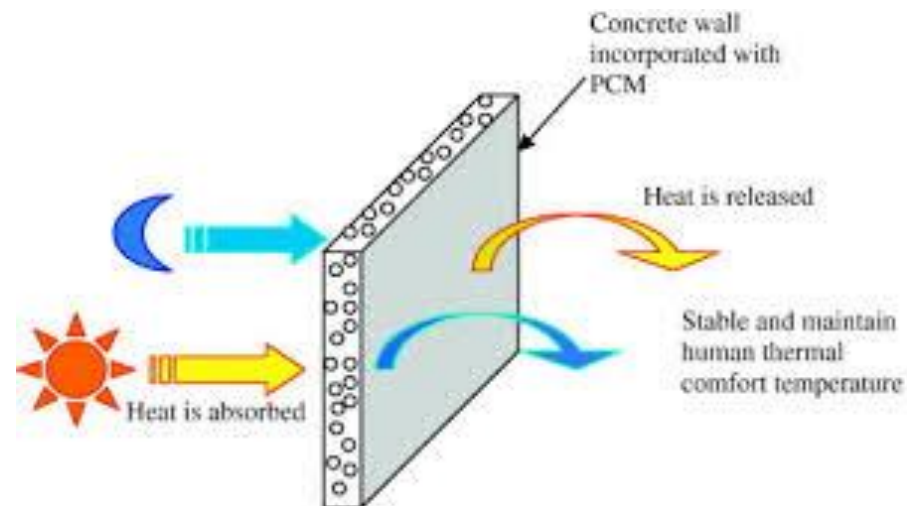


Image: sciencedirect.com

# 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 REDO REVISE

*Image:thelovelyside.com*





# Structural Insulated Panels (SIPs)

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

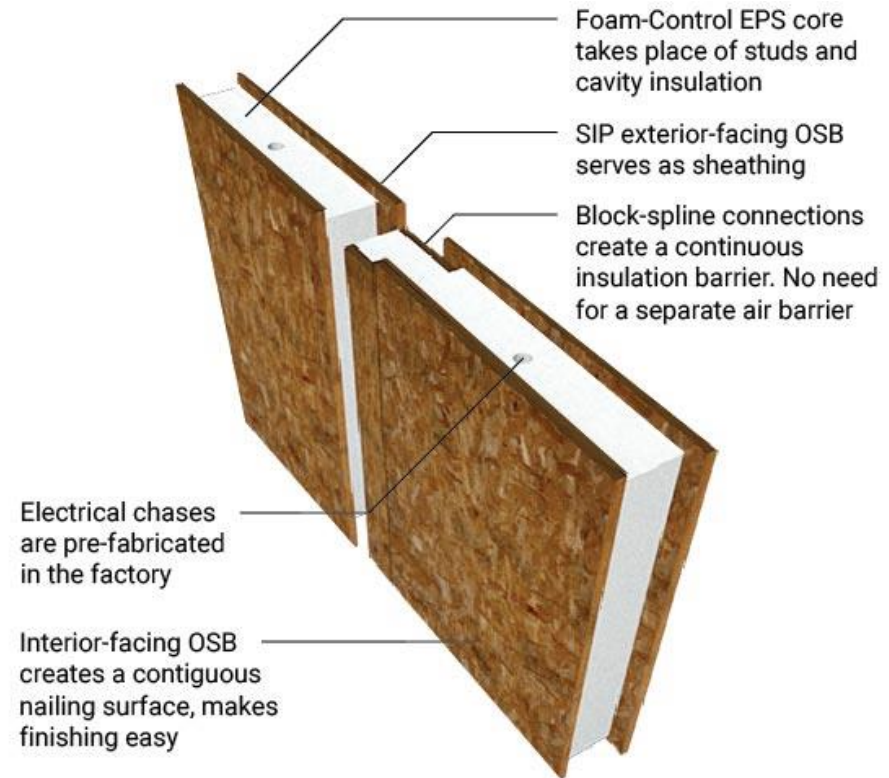


Image: [trinitybuildingsystems.com](http://trinitybuildingsystems.com);

# 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



*Images: superiorwalls.com; concreteconstruction.net*

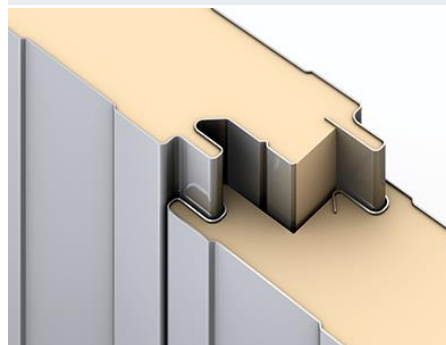
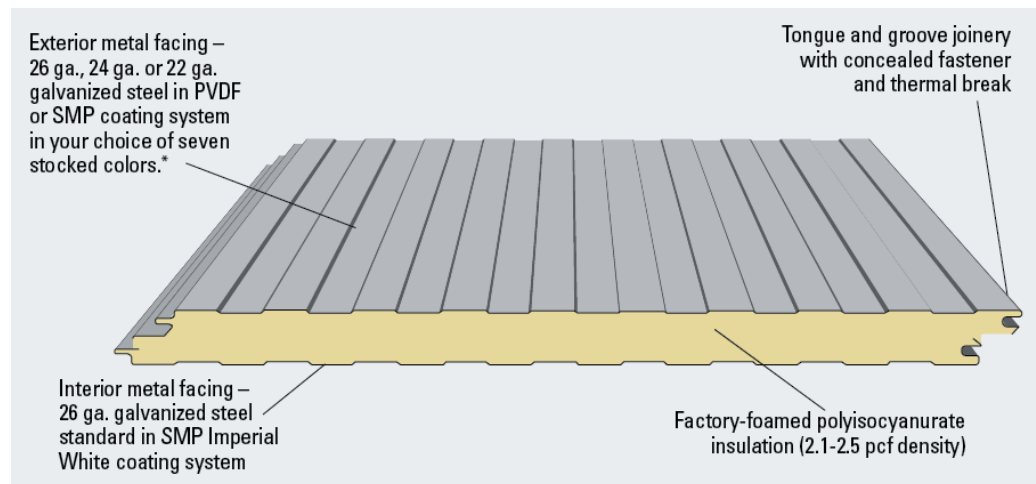
# Steel Insulated Panels

## Pros:

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

## Cons:

- Cost?
- Modifications
- Workforce



Images: [metalsales.us.com](http://metalsales.us.com); [atas.com](http://atas.com); [steelgenix.com](http://steelgenix.com)

# 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; columndandbeam.com



# Advanced Fenestration



# WHAT MAKES A WINDOW ENERGY-EFFICIENT?



LEARN MORE AT  
[energystar.gov](http://energystar.gov)

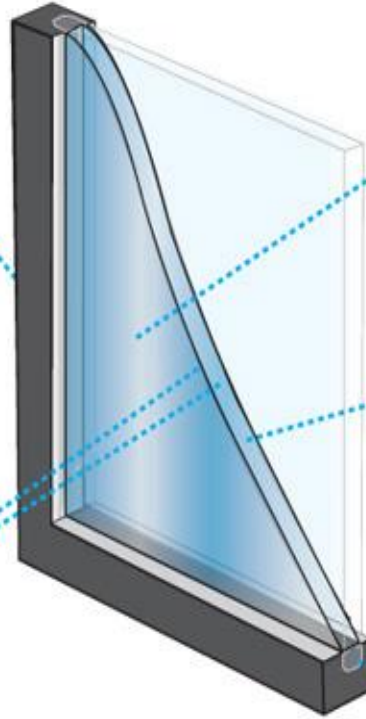
Today, manufacturers use an *array of technologies* to make ENERGY STAR qualified windows.

## QUALITY FRAME MATERIALS

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

## 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.



## 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

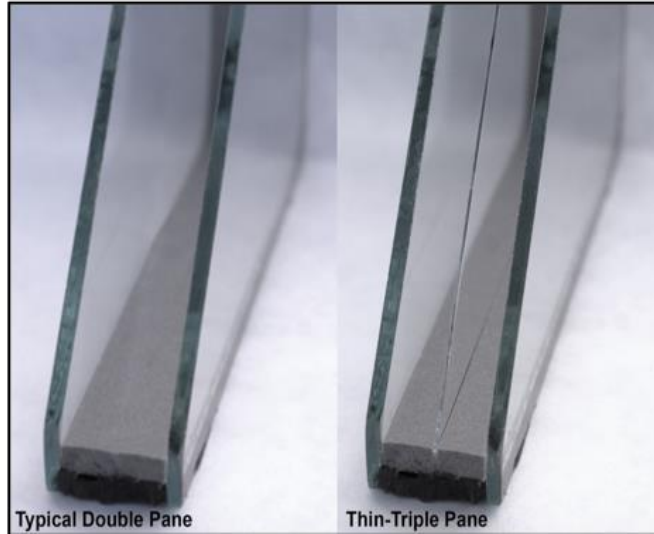
Some energy-efficient windows have argon, krypton, or other gases between the panes. These odorless, colorless, non-toxic gases insulate better than regular air.

## 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



Typical Double Pane  
Image: eta.lbl.gov

Thin-Triple Pane

## 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: dwmmag.com



# 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
  - 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

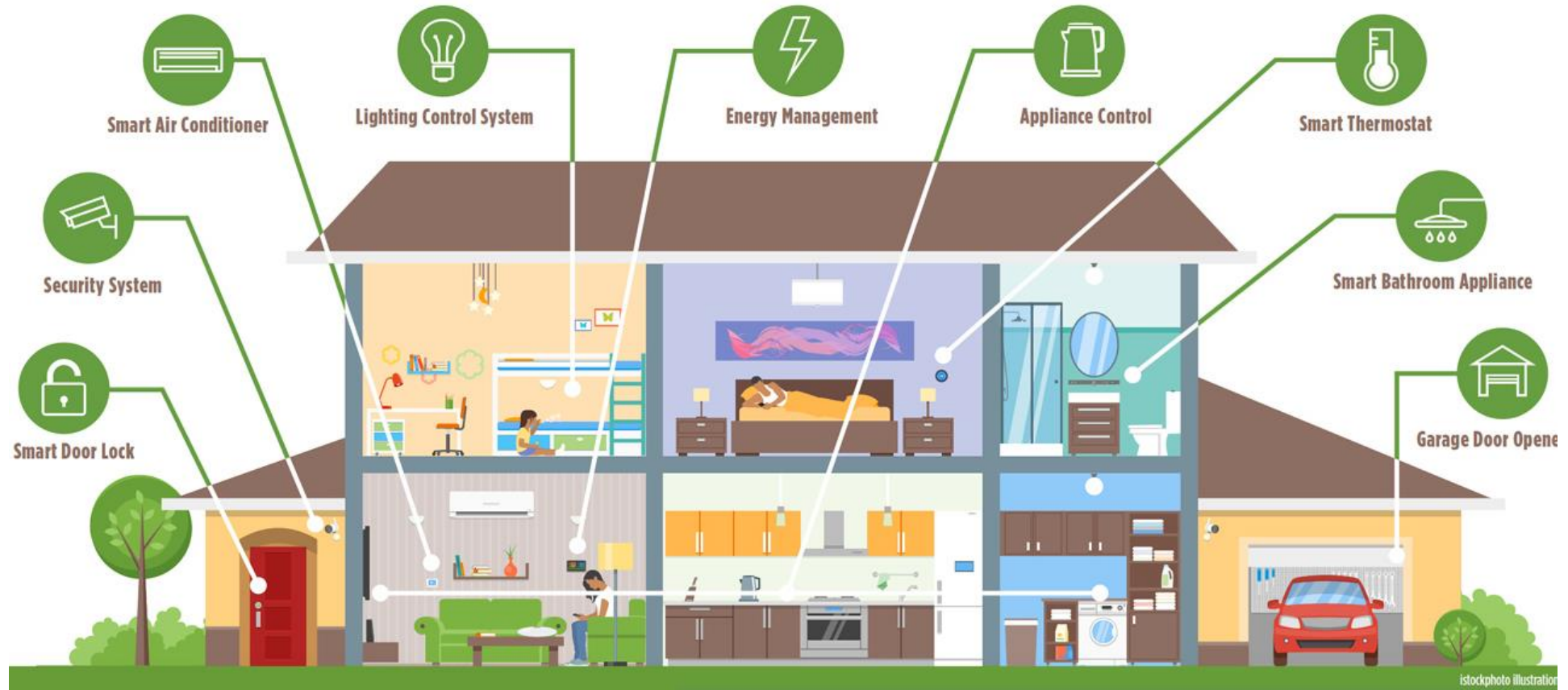


# Smart Homes



# HOME, SMART HOME

Cool gadgets, practicality drive trend in residential lifestyle technology





# 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](http://home.howstuffworks.com)

# Appliance Technologies

- Increased Efficiencies
- Maintenance Benefits
- Connected Devices

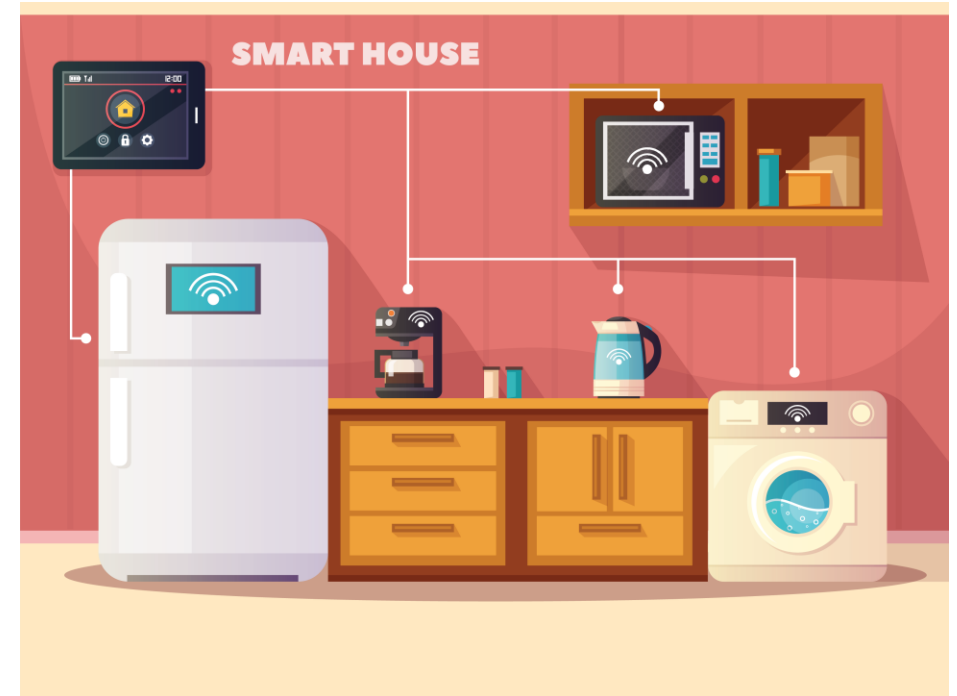


Image: southwestapplianceinc.com

# 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

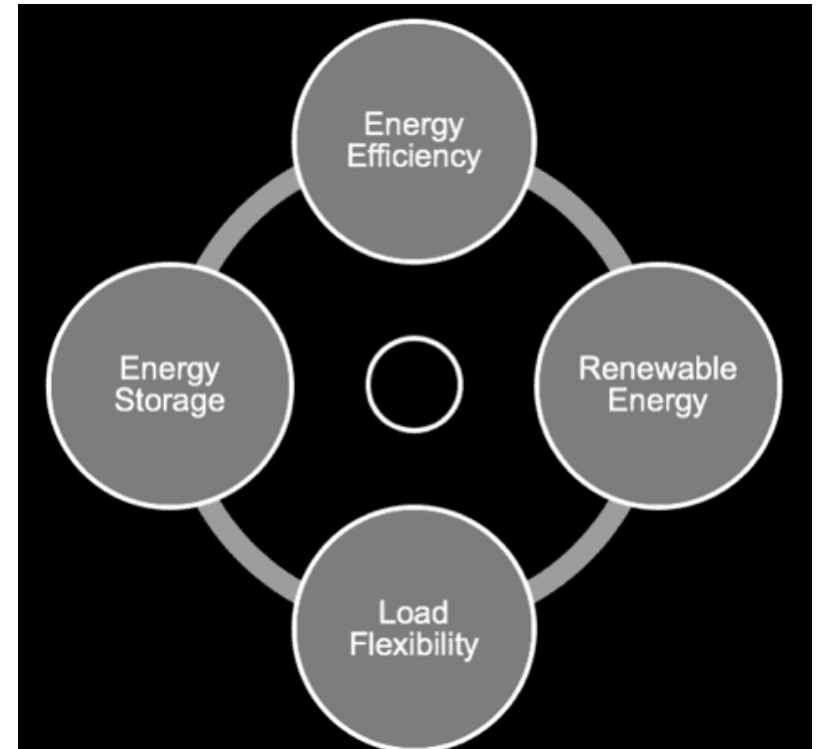
- Systems include storage tanks and solar collectors
- Active Systems: have circulating pumps
- Passive Systems: no circulating pumps
- May require back-up system



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.

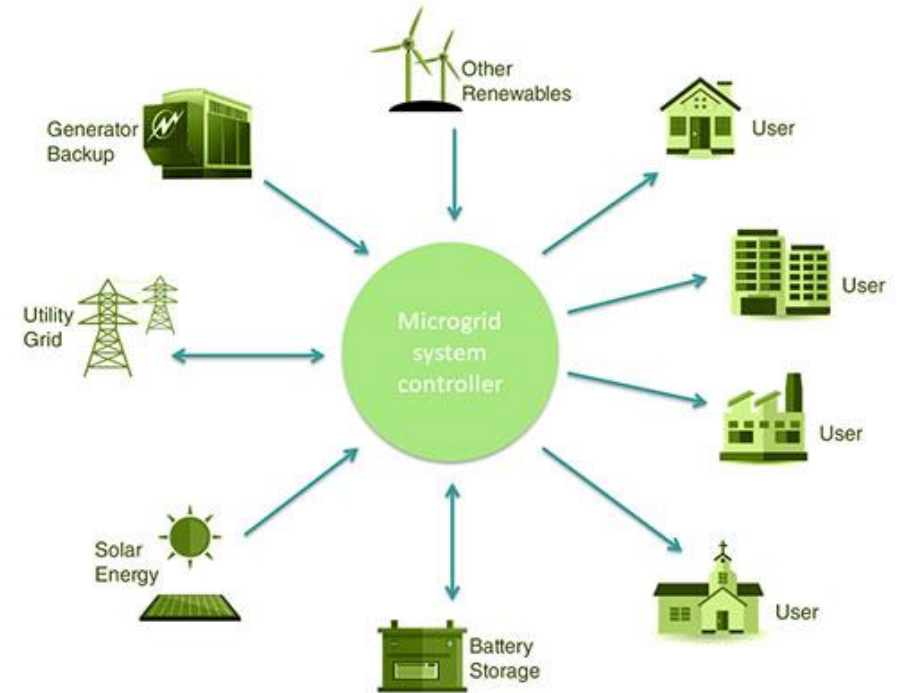


Image: strategicmicrogrid.com



# Grid-integrated Efficient Building - GEB



## EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure



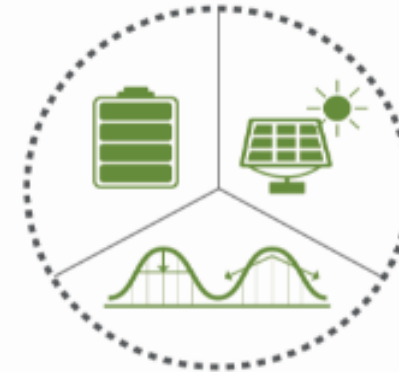
## CONNECTED

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



## SMART

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



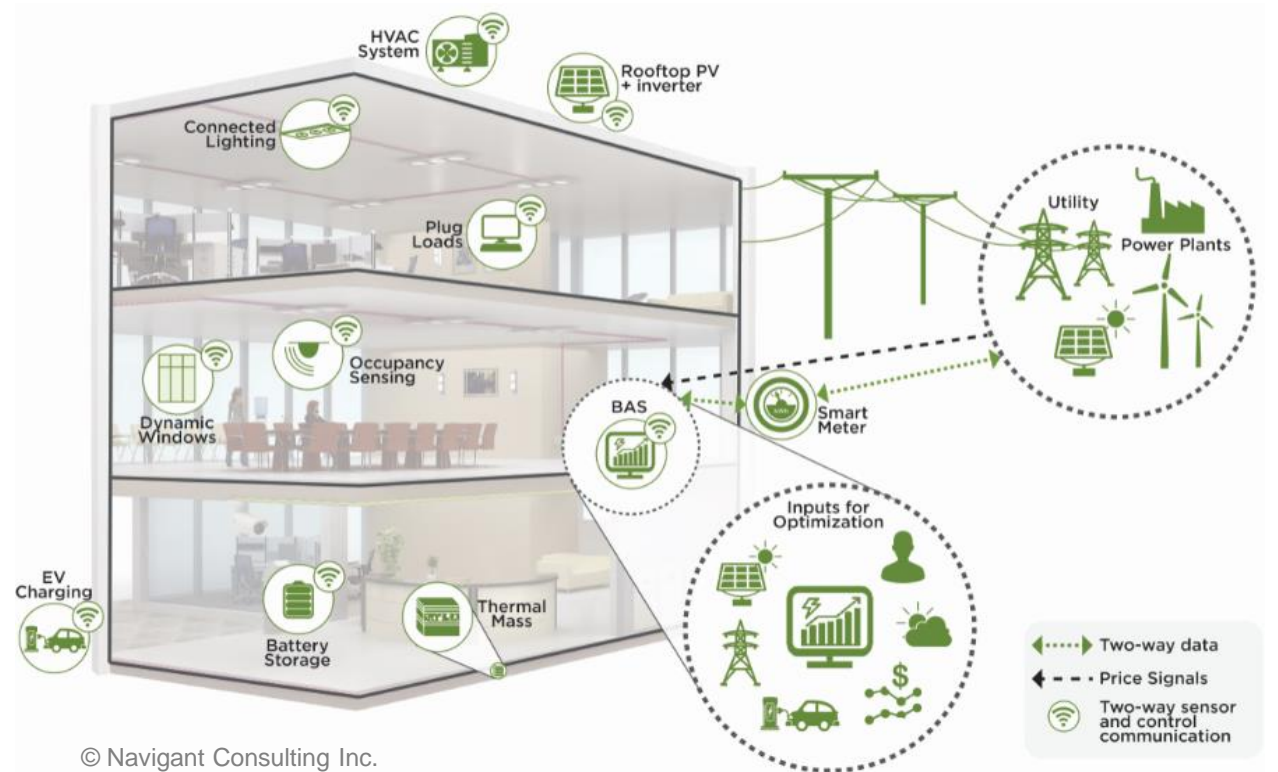
## FLEXIBLE

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



# 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](http://smartneighbor.com)



## Georgia Power Smart Neighborhood

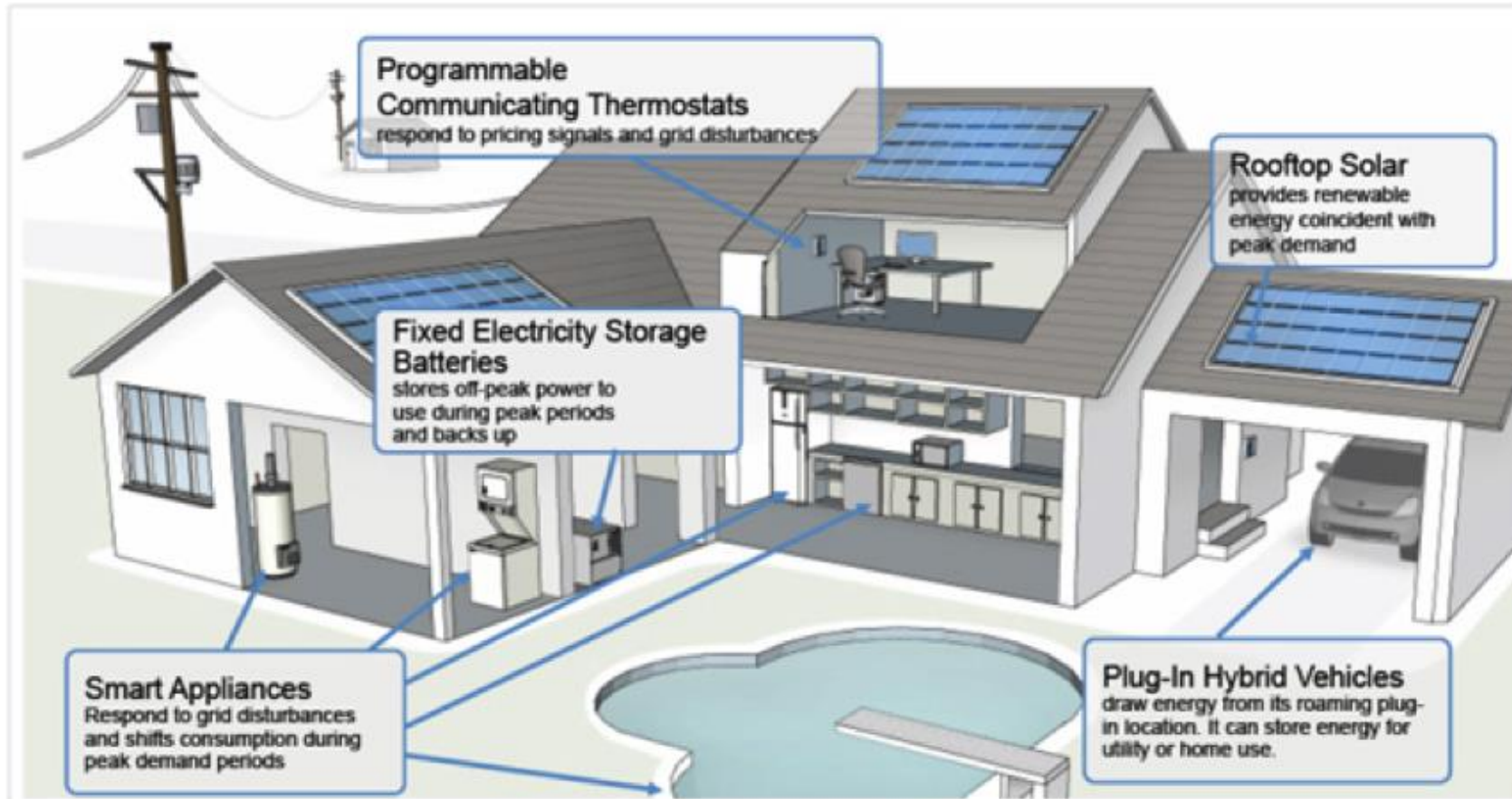
- 46 connected townhomes, HERS score in the 30's, advanced HVAC, solar, in-home battery storage.
- Up to 70% lower energy consumption
- [georgiapower.com/residential/save-money-and-energy/smart-neighborhood.html](http://georgiapower.com/residential/save-money-and-energy/smart-neighborhood.html)



Images: [alabamaneighborhood.com](http://alabamaneighborhood.com);  
[highrises.com](http://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!

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