METROPOLITAN
Community College

Residential Energy Code – Session 7

Advanced Building Efficiency Technologies

Instructor: Matt Belcher

March 9, 2021: 6:30-8:30pm

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)
  - Information at end of presentation
- Email nwestfall@mwalliance.org with questions

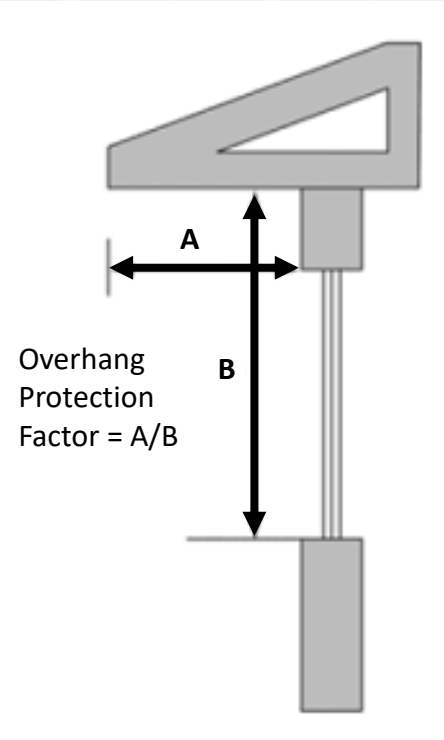
Today's Agenda

- 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)

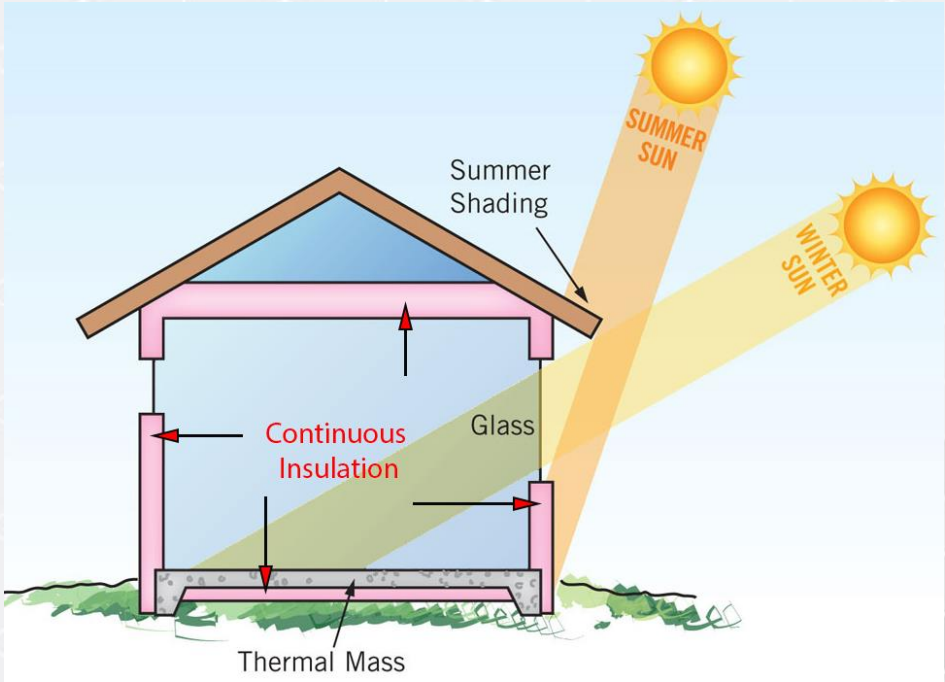
ADVANCED BUILDING ENVELOPE COMPONENTS

Building Envelope

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



Projection Factor



Solar Angle

Images: up.codes ecodesignadvisor.org.nz

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**

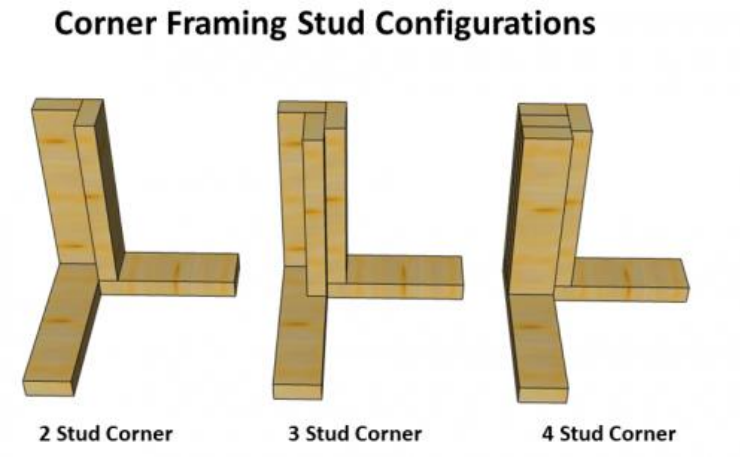
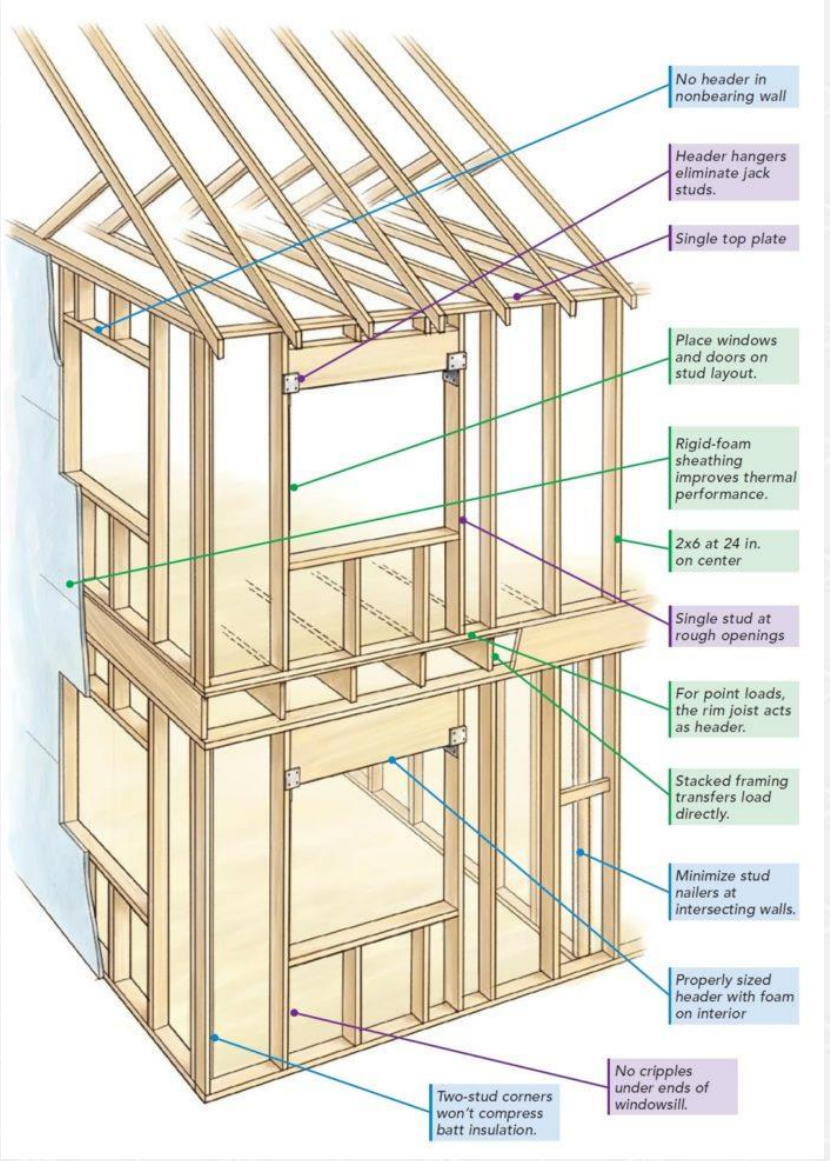


Image: greenbuildingadvosor.com; builderscalculator.com



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

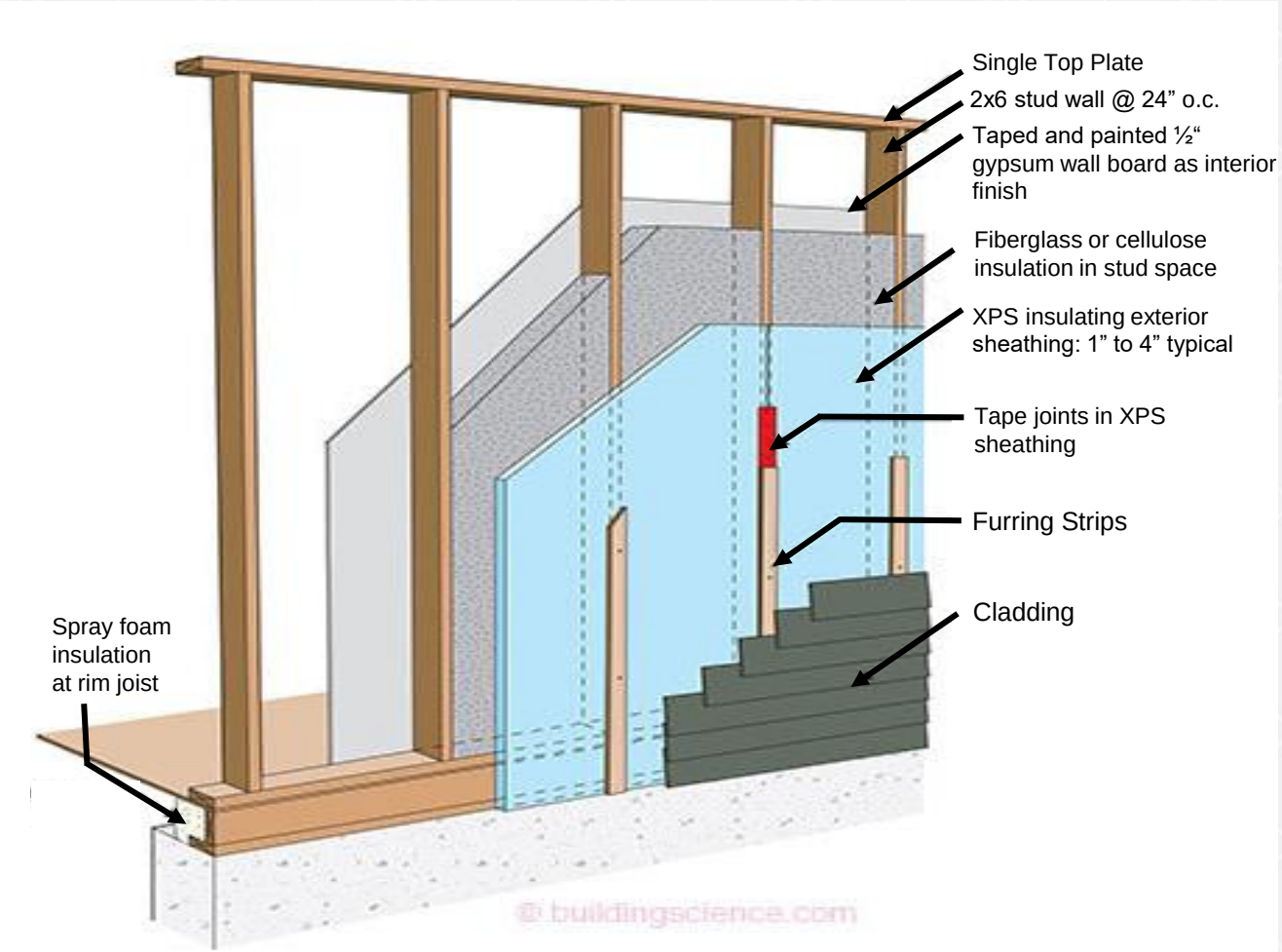


Image: buildingscience.com

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

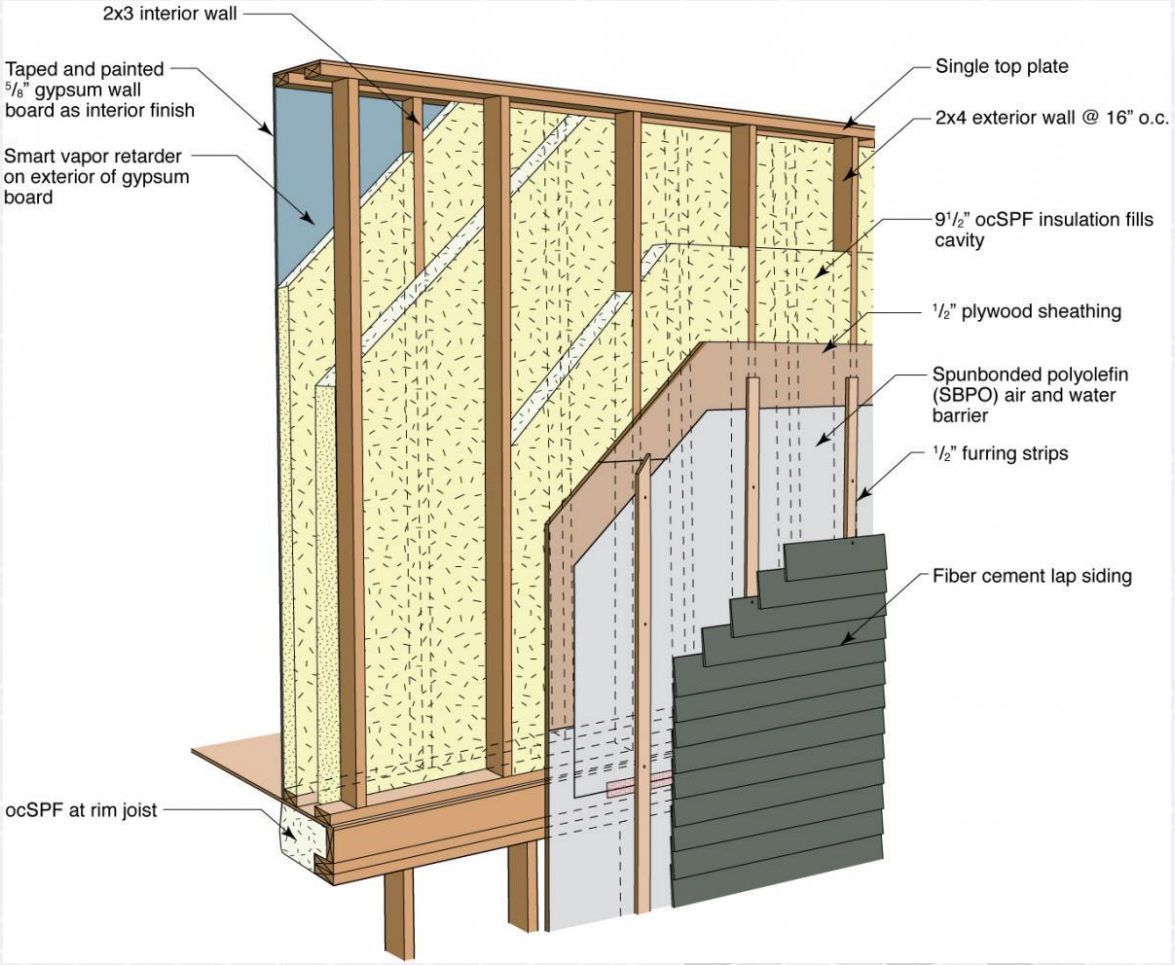


Image: basc.pnnl.gov

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.

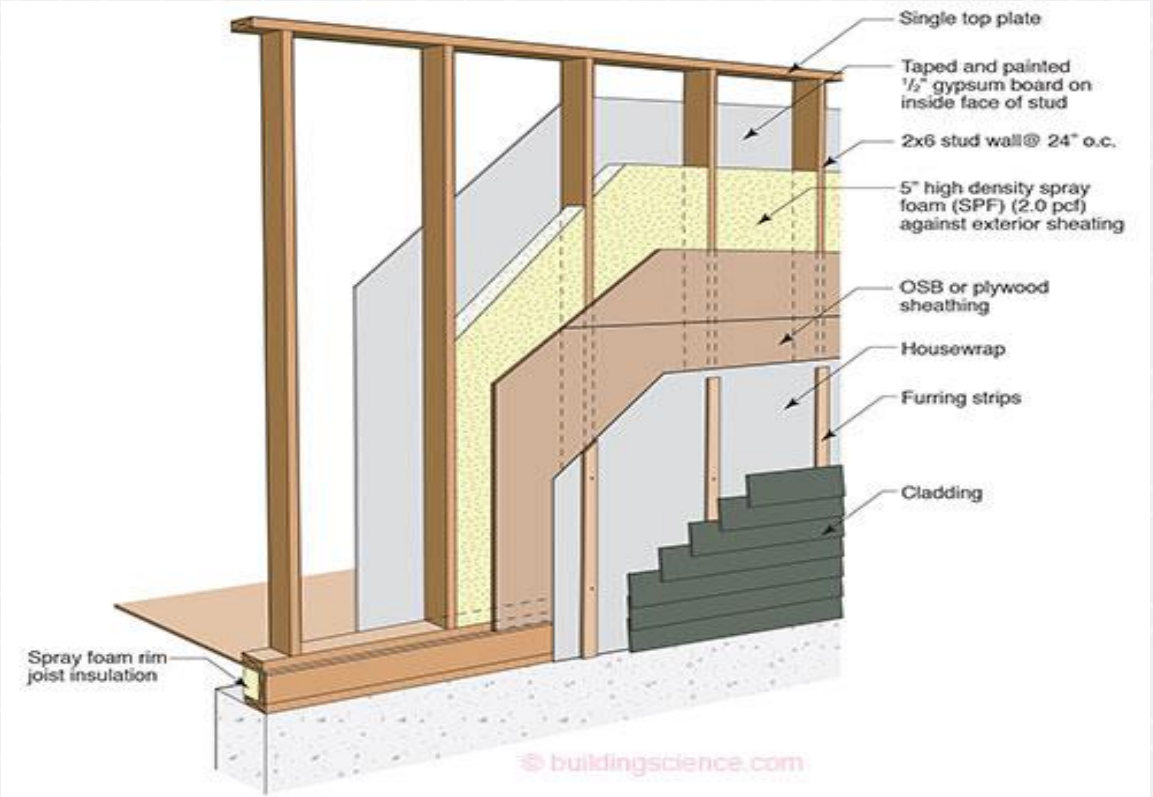


Image: buildingscience.com

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

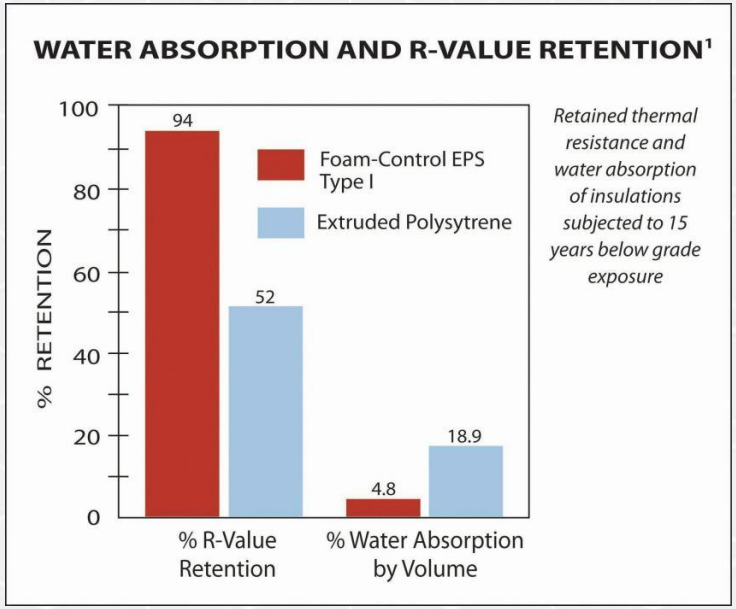
- High compressive strength
- High initial water resistance
- R-value: 5 per inch

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

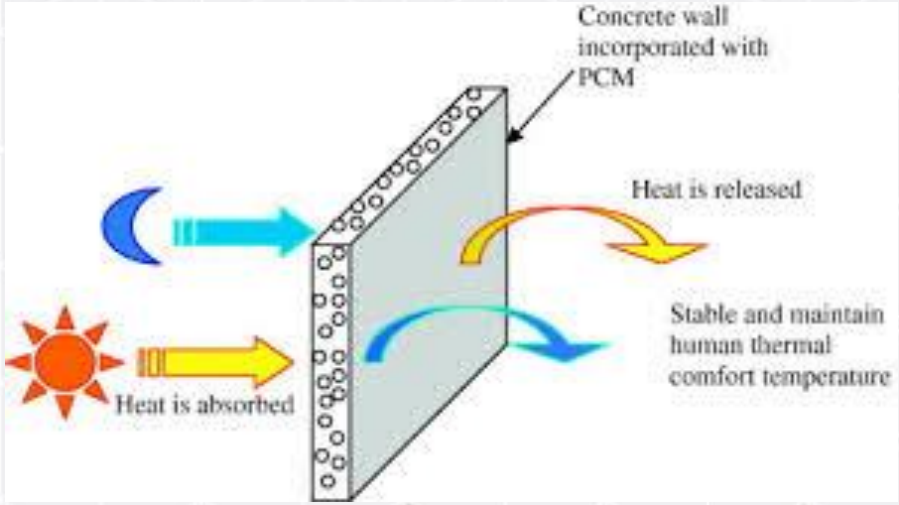


Image: sciencedirect.com

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

Image:thelovelyside.com

Structural Insulated Panels (SIPS)

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

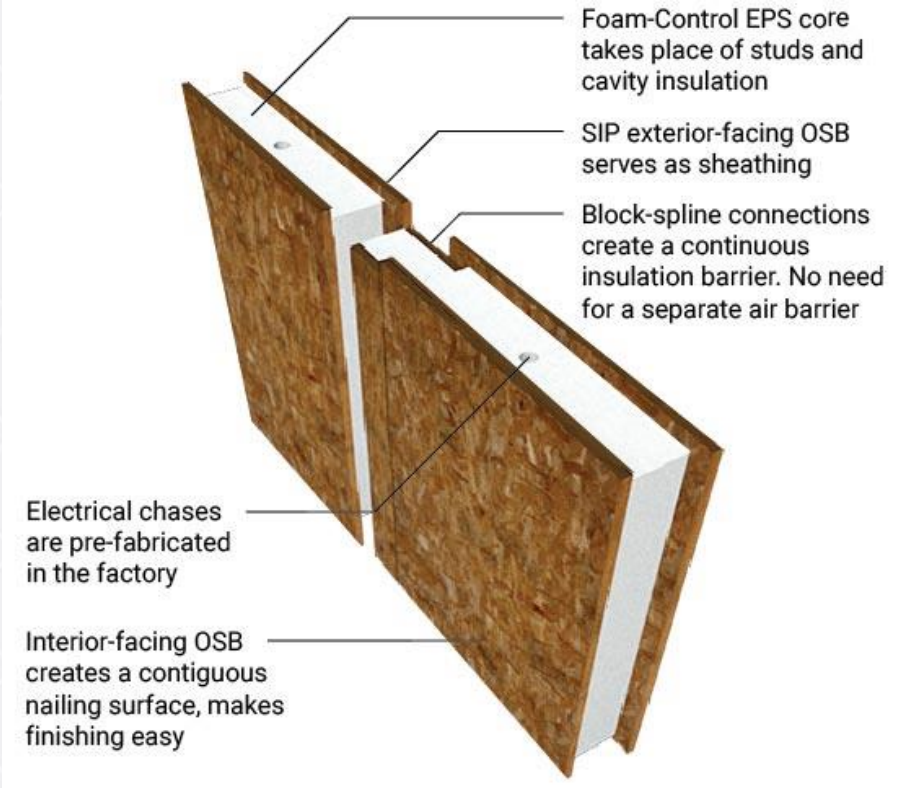


Image: trinitybuildingsystems.com;

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

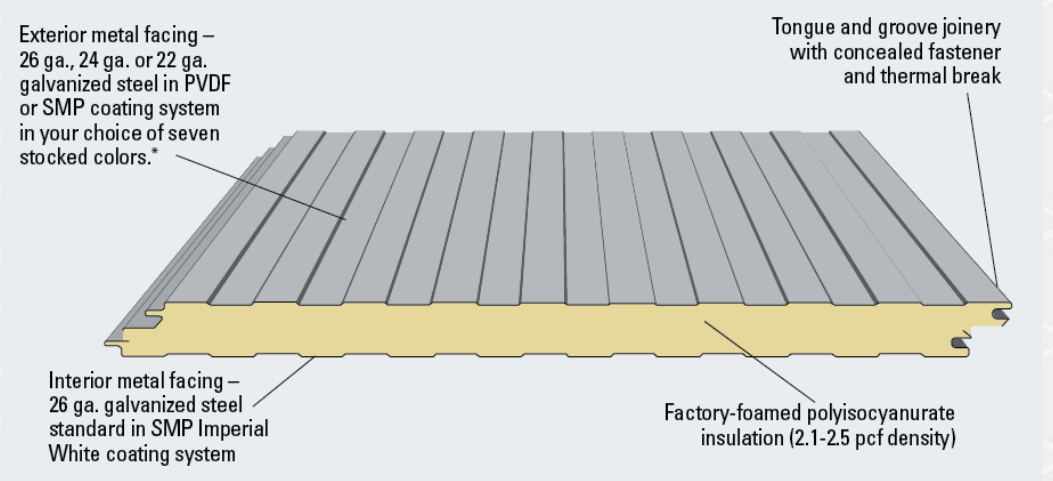
Steel Insulated Panels

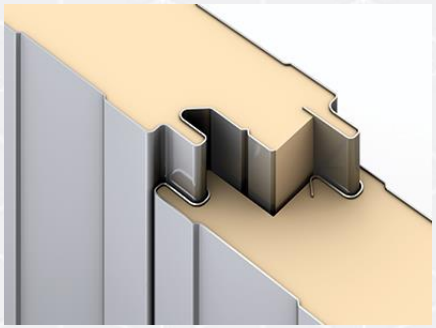
Pros:

- 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; atas.com; 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; columnandbeam.com

Session 7 – Review Question

Advanced Framing…

A. Allows for more insulated area.
B. Holds up the roof better than regular framing.
C. Costs more because it's worth more.
D. Is made to comply only with above code standards.

Session 7 – Review Question

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ADVANCED FENESTRATION

WHAT MAKES A WINDOW ENERGY-EFFICIENT?

LEARN MORE AT energystar.gov

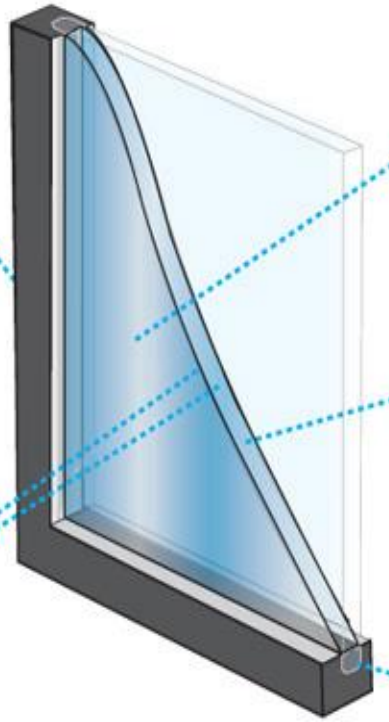
Today, manufacturers use an array of technologies to make ENERGY STAR qualified windows.

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.

Source: energystar.gov

Cutting Edge Windows: Thin Triple Pane and Vacuum Insulated Glazing

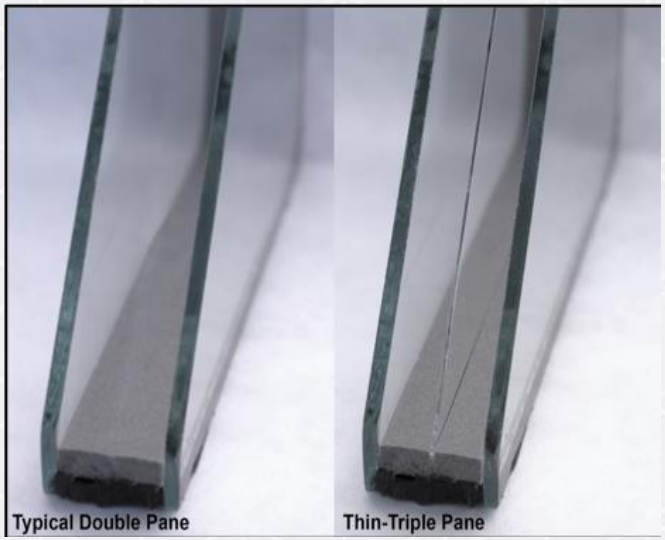


Image: eta.lbl.gov

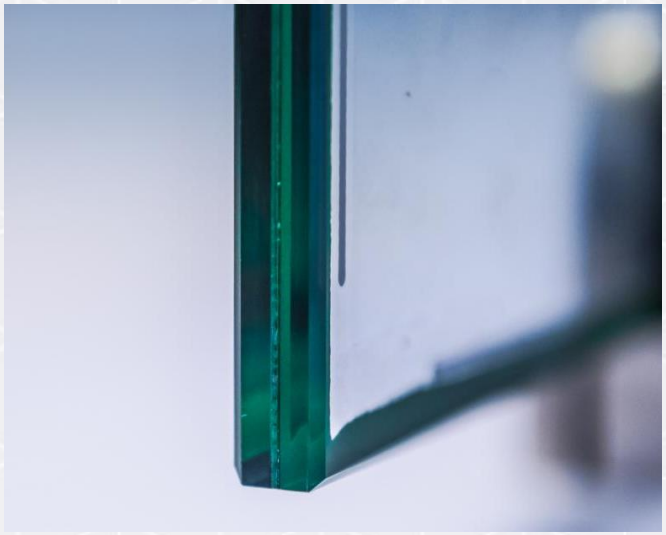


Image: agc-glass.eu

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)

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

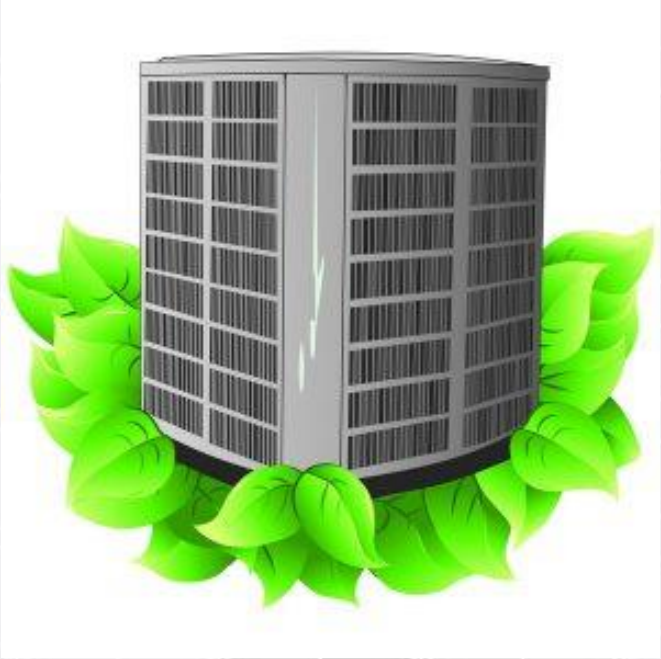
Image: 604goodguy.com

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

Image: energy .gov

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

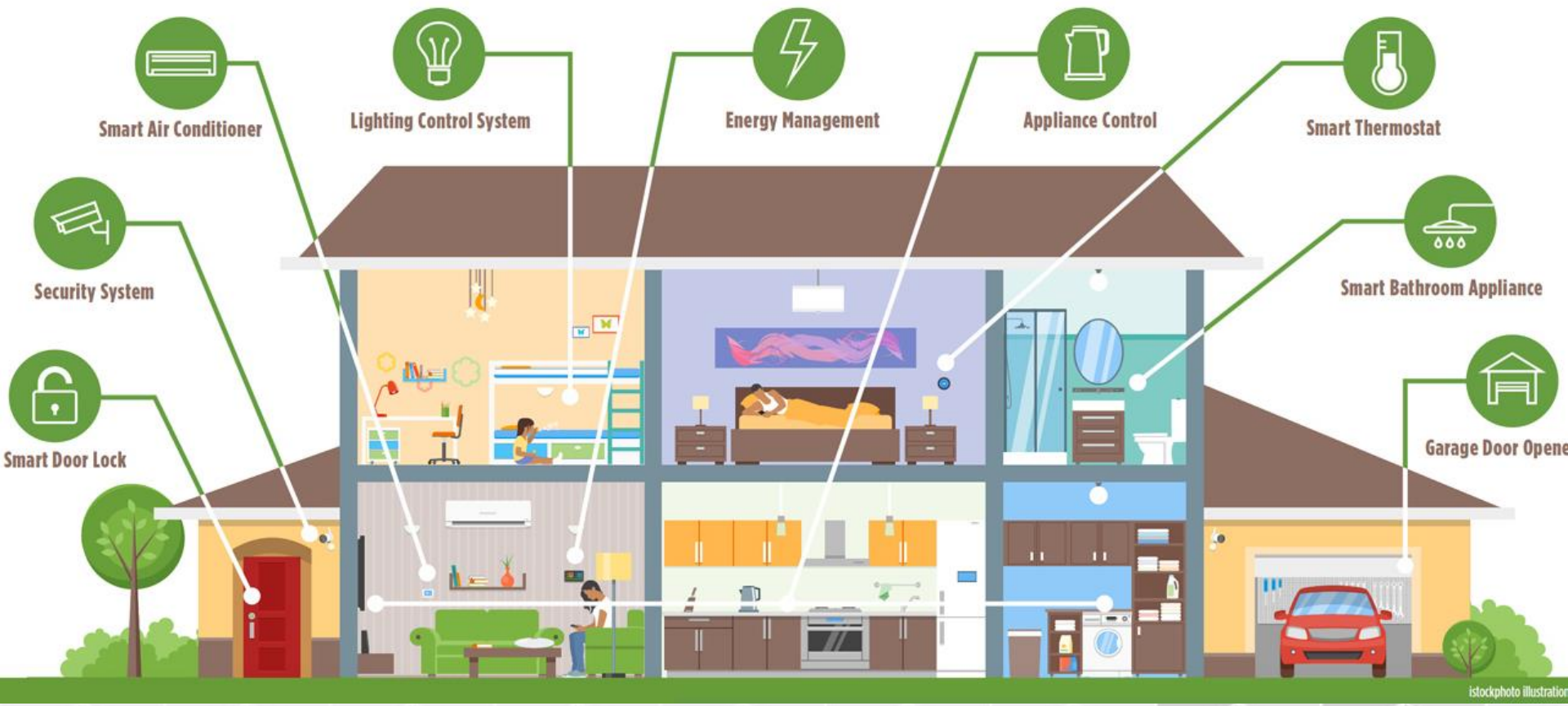
Heat Pump Water Heater

- 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

Appliance Technologies

- Increased Efficiencies
- Maintenance Benefits
- Connected Devices

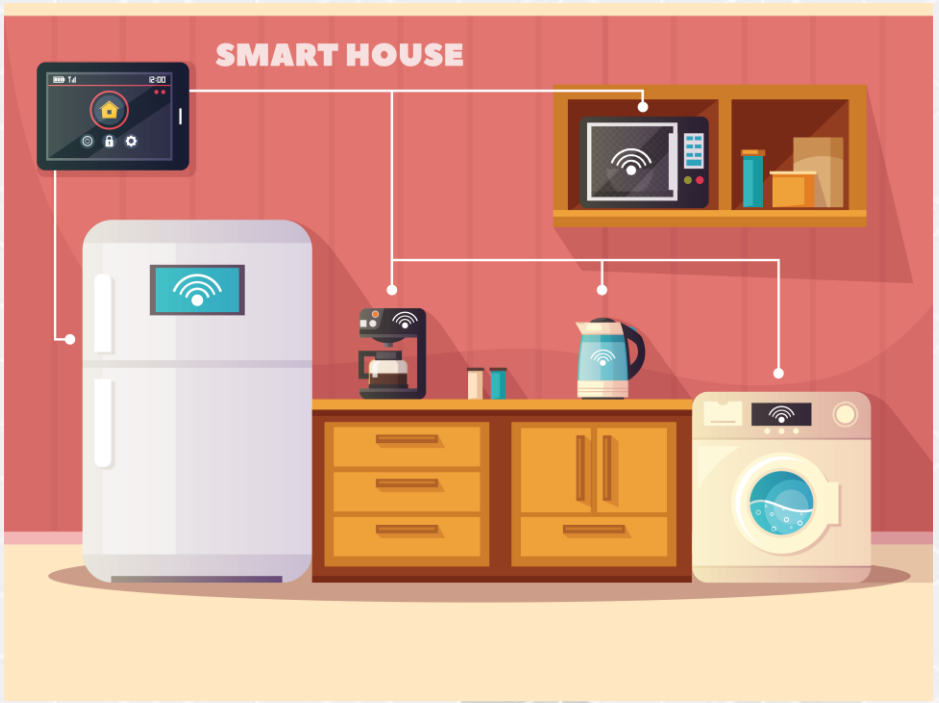


Image: southwestapplianceinc.com

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

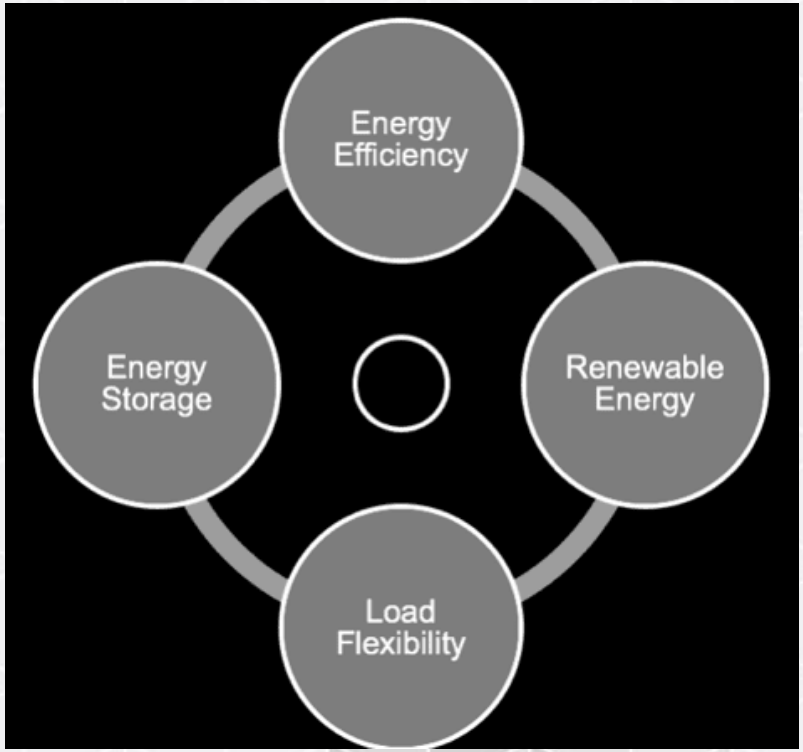
Solar Thermal Water Heater

- 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.

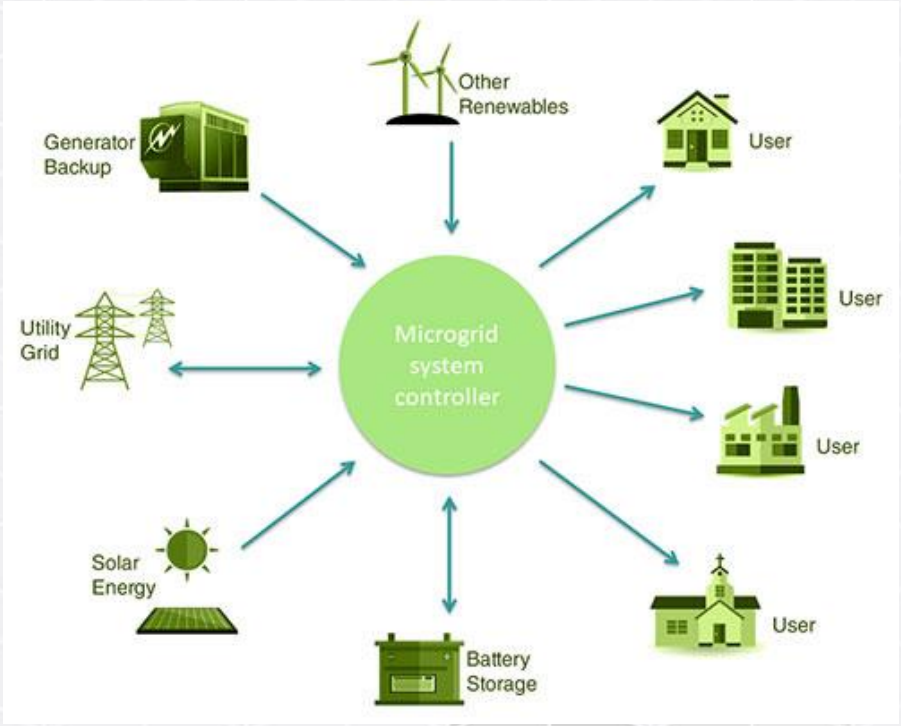


Image: strategicmicrogrid.com

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

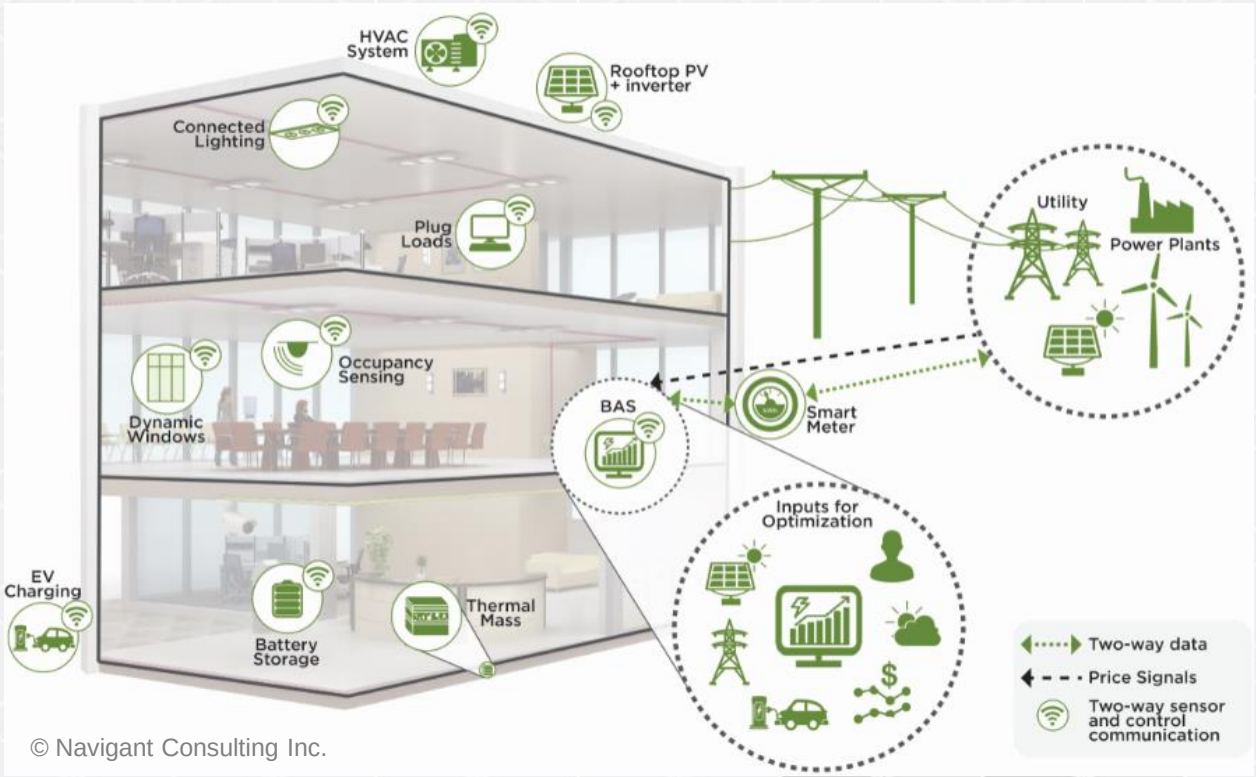


Image: energy.gov

Smart Neighborhoods: The Whole is More Efficient than the Parts

Alabama Power Smart Neighborhood

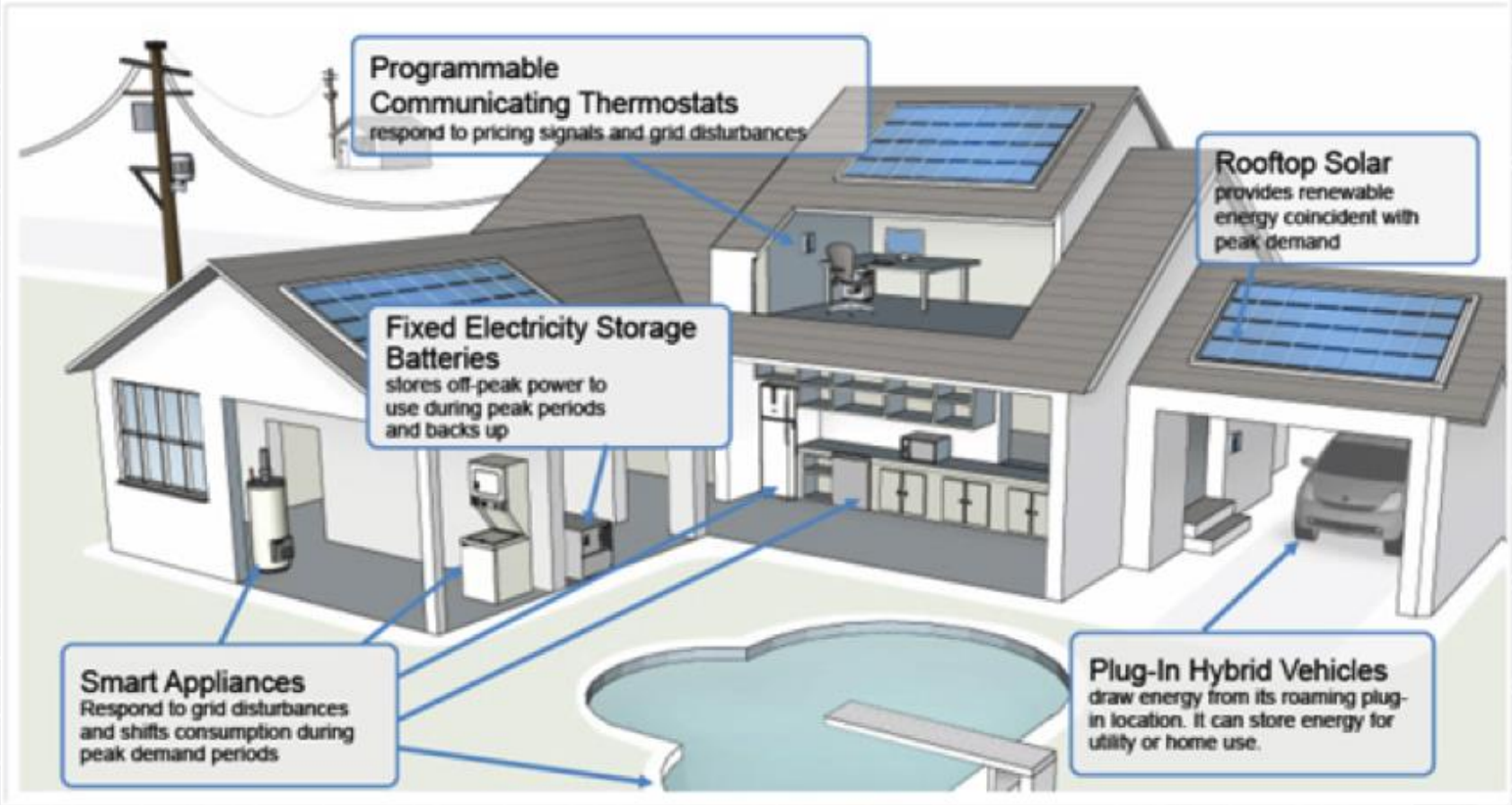
- 62 connected homes with state-of-the-art HVAC, neighborhood micro-grid, solar, battery storage.
- Up to 60% lower energy consumption
- smartneighbor.com

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: alabamanewscenter.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

Review Questions – Session 7

What are the risks in investing in one technology or energy source:

A. It can become obsolete rather quickly hurting performance and value.

B. It can work great, until it doesn’t, then what?

C. It can make replacement even more costly.

D. All of the above.

Review Questions – Session 7

What are the risks in investing in one technology or energy source:

A. It can become obsolete rather quickly hurting performance and value.

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Review Questions – Session 7

Well designed overhangs can give you a _____ % Head start on heating and cooling

A. 100%

B. 33-1/3%

C. 0%

D. 20%

Review Questions – Session 7

Well designed overhangs can give you a _____ % Head start on heating and cooling

A. 100%

B. 33-1/3%

C. 0%

D. 20%

Continuing Education Credits

- Participants of this session are eligible for continuing education credits from the International Code Council

- Course ID: **27513**
- CEUs: **0.2**

- If you would like a certificate of completion for this session, email Nicole at nwestfall@mwalliance.org

Next Week – Last Class!

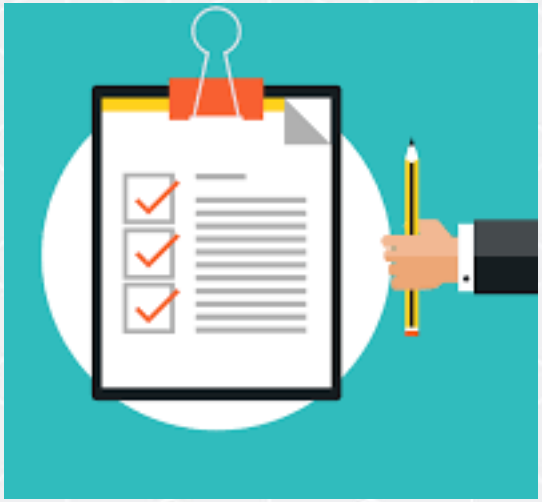
- March 16, 2021, 6:30-8:30pm
- Topic: Energy Code Benefits, Marketing, Review and Exam
- Contact Matt with Questions: matt@verda-solutions.com

Next Class

- 50 minutes – Energy Code Benefits and Marketing
- 30 minutes – Q&A and Course Review
- 40 minutes – Final Exam
  - 20 questions
  - Key topics from all 8 classes
  - 80%+ receives certificate of completion for course

Stakeholder Survey

- Goal: to better understand how different stakeholders interact with the energy code and energy efficient technologies
- 15-minute online survey
- Results will help identify topics to include in the trainings
- Survey link will be distributed after the class



Matt Belcher

matt@verda-solutions.com

SEE YOU NEXT WEEK!