Nebraska Commercial Energy Code:

Advanced Building Efficiency Technologies

Instructor: Matt Belcher

June 22, 2022

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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 posted on MEEA's website
- CEUs are available for ICC and AIA
  - Look out for follow-up email to provide your AIA #
- Email canderson@mwalliance.org with questions

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Today's Agenda

1. Advanced Insulation/Building Envelope
2. Phase Change Materials
3. Systemic Approach to Building
4. Advanced Fenestration
5. Advanced HVAC Equipment
6. Smart Homes
7. Electric Vehicles
8. Grid-integrated Efficient Buildings (GEB)
9. Carbon Defined

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Commercial Buildings in the IECC

Under the Purview of the Commercial Code

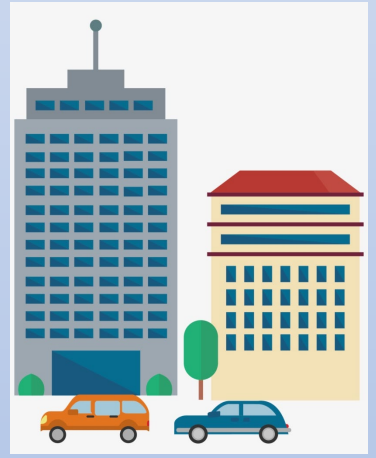
✓Buildings with commercial use

✓Multifamily residential buildings four stories or greater in height

Not Under the Purview of the Commercial Code

×One- and two-family residential

×R-2, R-3, R-4 three stories or less in height



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What About Mixed Use? – C101.4.1

- Treat the residential building portion under the applicable residential code
- Treat the commercial building portion under the commercial code
- Code Official has final authority

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Commercial Compliance Options

ASHRAE 90.1-2016

OR

2018 IECC – Prescriptive

- ✓ C402 – Envelope
- ✓ C403 – Mechanical
- ✓ C404 – SWH
- ✓ C405 – Lighting

AND Pick **at Least One C406**:

- ❑ C406.2 – Eff. HVAC Performance
- ❑ C406.3 – Reduced Lighting Power
- ❑ C406.4 – Enhanced Lighting Controls
- ❑ C406.5 – On-site Supply of Renewable Energy
- ❑ C406.6 – Dedicated Outdoor Air System
- ❑ C406.7 – High Eff. Service Water Heating
- ❑ C406.8 – Enhanced Envelope Performance
- ❑ C406.9 – Reduced Air Infiltration

OR

2018 IECC – Performance

- C407 – Total Building Performance
- C402.5 – Air Leakage
- C403– Mandatory Mechanical Provisions
- C404 – SWH
- C405 - Lighting
- Building energy cost to be < 85% of standard reference design building

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Additional Efficiency Package Options
Section C406

- <u>One</u> additional efficiency feature ***must*** be selected to comply with the IECC:
- C406.2 – Eff. HVAC Performance
- C406.3 – Reduced Lighting Power
- C406.5 – On-site Supply of Renewable Energy
- C406.6 – Dedicated Outdoor Air System
- C406.7 – High Eff. Service Water Heating
- C406.8 – Enhanced Envelope Performance
- C406.9 – Reduced Air Infiltration

More Efficient Lighting System

Onsite Renewables

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Advanced Building Envelope Components C406.8 & C406.9

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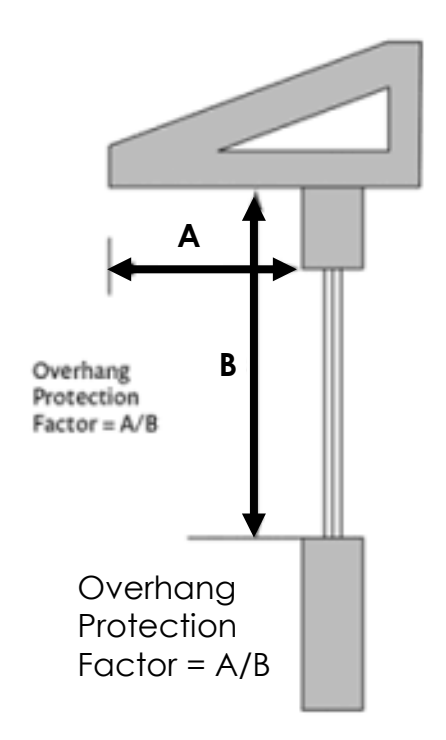
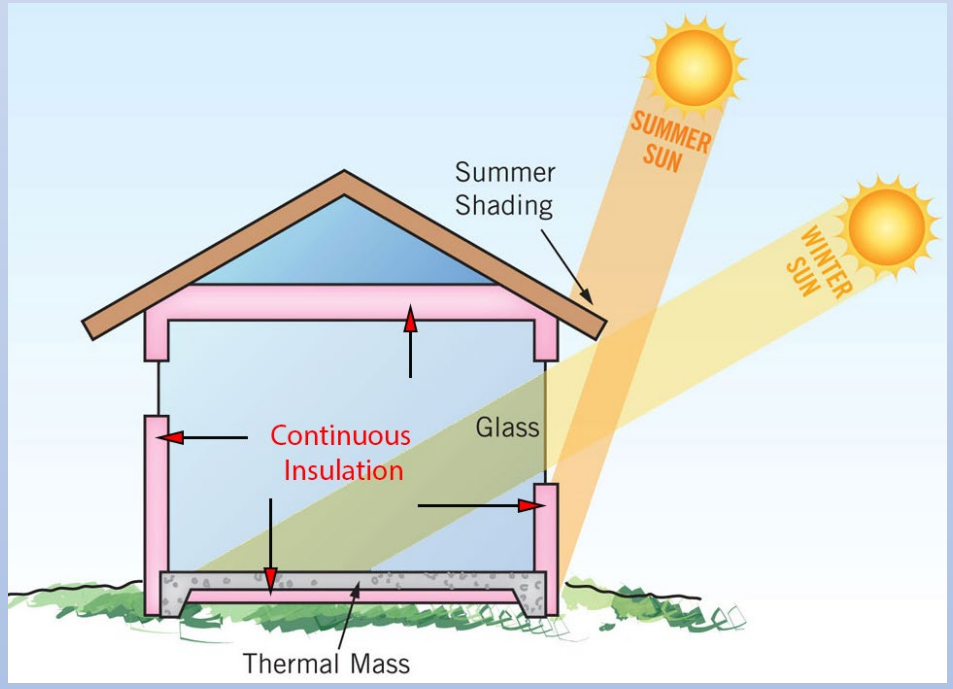
Building Envelope

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



Projection Factor



Solar Angle

Images: up.codes ecodesignadvisor.org.nz

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

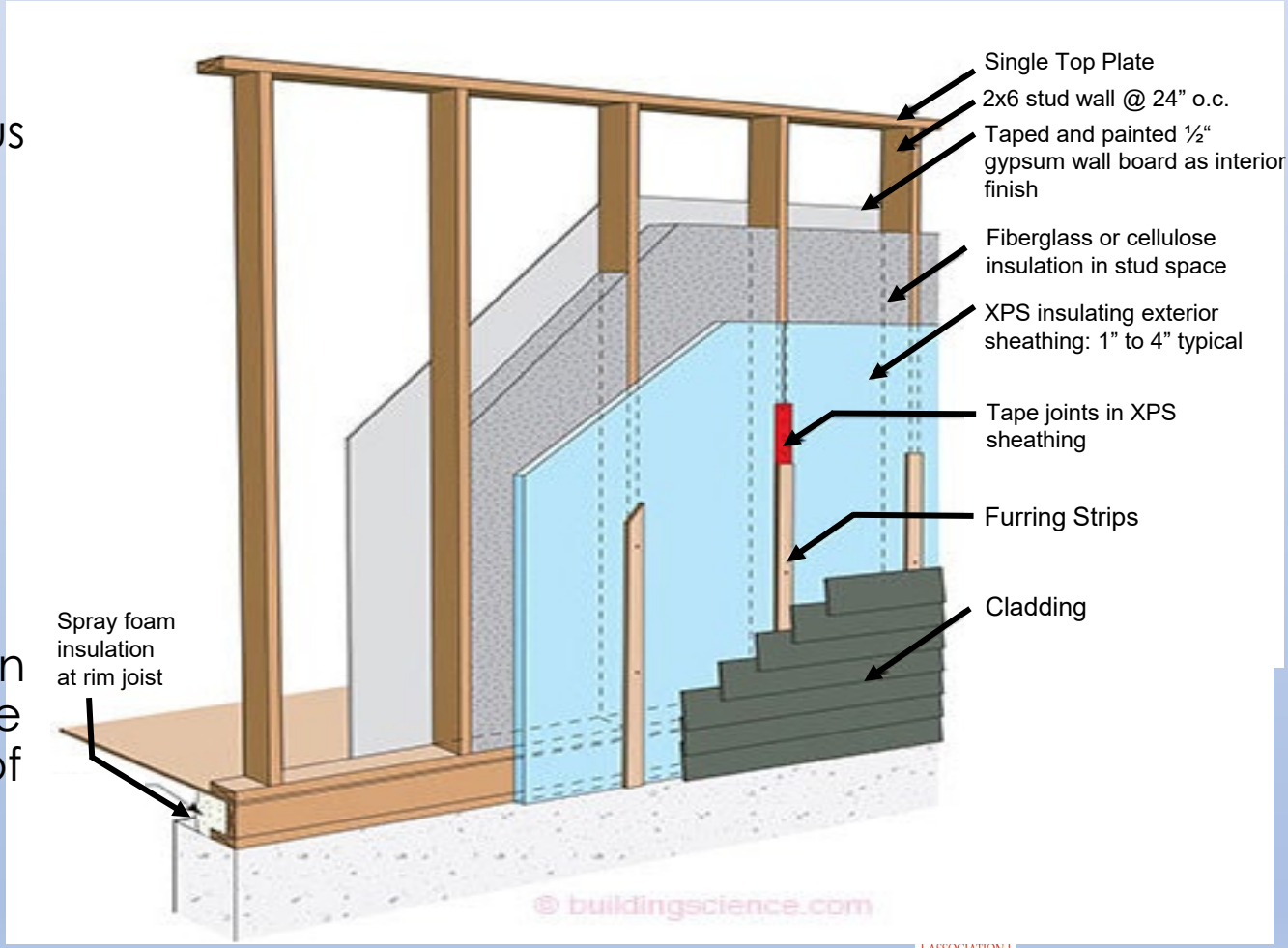


Image: buildingscience.com

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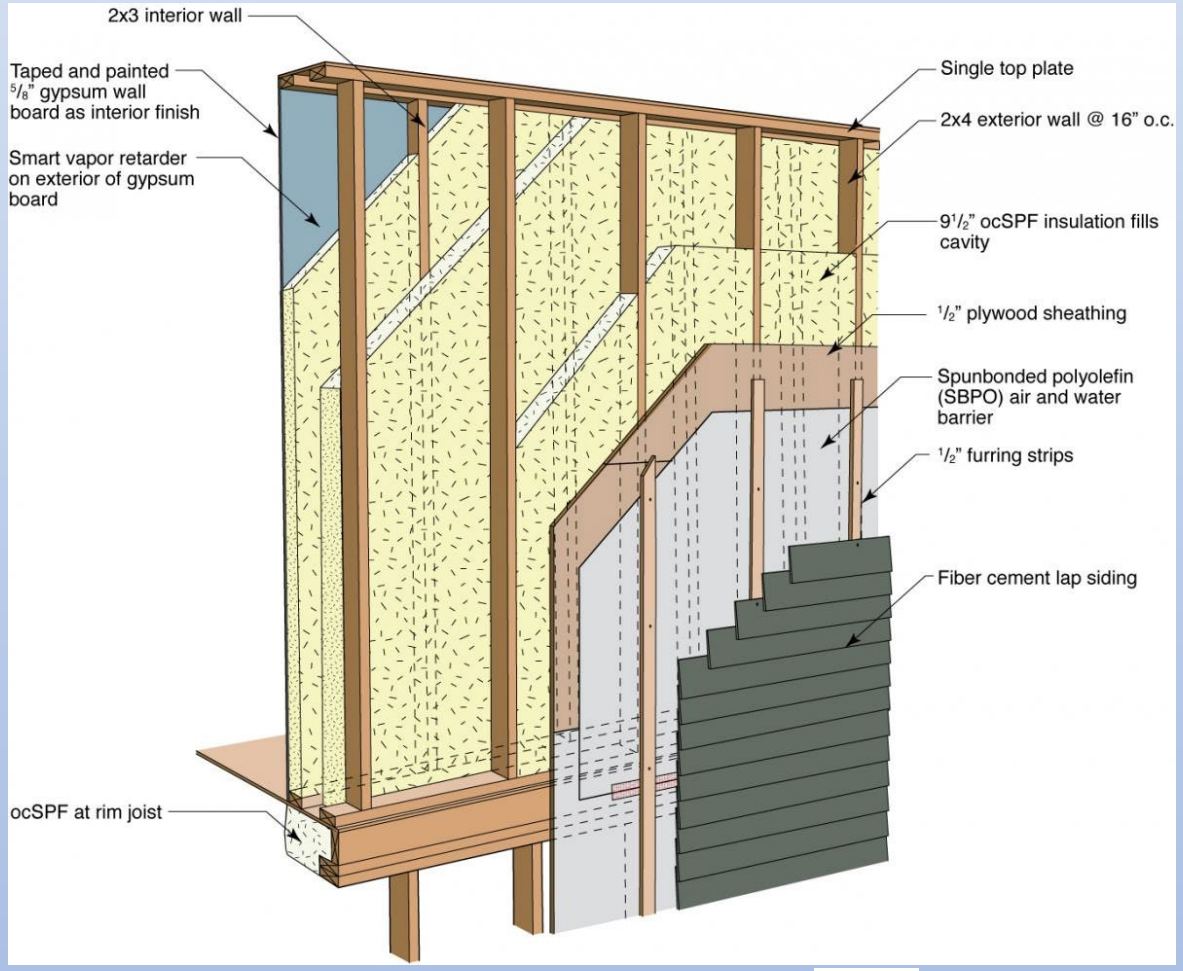
Continuous Insulation - Advanced Framing

- 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



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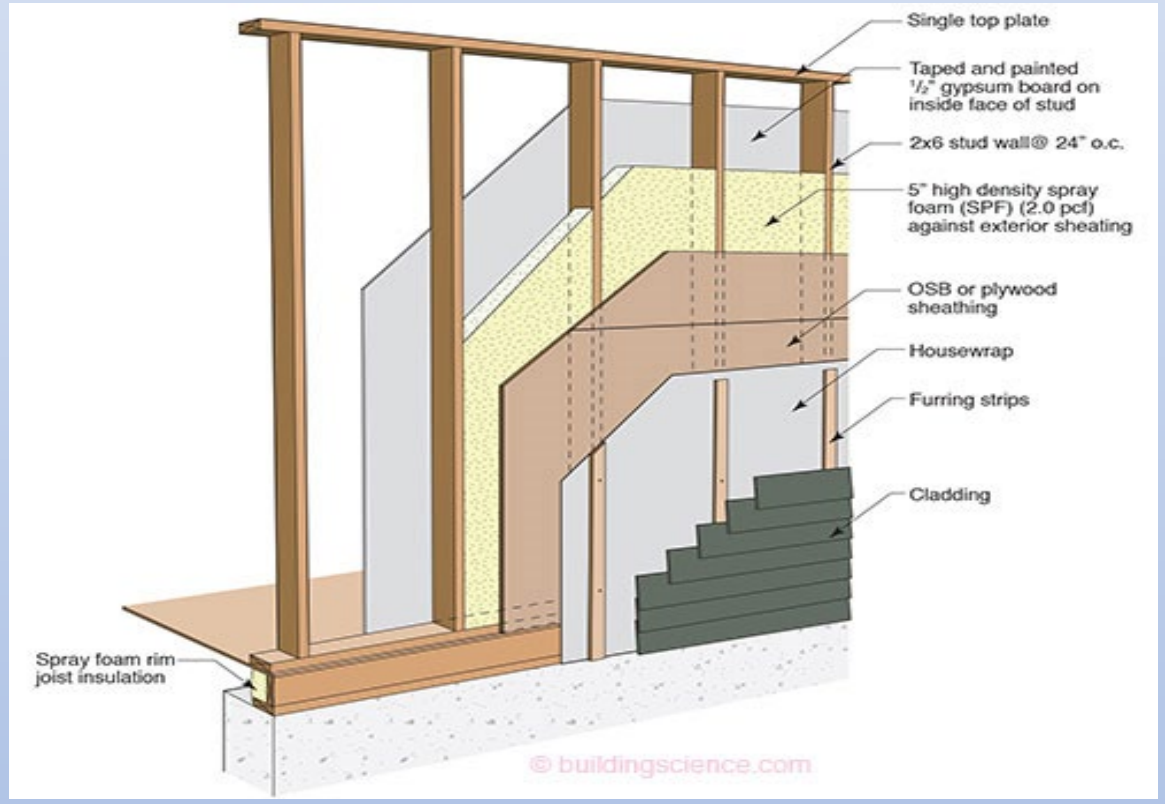
Insulation - Framing with Spray Foam

- 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 has to be carefully mixed on-site by installer.
- Spray foam has to be carefully applied to prevent shrinkage, lack of adhesion, and other problems.



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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

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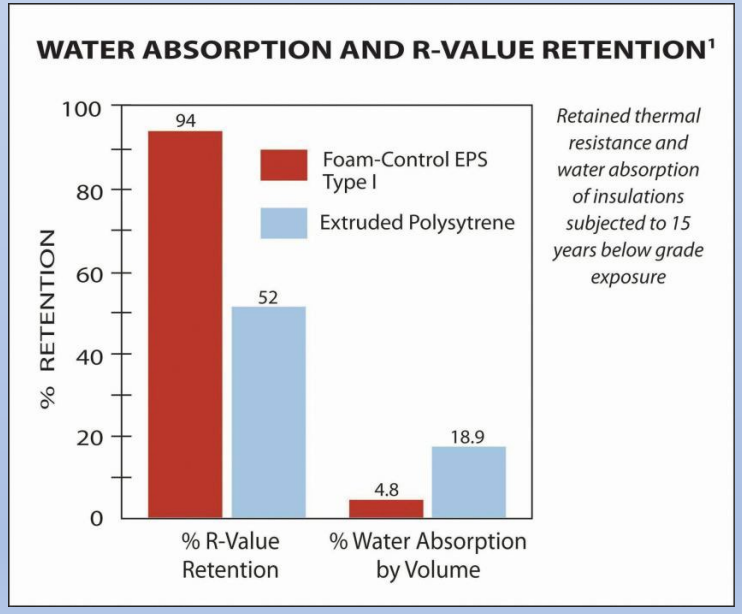
Comparing EPS and XPS

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

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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

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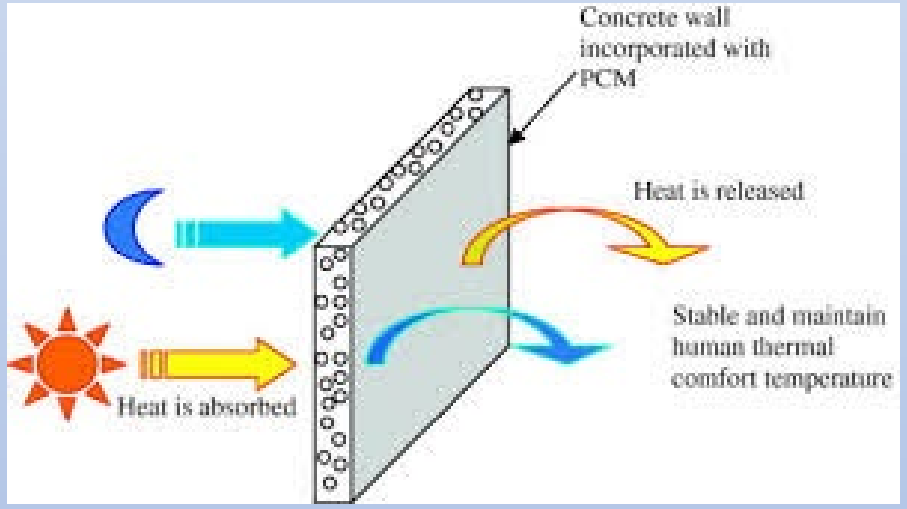
Phase Change Materials

- 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



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Systems Built 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

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Structural Insulated Panels (SIPS)

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

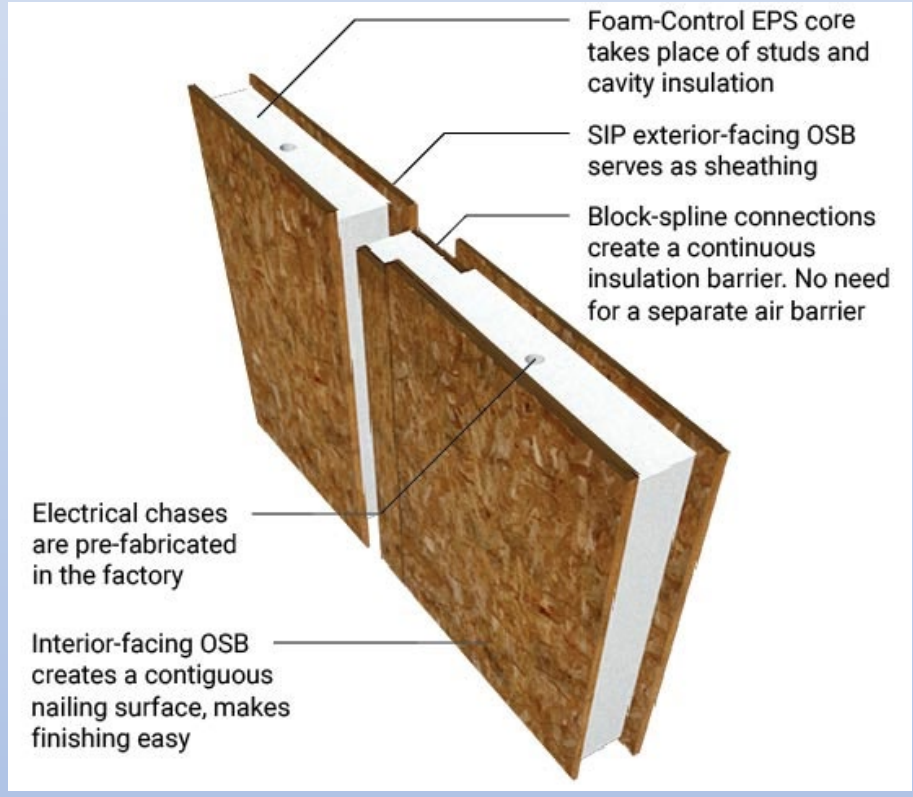

Image: trinitybuildingsystems.com;

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Panelized, Systemic Construction

Images: sips.org

Time = Money!
Enclosed and Insulated < Week

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Allows for quick assembly

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Precast Basement/Wall 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

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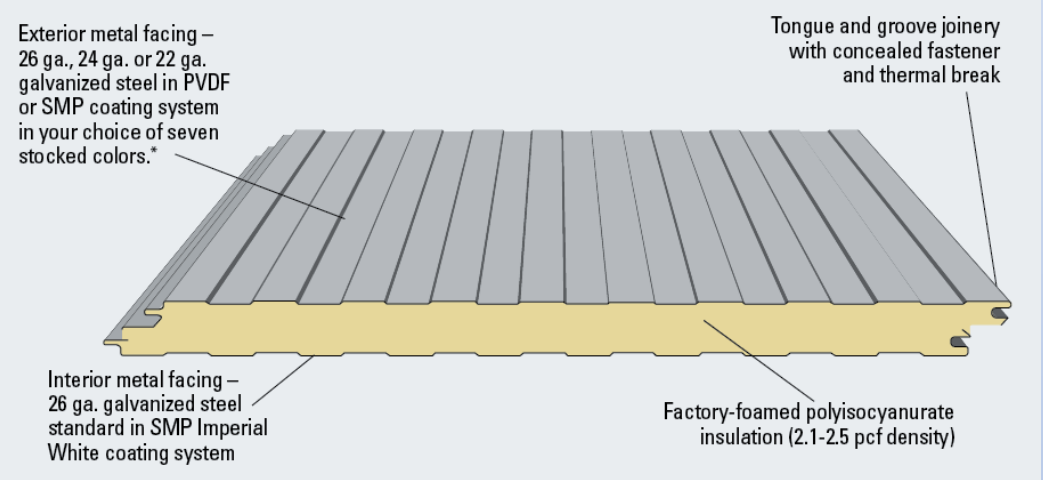
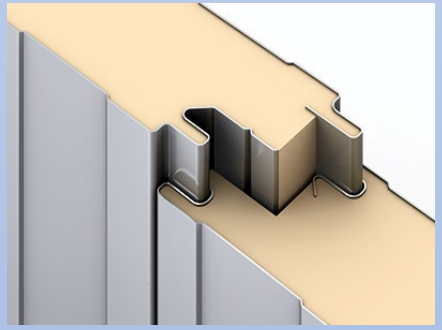
Steel Insulated Panels

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

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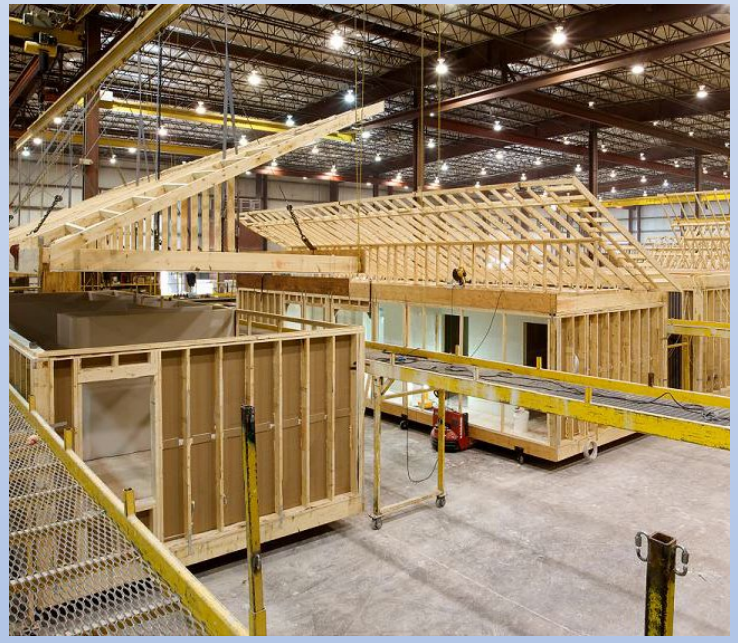
Modular/Volumetric

- 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



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Modular/Volumetric

- Gaining single family market share

- *REALLY* gaining multi-family market share

Image: bonestructure.ca; columnandbeam.com

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Advanced Fenestration

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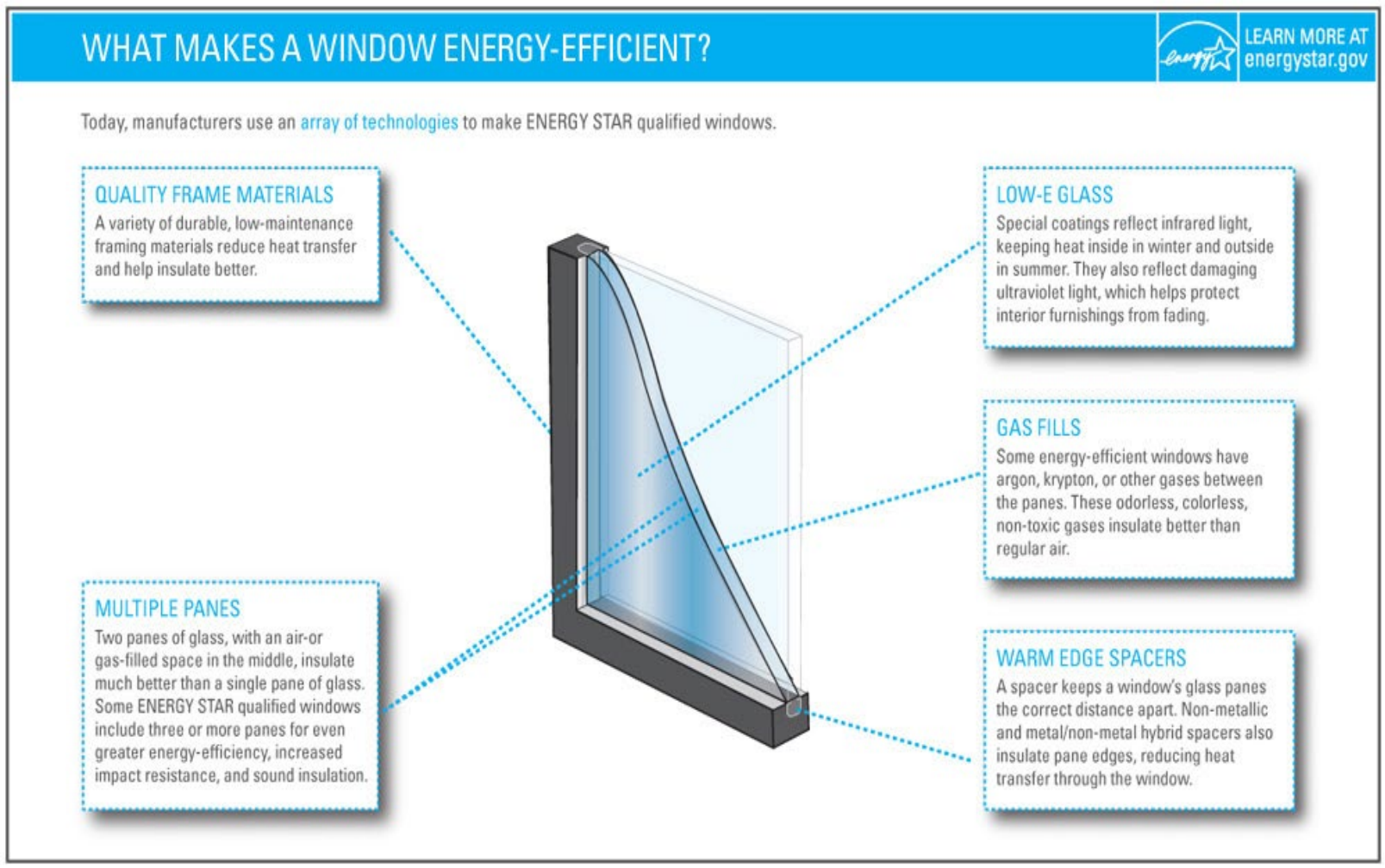

Source: energystar.gov

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Cutting Edge Windows: Thin Triple Pane and Vacuum Insulated Glazing

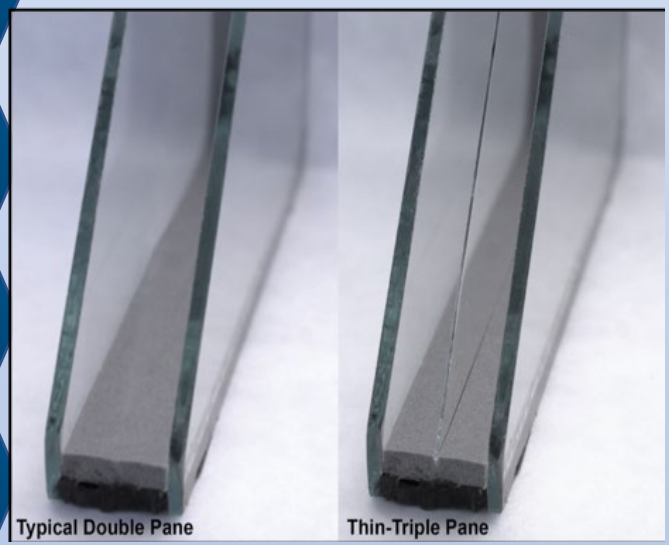

Image: eta.lbl.gov

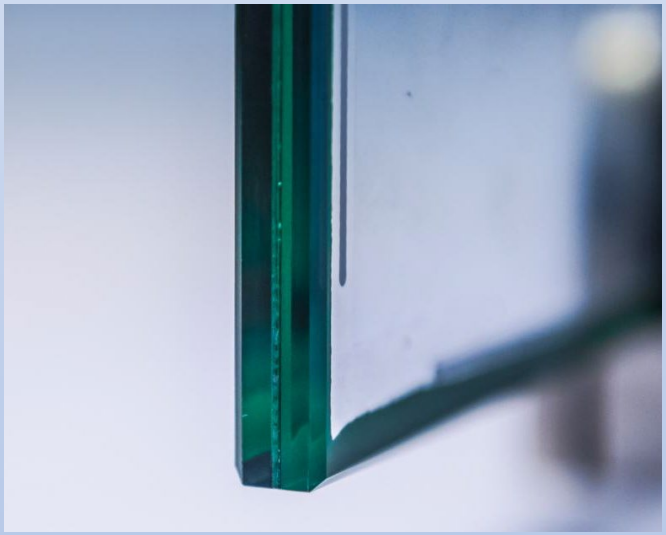

Image: agc-glass.eu

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

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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

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Air Barrier Construction
Section C402.5.1.1 (Mandatory)

- Air barrier placement allowed:
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope

    OR
  - Any combination thereof

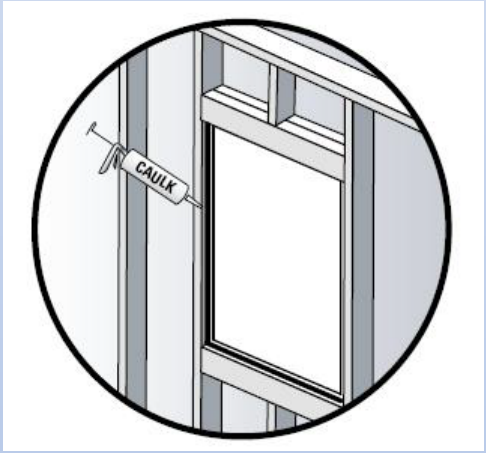

Image: bcapcodes.org

- Must be continuous for all assemblies and joints that are part of the thermal envelope

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Air Leakage
Section C402.5 (Mandatory)

- Tested (blower door) in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft^2

OR

- Comply with Sections C402.5.1 through 5.8

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Advanced Mechanical Systems
C406.2 & C406.6

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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

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HVAC Load Calculations
Section C403.1.1 (Mandatory)

Heating and cooling load sizing calculations required:

- ASHRAE/ACCA Standard 183

- OR -

- Other approved computation procedures – defined in Chapter 3
  - Interior design conditions specified by Section C302
    - ≤ 72°F for heating load
    - ≥ 75°F for cooling load
- Loads reduced from energy recovery systems utilized in the HVAC system shall be accounted for in accordance with the ASHRAE HVAC Systems and Equipment Handbook

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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

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Service Water systems C406.7

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Service Water Systems

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

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Service Water Systems

Mechanical Systems and SWH Commissioning
Section C408.2

- Prior to the final mechanical and plumbing sections, the registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion in accordance with section C408.2
- Mechanical Systems exempt from commissioning requirements (all other systems must comply)
  - In buildings where total mechanical equipment capacity is
    < 480,000 Btu/h (40 tons) cooling capacity **and** < 600,000 Btu/h combined service water heating and space-heating capacity
  - Included in Section C403.3 that serve individual dwelling units and sleeping units

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Smart Buildings and Homes C406.5

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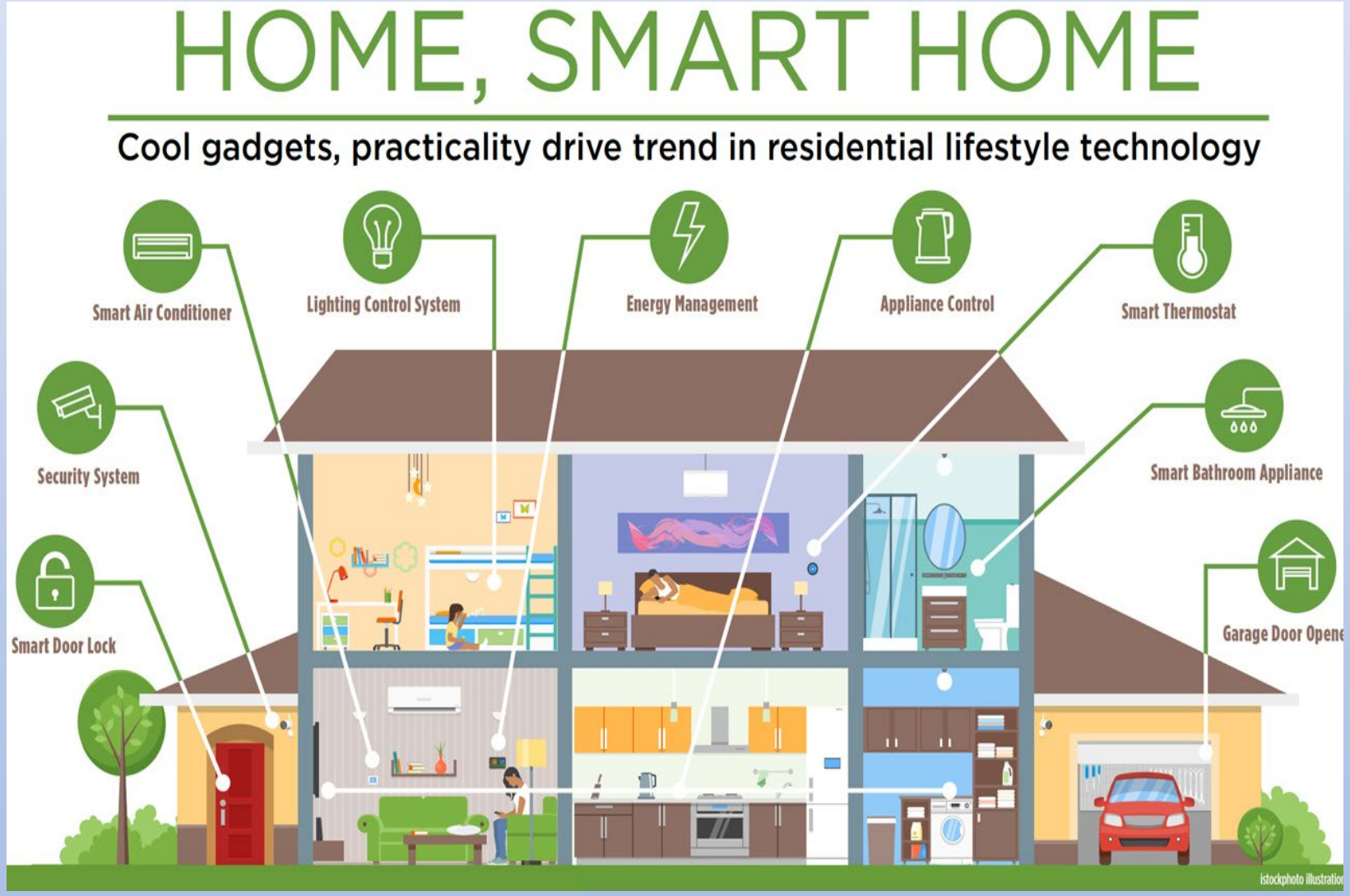

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System Technologies and Management

- 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

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Systems Commissioning and Completion Requirements
Section C408

- Commissioning is critical to ensure that buildings are **working as designed**
- Preliminary and final reports required
- Mechanical and lighting commissioning detailed in section C408

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Appliance Technologies

- Increased Efficiencies
- Maintenance Benefits
- Connected Devices

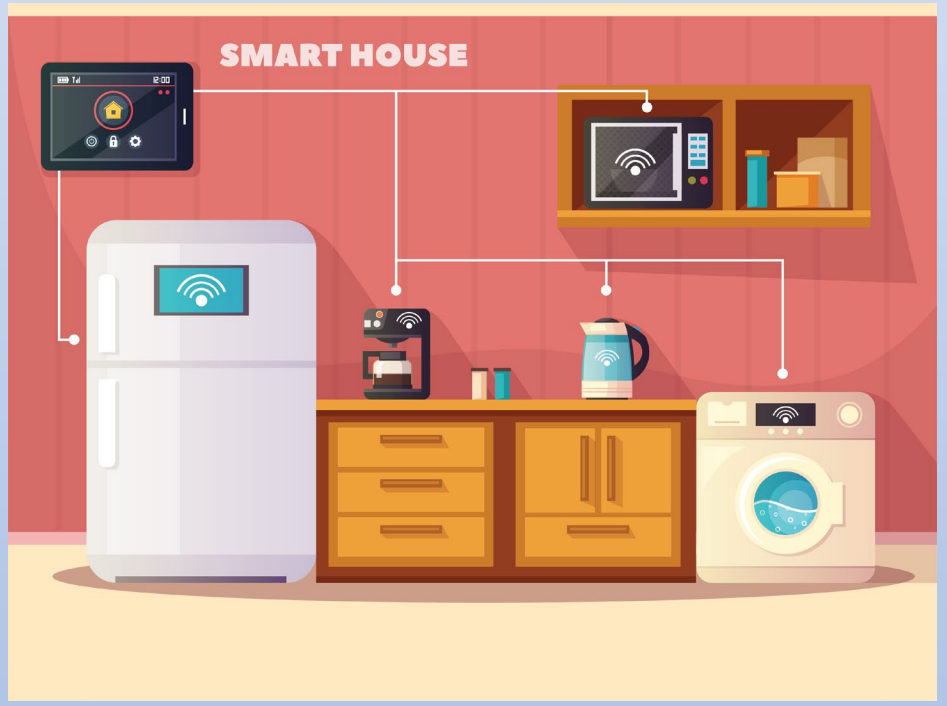

Image: southwestapplianceinc.com

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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

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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

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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

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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

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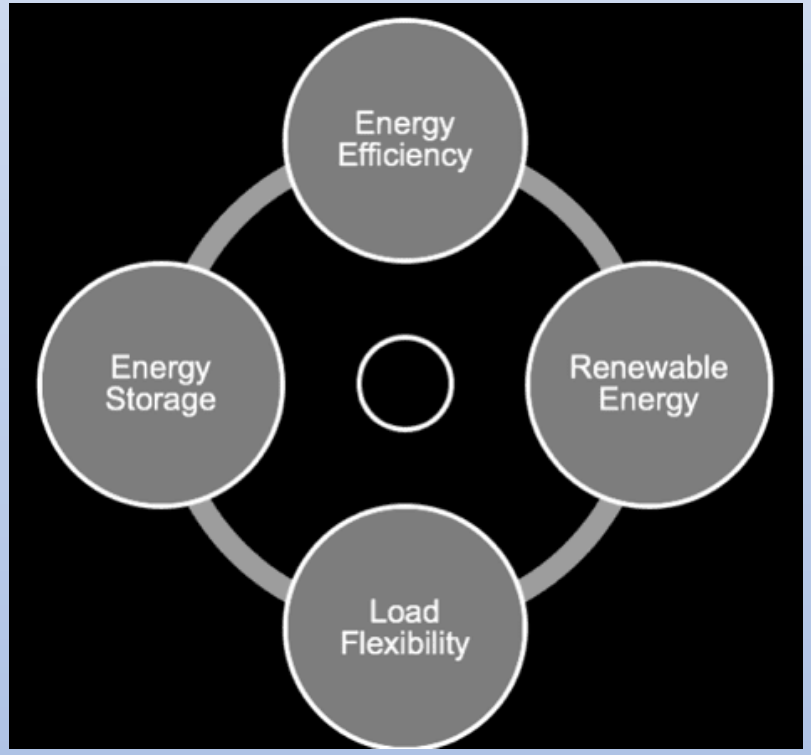
Energy/Battery Storage

- 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



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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.

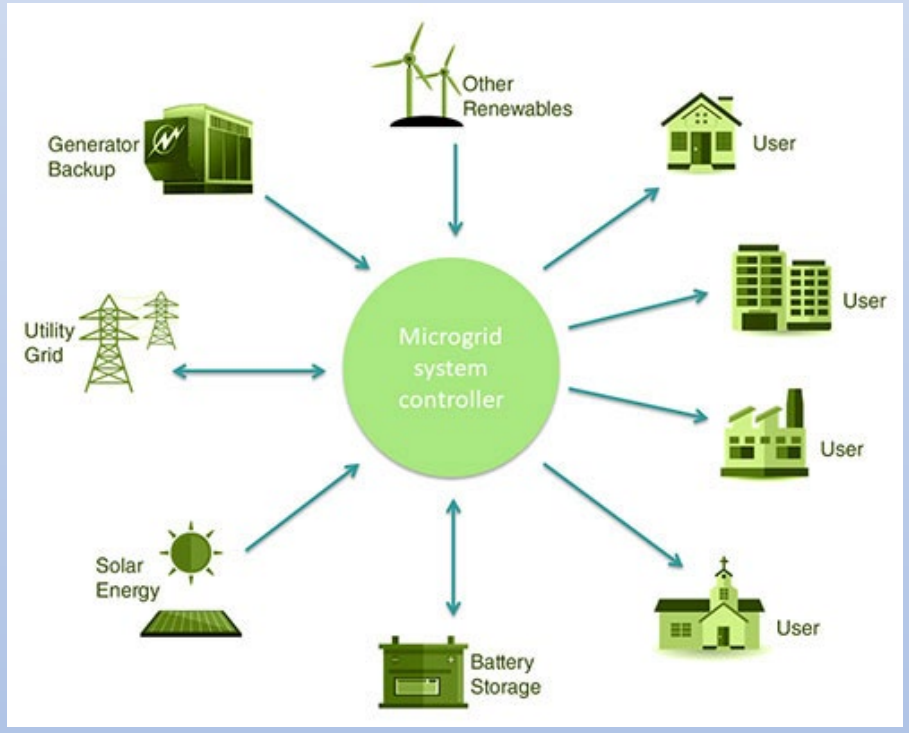

Image: strategicmicrogrid.com

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Grid-integrated Efficient Building - GEB

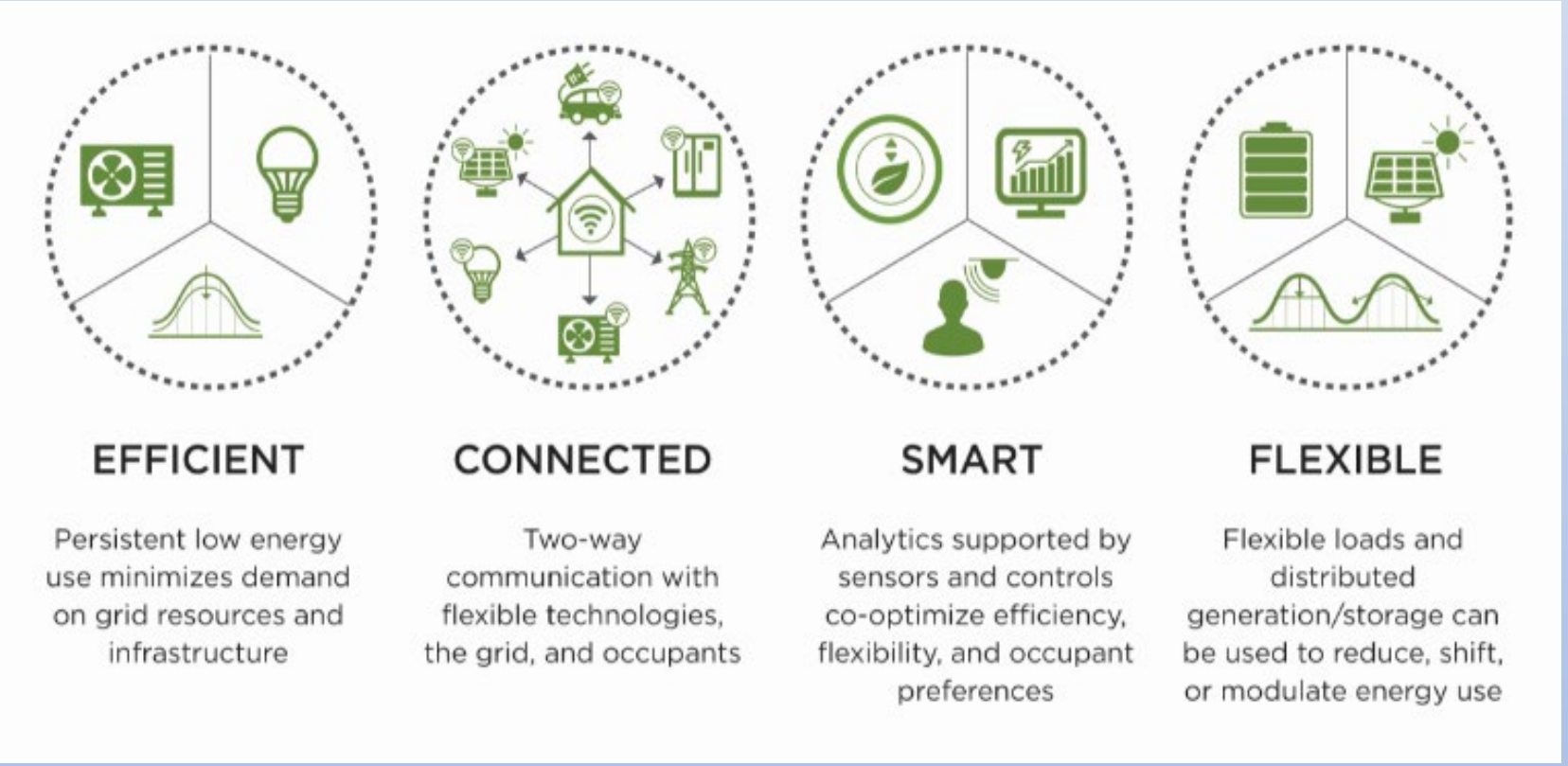

Image: energy.gov

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Grid-integrated Efficient Building - GEB

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

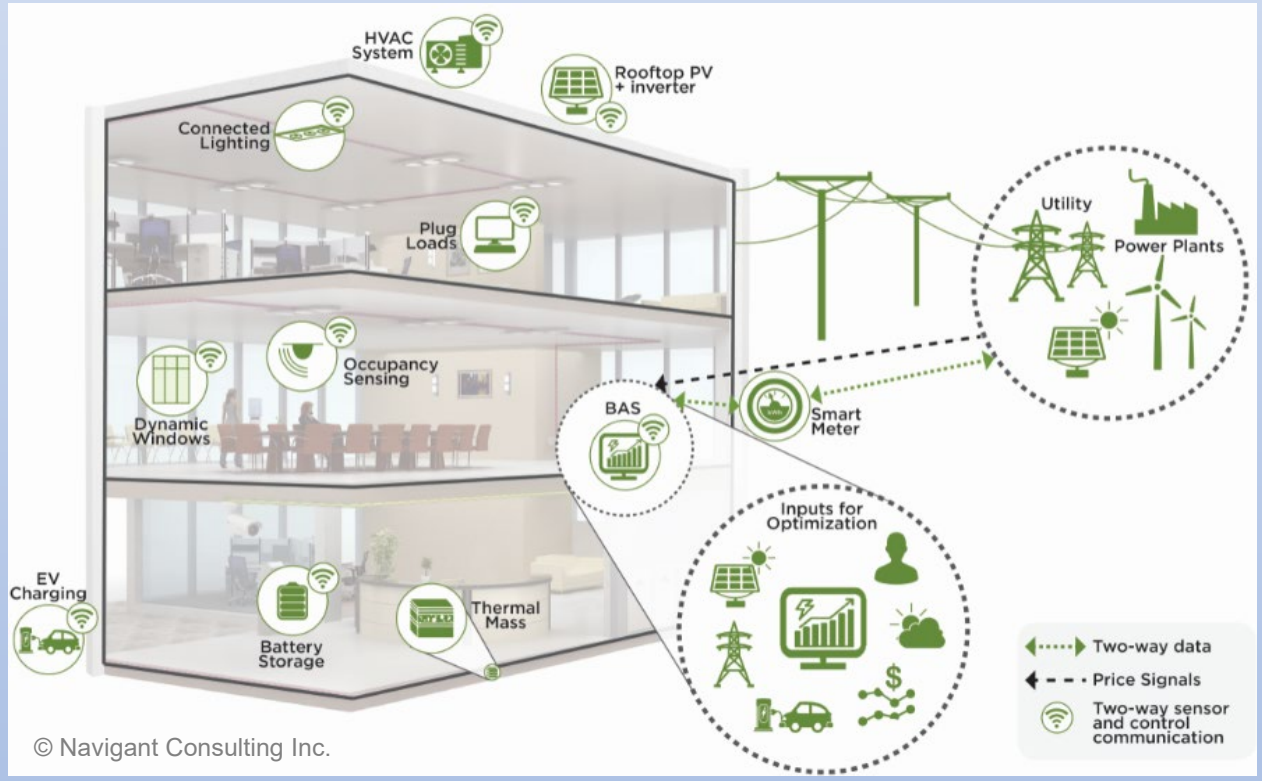

Image: energy.gov

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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

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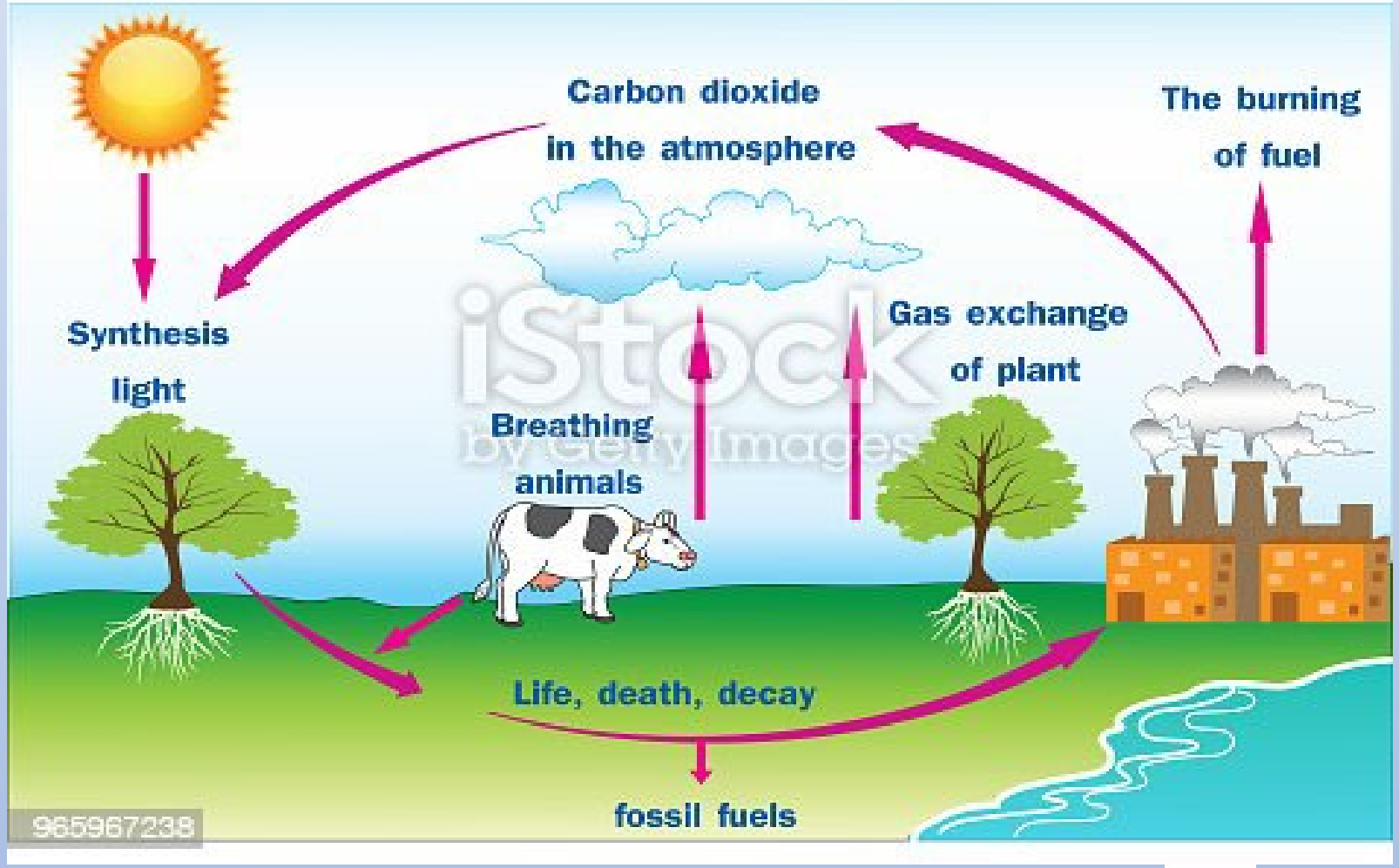
Carbon

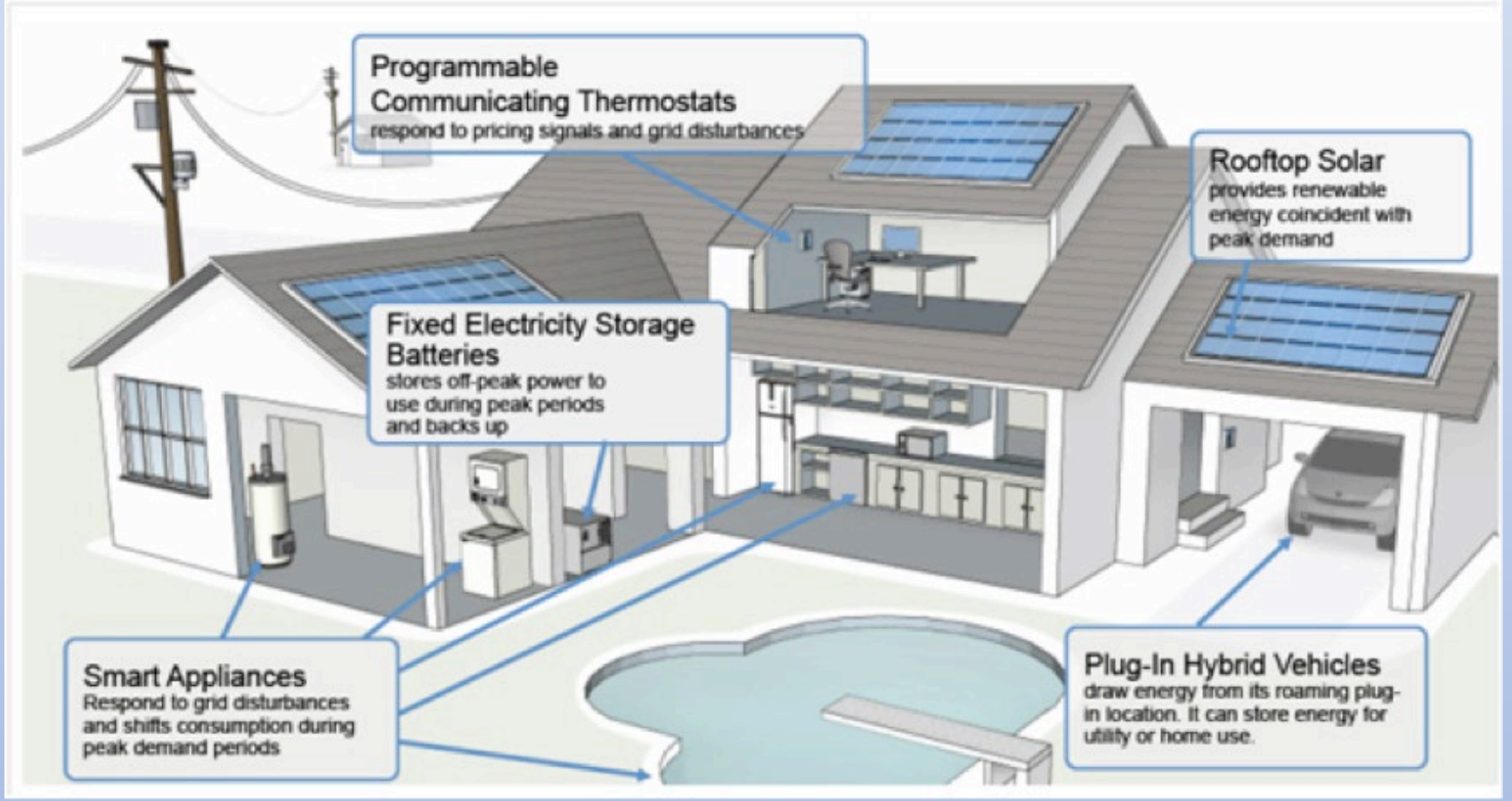
- **What is a carbon credit?**
- A carbon credit represents one unit of greenhouse gas (GHG) emissions reduced or carbon dioxide removed from the atmosphere.

- Carbon credits can be used to offset emissions.

Carbon cycle



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



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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!

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Questions?

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

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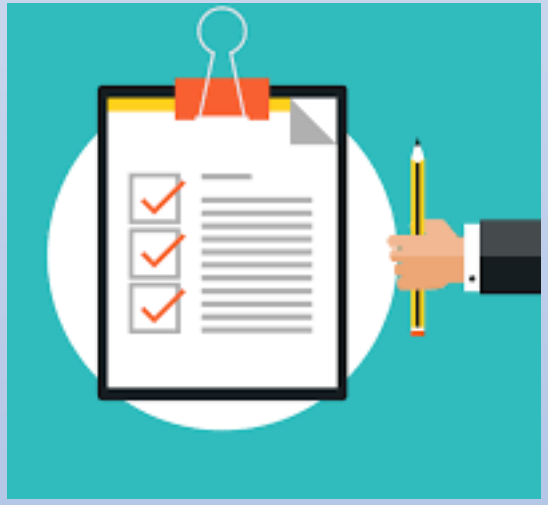
Stakeholder Survey

- 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



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Thank you!

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See you next Month!