Anderson Sargent Builders

Barley Pfieffer Architects

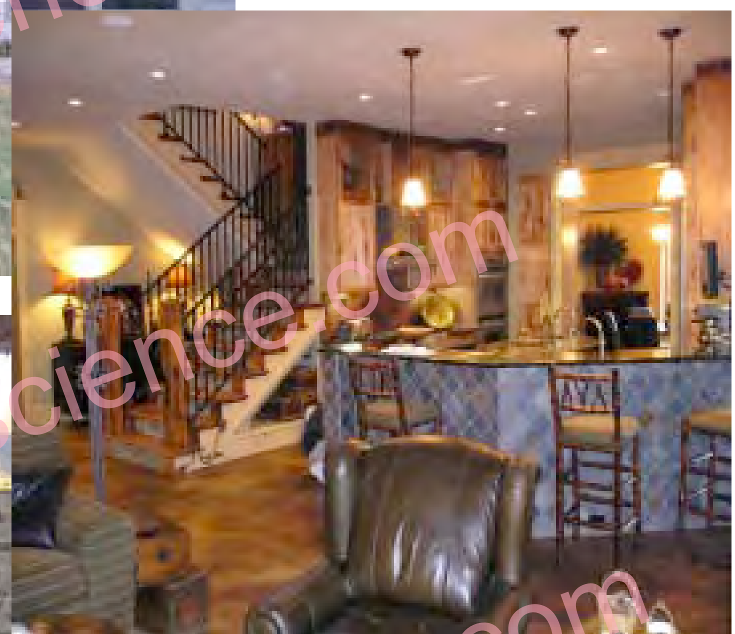
Building Science Corporation

The Energy Efficient Building Assoc.

US DOE Building America Program

Present

The Anderson/Sargent Dallas Show House: A Case Study



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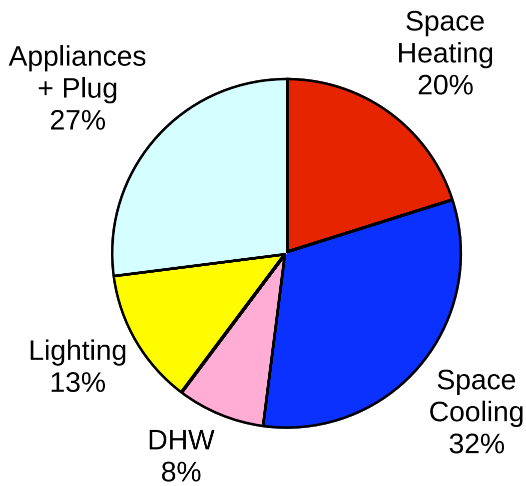
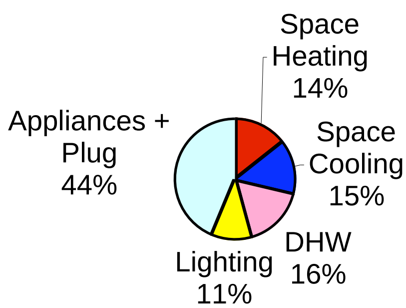
Energy Performance

Benchmark Home Predicted Energy Use:
329 MMBtu/yr

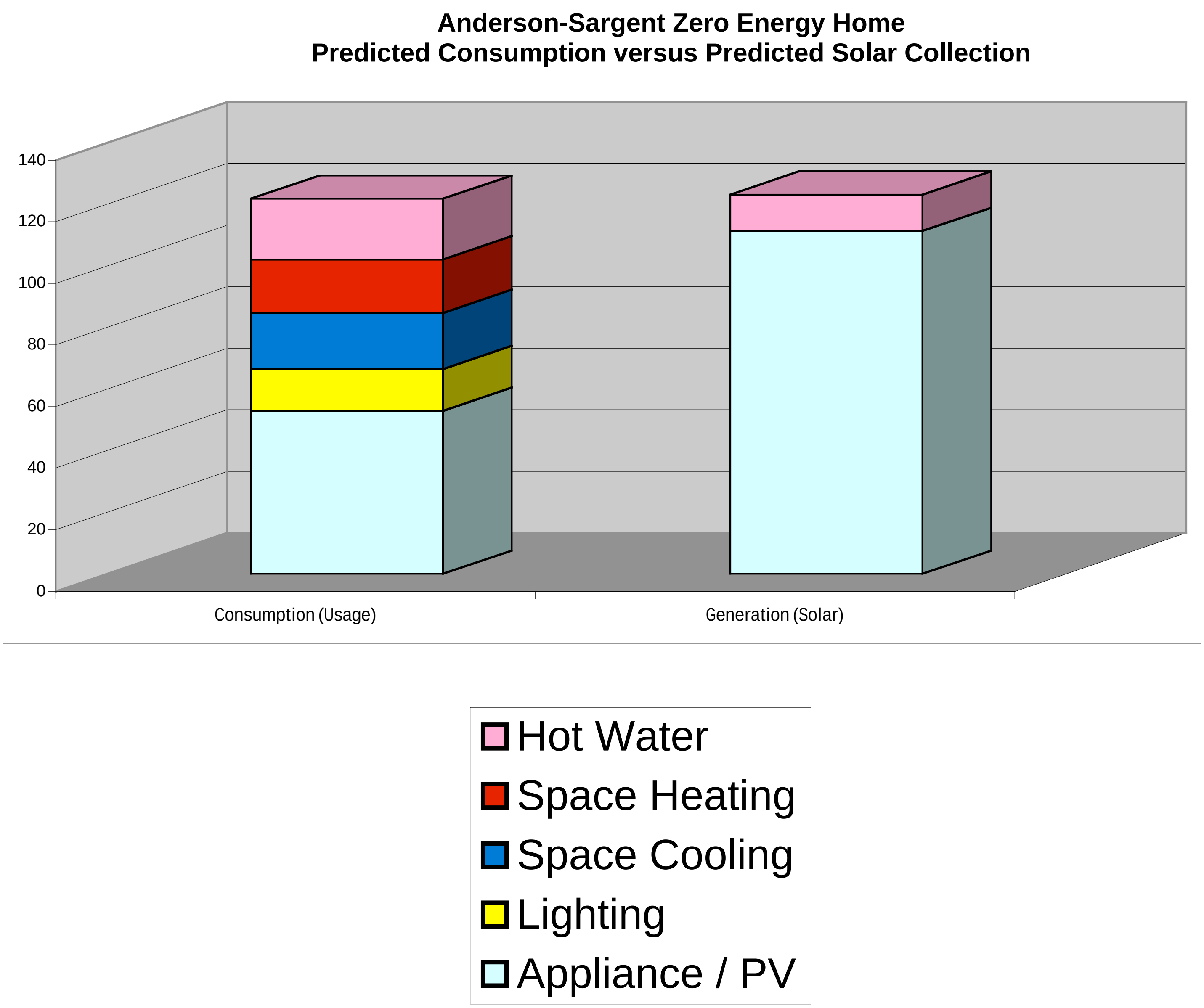


Zero Energy Home Predicted Energy Use:
122 MMBtu/yr *



* Actual use may vary with consumer behavior

Predicted Energy Use
vs. Predicted Energy Collection



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Predicted Energy Use
vs. Predicted Energy Collection

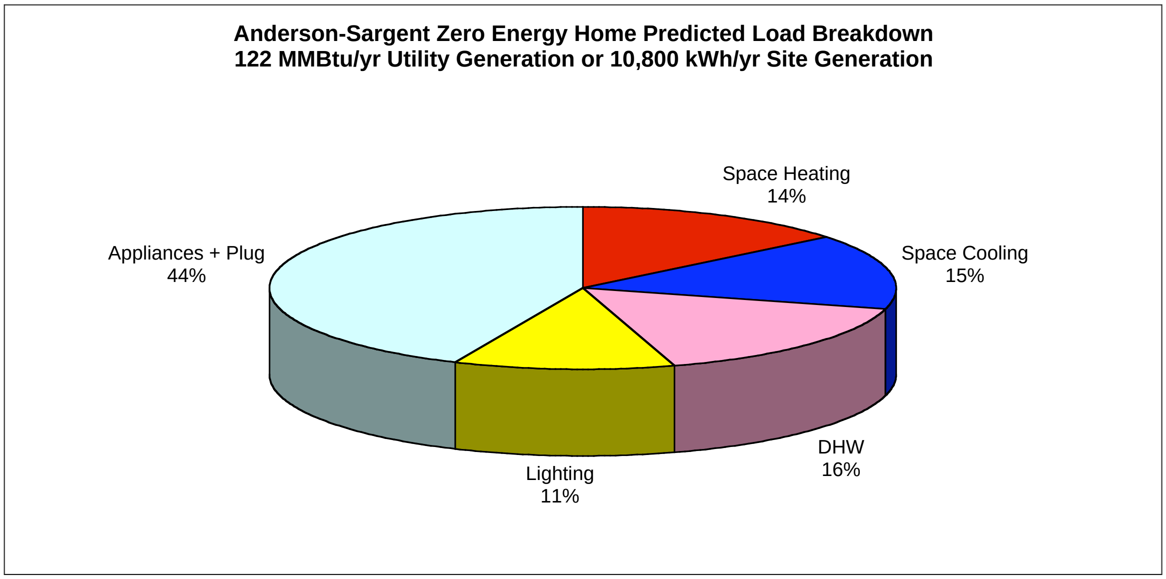

Table 2. Summary of End-Use Source-Energy and Savings

	Estimated Annual Source Energy		Source Energy Savings	
			Percent of End-Use	Percent of Total
End-Use	BA Benchmark 10^6 BTU/yr	Prototype 1 10^6 BTU/yr	Prototype 1 savings	Prototype 1 savings
Space Heating	66	17	**74%**	**15%**
Space Cooling	106	18	**83%**	**27%**
DHW	27	20	**26%**	**2%**
Lighting	41	14	**67%**	**8%**
Appliances + Plug	89	53	**41%**	**11%**
OA Ventilation**	0	0	**0%**	**0%**
Total Usage	329	122	**63%**	**63%**
Site Generation	0	-111		**34%**
		-12		**4%**
Net Energy Use	329	-1	**100%**	**100%**

Notes:

Energy Star Score = 94.5

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The Anderson Sargent home is expected to produce as much energy as it consumes. But many logical strategies to improve performance were applied to this system prior to providing site generated power

Energy Efficient Systems
- Thermally efficient enclosure
- Air leakage control
- Duct Sealing

Water Efficient Systems
- Indoor
- Outdoor

Healthy Interior Environments
- Comfort
- Air change /Diluting the source
- Source control / Capturing the source

Information to Homeowners
- Homeowner education
- Homeowners operation and maintenance manual

Reduced Global Impact
- Increased Durability/ Moisture Control
- Reduction of carbon dioxide
- Passive designs

Environmentally Sensitive Site Planning and land use
- Low impact development
- Preserve & protect natural environment

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Homeowner benefits include.........

- Lower operating costs
- Increased comfort
- Improved environmental quality
- Enhanced durability & less maintenance

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Specifically, the house uses the following strategies to reduce impact and improve performance.................

1. Site Development
Lot Design, Preparation and Development

- Building on an existing developed lot

- Oak tree on lot was preserved
- Soil erosion and disturbance minimized during construction
- Manage storm water w/low impact, low water use landscape-xeriscape

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2. Resource Efficiency

- Durisol Block
  - Enhance durability & reduce maint.
  - Durisol block uses recycled content materials
- Reuse materials - stair treads from old beam
- 45% fly ash additive to concrete used
- Fibercement siding on furring
- strips over housewrap for longer life

- Complete window and door flashing packages
- Non-paper faced gypsum board- less moisture sensitive
- Stone facing at grade level for additional durability
- Floors stained concrete finish

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3. Energy Efficiency

- Exceeds 2003 IEEC
- 94.5 Energy Star Score
- Verify performance with 3rd party
- Thermally efficient enclosure
- Passive cooling strategies
- Air sealing
- High efficiency HVAC design & equipment
- Solar Thermal Design
- Solar Electric Design
- All Energy Star Appliances
- 90% Compact Fluorescent Lights

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4. Indoor/Outdoor Water Use

- Water conservation system – This home will use 30% less water for indoor needs and supply nearly all of its own water for outdoor use.

- Xeriscaping & Drip Irrigation: The landscaping consists of an impressive variety of native and low water use vegetation. Sod is drought tolerant Zoysia. All planting areas, other than sod, are drip irrigated

- Rain water harvesting designs with cisterns, enough water collected (up to 5000 gallons) that no water expected to be needed from city to water yard

- High Performance Hot Water Distribution System –optimizing the layout (shortest route) right-sizing the pipe, selecting the right type of pipe, and a recirculation loop run by an efficient pump.

- The wait time in the North Texas ZEH is about 5 seconds for 120° F water and all the cooled water is sent back to the water heater tank.

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4. Indoor/Outdoor Water Use (continued)

Delta® low-flow faucets and showerheads, delivering the same wetting characteristics as conventional fixtures, but using 35% less water

Metlund® Hot Water D'Mand system, recirculating cooled water in your hot water pipes back to your water heater; saving water, energy, and adding the convenience of "instant" hot water

Toto® water closets, toilets that actually work, requiring a single flush of 1.6 gallons or less (Toto is the only manufacturer to have all of their products pass the new stringent MaP Test

Whirlpool® clotheswasher, using up to 42 percent less energy and up to 59 percent less water compared to standard-efficiency clotheswashers

Whirlpool® dishwasher, using at least 25% less energy and 44% less water than conventional dishwashers

The ETWater Systems controller, reducing outdoor water use by up to 50% while maintaining health and vigor of turf and plants. This system uses the internet as its vehicle for communications

5. Indoor Environmental Quality

- Source control with closed combustion gas appliances
  - fireplace
  - instantaneous hot water heater
- Dilution ventilation in accordance with ASHRAE 62-2, provided by outside air mixed and distributed through the air handling system
- Exhaust ventilation at pollution source
  - Bathrooms
  - kitchen
- Designed for natural flow through of outside air
- Window glazing selected for true color rendition
- Finishes chosen for low VOC's
- Surfaces chosen for ease of cleaning with low toxic products
- High efficiency filtration at return
- Mold and mildew prevention
  - Interior relative humidity control
  - Control of liquid water entry
  - Non-moisture sensitive construction materials

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5. Indoor Environmental Quality (cont.)

- Comfort Features
  - Building Enclosure designed to be leak free to stop unintentional air leakage
  - Interior environmental controls allow for maximum flexibility of interior environment
  - Continuous airflow provides clean smell
  - Day-lighting provides connection to outside
  - Screened and shaded porches for variety
  - Shaded backyard kitchen allows for heat to remain outside
  - High mass interior and exterior walls help keep temperature constant
  - Sound attenuated by block and foam gaskets between floors and at laudry room wall

Systems Engineering

Systems-Engineering means coordinated, comprehensive high performance.

We know this and expect this of our cars—the engine, the transmission, the brakes, the chassis are all matched in design and operation, to work as a system.

It means the same for and we should expect the same of our homes.

The building shell, the windows, the HVAC, the hot water, the electrical are designed and constructed recognizing the impacts these systems have on each other and, ultimately, on home performance.

The result is a quality home, a house that works—safe, comfortable, healthy, efficient, easy to own and operate.

Building Enclosure

All six sides of any building (the four walls, the roof and the foundation) must be designed to manage the flow of liquid water, water vapor, air, and heat (including the transitions from roof to wall and wall to foundation). Key aspects of this home include:

Roof assembly–

Spray foam insulation (R-30) that manages moisture, air and heat in the roof assembly, particularly at the eave transition to the top of the walls.

Roof cladding –

The metal roof has a high performance coating, giving it relatively high solar reflectance (28%) and emmissivity (85%). Hence the name "Ultra-Cool" for this roofing material.

Exterior walls –

This is a moisture-forgiving assembly throughout—from the furred out fibercement siding to the wood-cement composite block (Durisol- R-14) to the non-paper faced gypsum board interior.

High performance windows –

The spectral properties of window glazing can be tuned in terms of rejecting and retaining different forms of heat. The windows in this home are tuned for the Dallas climate (low-e, U = 0.38, SHGC = 0.29); the glazing is even different on the south side of the house (SHGC = 0.48) to maximize winter sun gain.

Foundation –

A continuous capillary break separates the grade beams and slab foundation from the ground and soil moisture; rigid foam insulation (R-5) under the secondary cast concrete slab keeps radiant floor heat "in."

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Building Enclosure Characteristics

Passive Design – Passive Design uses the building to even out highs and lows of heating and cooling, and to promote natural ventilation and day-lighting. Note the following passive features of this home:

- Eave overhangs and window awnings – Both are sized to reject high-angle summer sun, receive low-angle winter sun, and let in plenty of diffuse light year round.

- Windows and their placement –
  - The windows in this home have been sized and placed for maximum cross ventilation as well as for "thermo-siphoning" (Operable windows at the stair landing on the leeward side of the home encourage hot air exhaust up high and cool air intake down low).
  - The centrally-located stair tower and north-sky facing skylight bring natural daylight into the core of the house, much like in vernacular Texas architecture, reducing reliance on electric lighting and enhancing the interior ambiance.

- Thermal mass – the block walls and first floor concrete slab have lots of mass interior to the insulation. The walls and floor act as a heat sink, storing heat for later release, smoothing out daily high and low temperatures during both heating and cooling.

- Garage Placement
  - On north side of house, blank walls protect house from northern winds
  - Substantially detached from house to avoid carbon monoxide and other product contamination to house
  - Garage vented with screens on two sides

What does a building enclosure need to do?

1. Control heat flow, airflow, and water vapor flow
2. Control rain and ground water
3. Control light and solar radiation
4. Control noise and vibrations
5. Control contaminants, environmental hazards and odors, insects, rodents and vermin
6. Control fire
7. Provide strength and rigidity
8. Be durable
9. Be aesthetically pleasing

These assemblies do it all.

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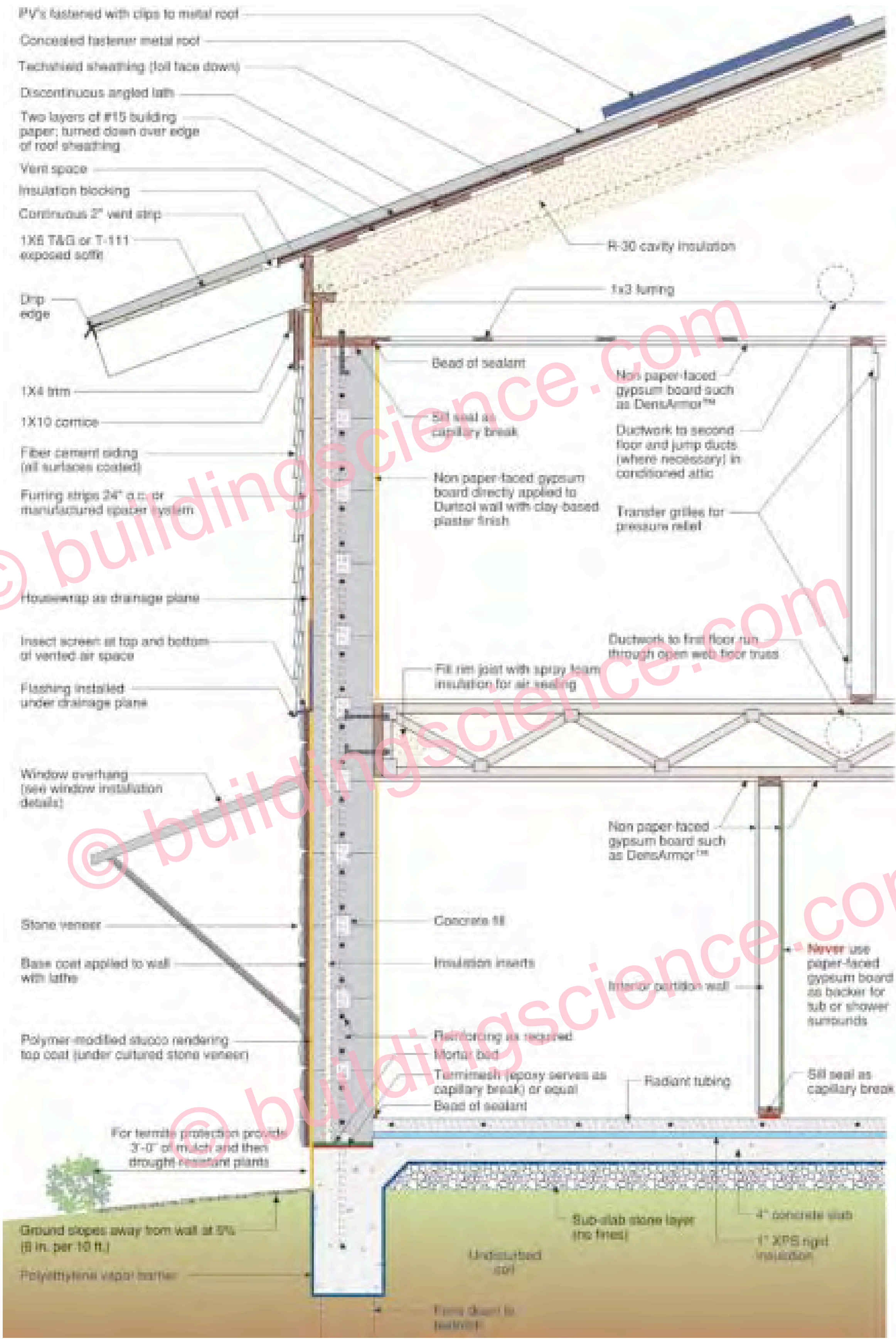

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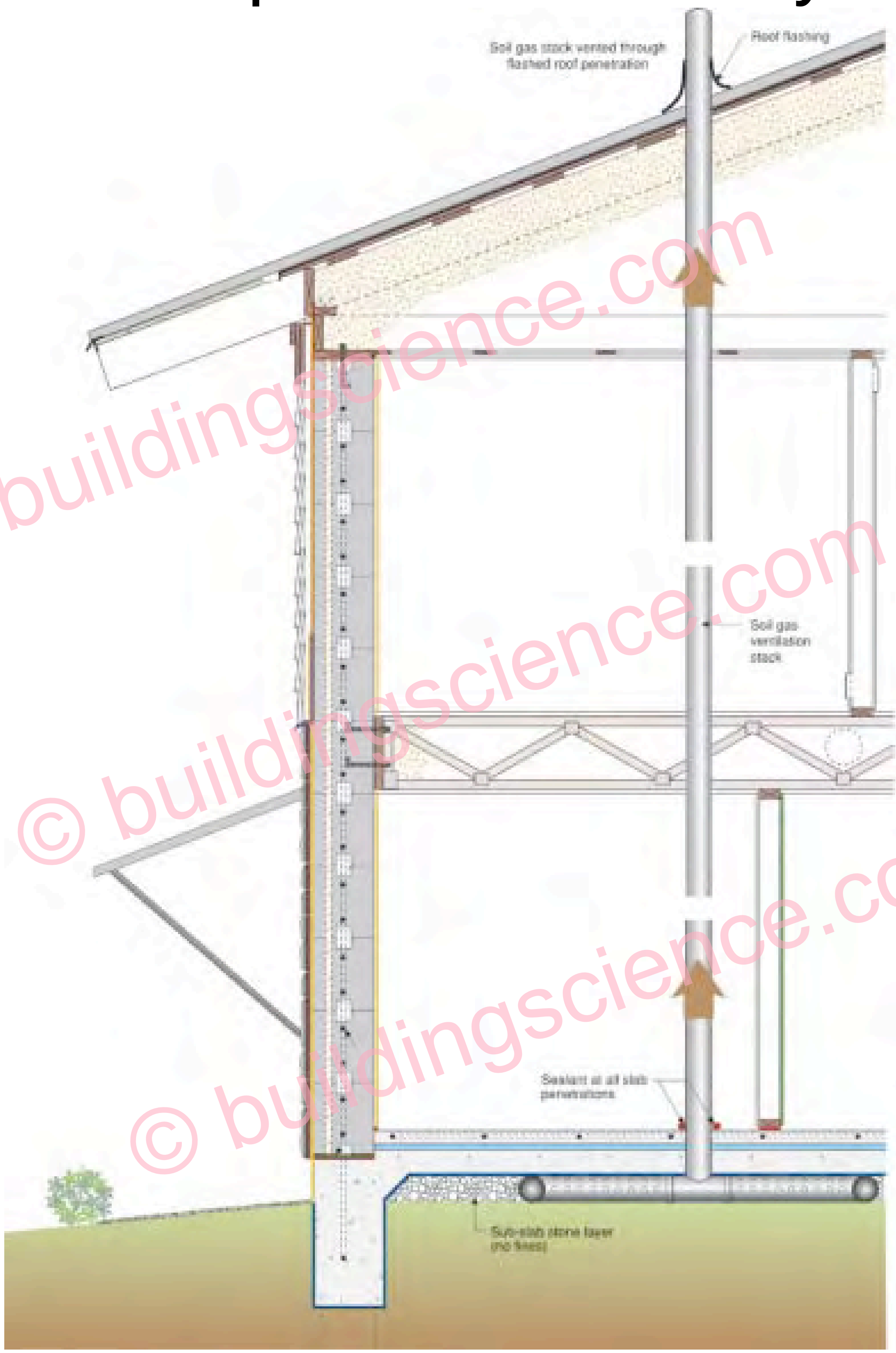
FlexWrap
FlexWrap

Subsoil Depressurization System



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Overhangs designed to allow for passive gain in the wintertime and to assist with shading in the summertime

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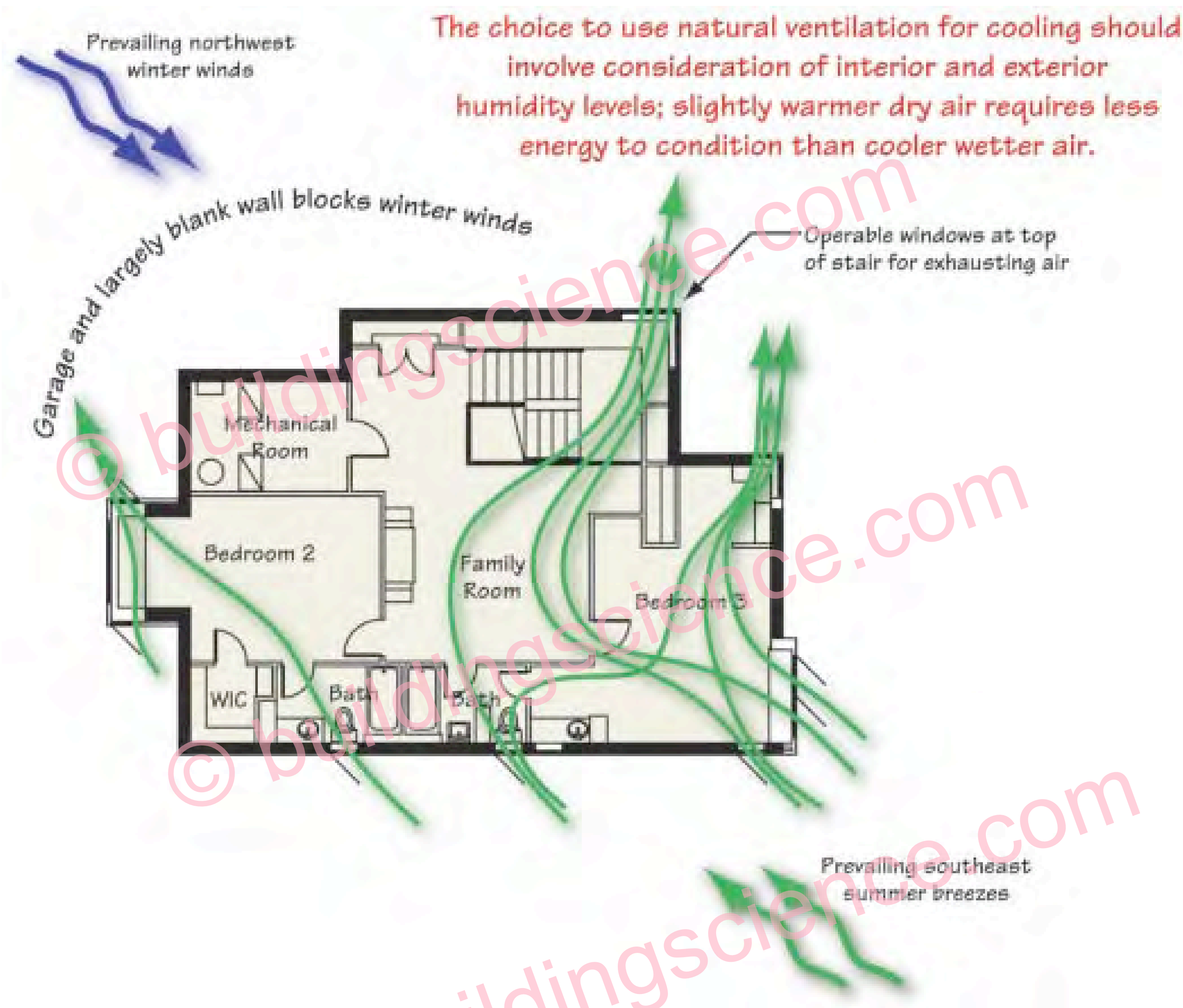
Prevailing northwest winter winds
The choice to use natural ventilation for cooling should involve consideration of interior and exterior humidity levels; slightly warmer dry air requires less energy to condition than cooler wetter air.
Garage and largely blank wall blocks winter winds
N
Master Bath
Master Bedroom
WIC
Garage
Utility
D W
Bath
Study
Living Room
Kitchen
DW
Dining Room
Foyer
Screen Porch
Air rises up stairwell and out operable windows at top of stair
Casement windows open to catch prevailing breezes
Prevailing southeast summer breezes

First Floor



Second Floor

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Building Mechanical Characteristics

- Heat
  - Radiant slab hydronic system w/solar and gas heating
  - Gas fired tankless water heater backup
  - Optional high HSPF (9.3) Heat Pump
- Cooling/dehumidification
  - Multi Stage, Multi Zone Chilled water system built from 1.5 T & 2.0 T High SEER (13+) Heat Pumps
  - 3 zones of variable speed air handlers
- DHW
  - Solar and gas tankless heater indirect water heater
  - Rinnai tankless water heater (0.82EF) backup

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Building Mechanical Characteristics (cont.)

- Solar Thermal
  - 64 s.f. Two panel hot water system
  - 105 gallon tank
- Solar Electric
  - 8.12 W peak Photovoltaic system
  - Grid tied inverter
- Ducts
  - In conditioned space
  - No leakage to the outside
- Appliances - EnergyStar
- Lighting - 90% compact fluorescent

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Building Mechanical Characteristics (cont.)

- Mechanical Ventilation
  - A high performance building enclosures is tight enough to require purposeful and measured introduction of outside air for a high performance indoor environment.
  - This home has a fresh air duct linked to the central forced-air system that not only introduces outside air, it distributes it throughout the entire home.
  - A damper and cycling controller ensure that not too much outside air is pulled in during extended periods of forced-air operation and enough outside air is introduced during extended periods when the house is not calling for space heating or cooling.
  - 68CFM average flow

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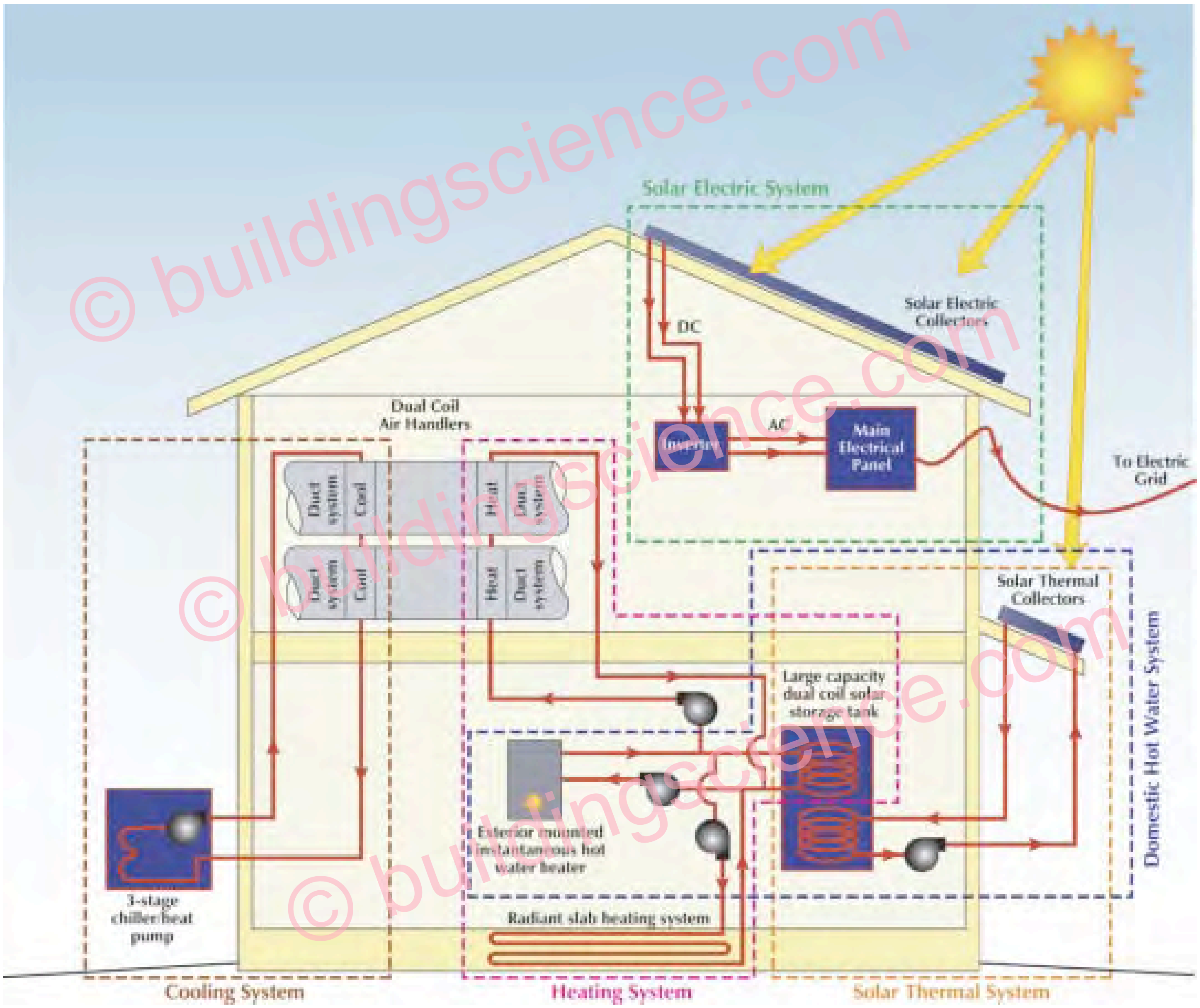
Mechanical Systems
Heating, Cooling, DHW



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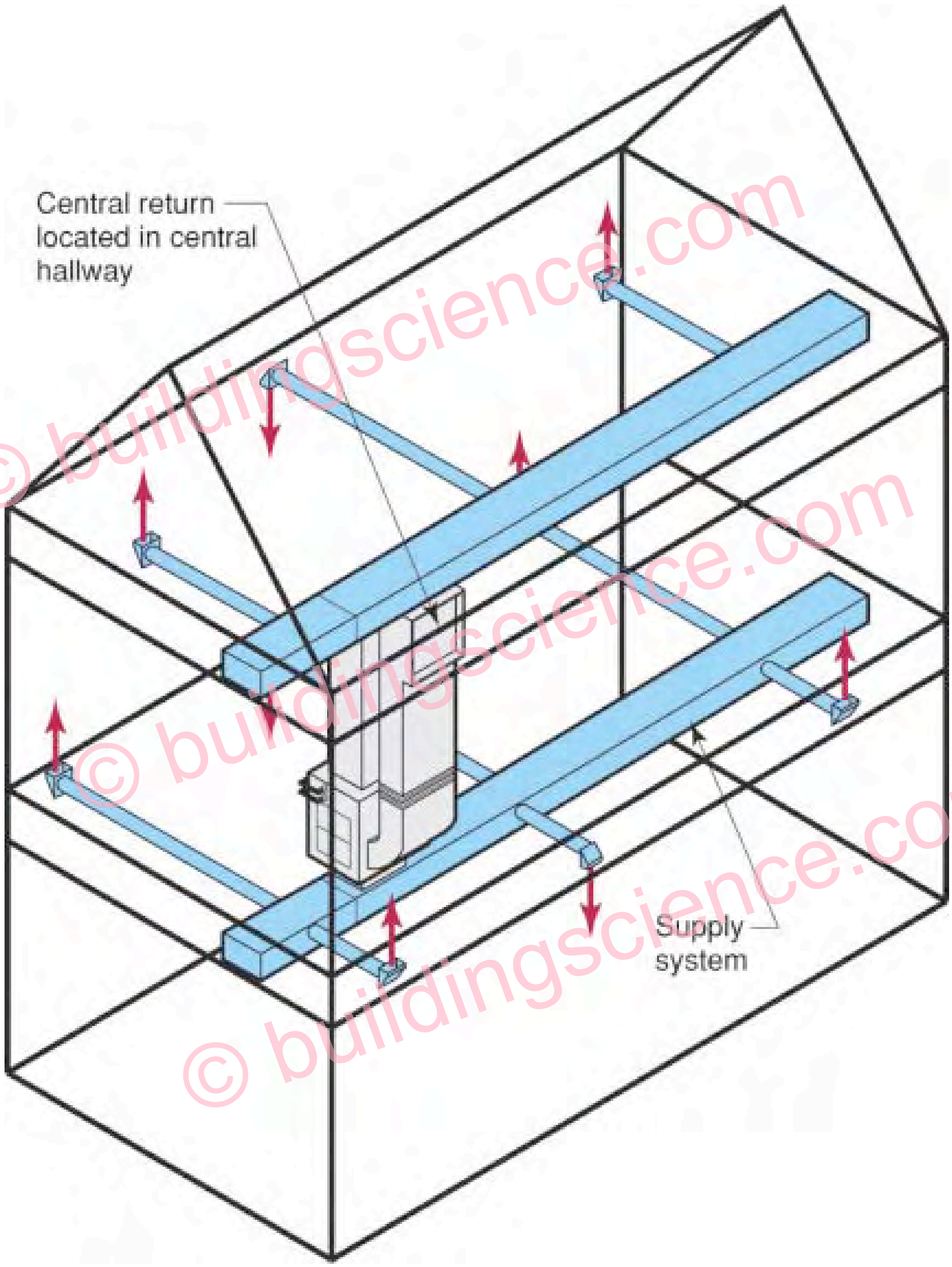
Ducts Inside the Conditioned Space



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Ducts Inside the Conditioned Space

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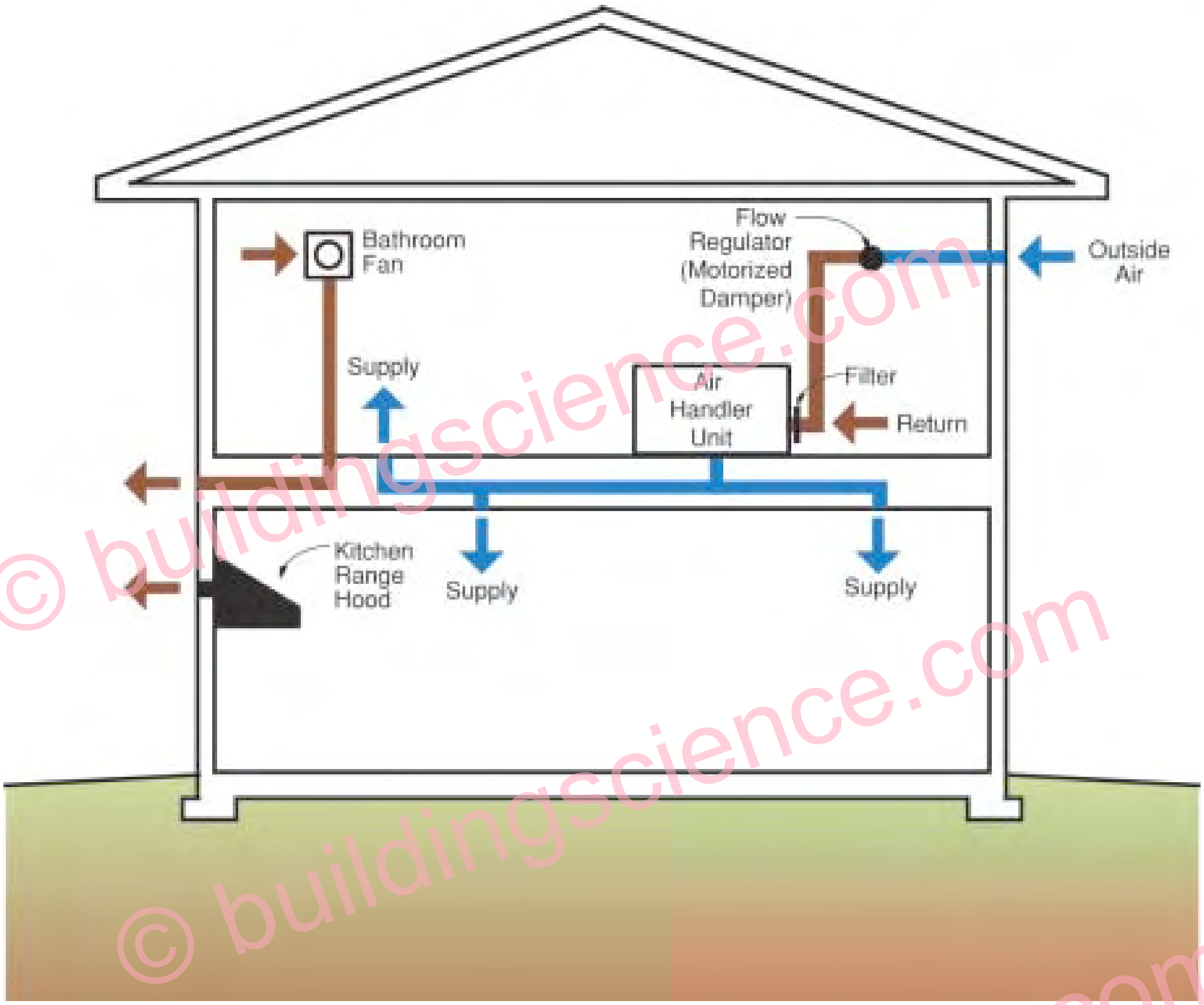
Ventilation Scheme



- Continuous supply air enters at a low rate
  - (68 CFM)
- Return air mixed with incoming air and brought through a filter
  - Brought in through a high efficiency filter
- Point source exhaust at baths and kitchen
  - Operate on demand at time of pollution generation

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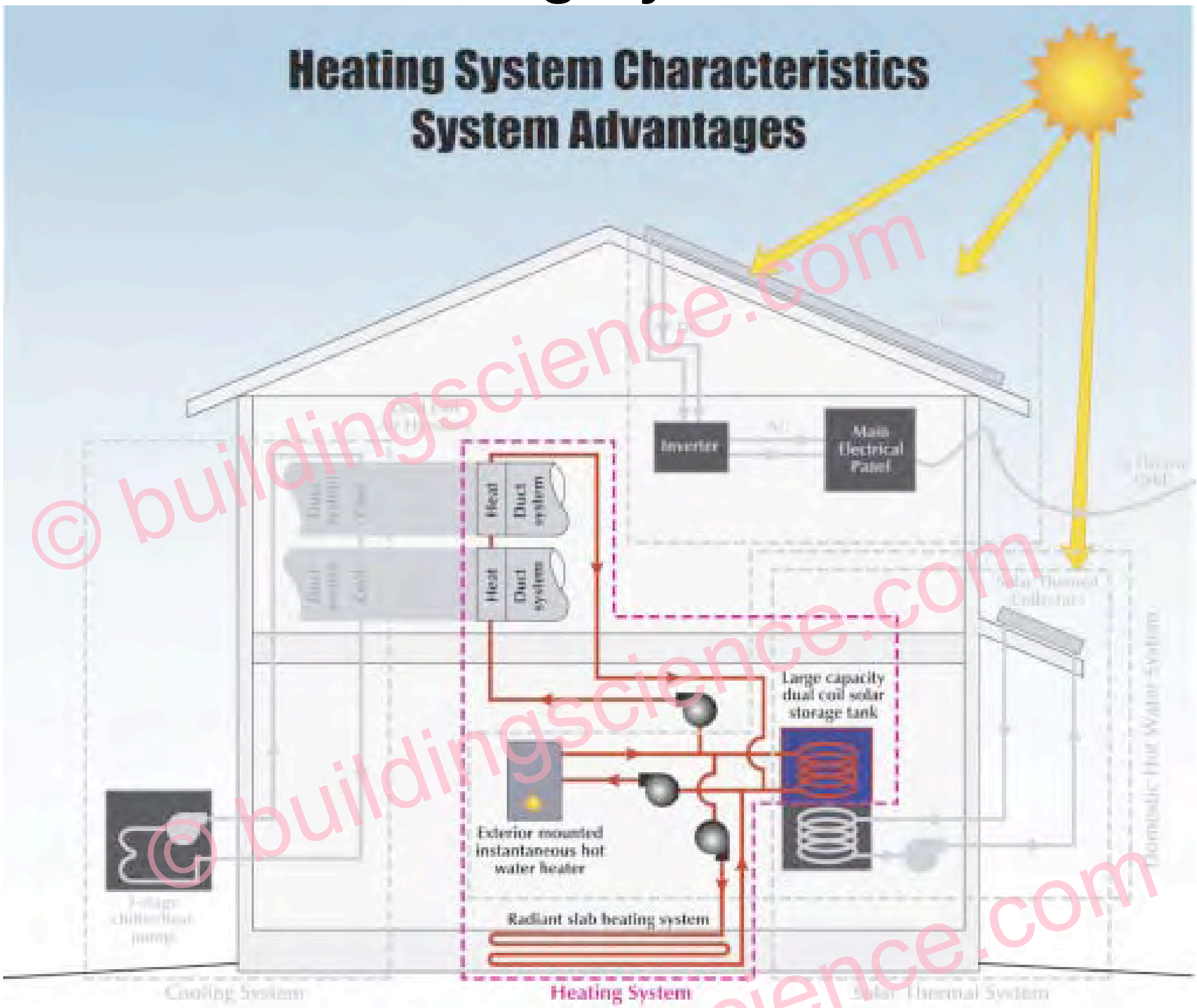
Heating System



- House can be heated by excess solar capacity through radiant slab or air handlers
- Radiant slab tempers floor and offsets heating load
- Air handlers heat and circulate air
- Key component is large domestic water storage tank with separate coils at top and bottom of tank
- Bottom coil is for solar heat input, top coil is for gas back-up heat input or heat output

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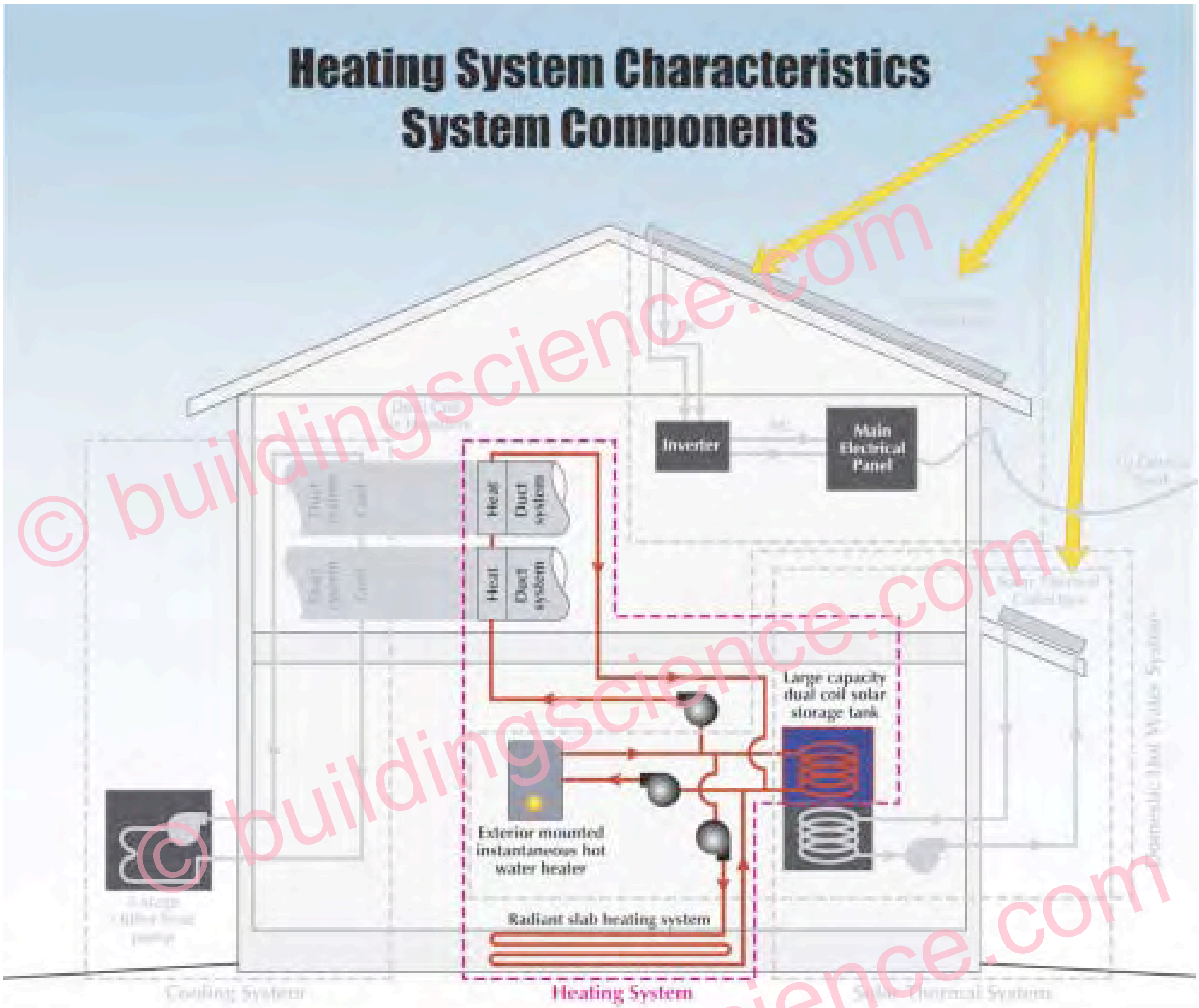
Heating System



- Large capacity (105 gallon) hot water/heat energy storage tank
- Lower coil in storage tank is solar heated
- Top coil in storage tank can be heated by instantaneous hot water, or heat can be pulled from tank and distributed to house
- Instantaneous hot water heater as gas fired back-up heating
- Hot water coils of dual coil fan-coil air handlers (3 zones)
- Radiant slab heating system for floor warming
- Heat pump can be used as heating source

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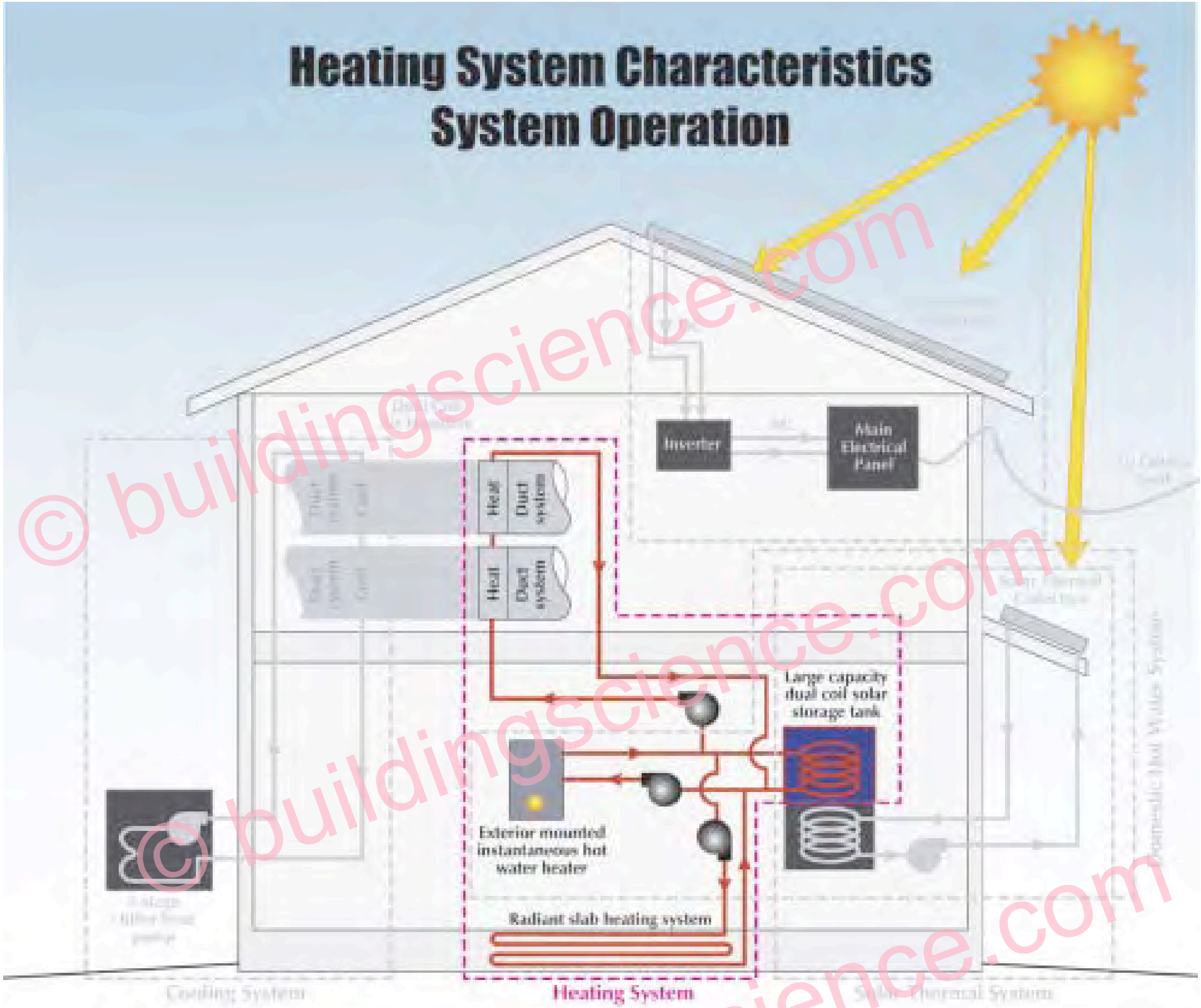
Heating System



- On a call for heating of the radiant slab or zone sensor, circulator pumps heat exchange water through the top coil in the domestic storage tank where it is heated
- Heat exchange water then flows to the radiant slab or air handler to distribute heat to the space
- If and when the temperature in the top of the tank falls below domestic hot water set-point, the gas fired instantaneous hot water heater operates to re-heat the top of the storage tank using the same coil

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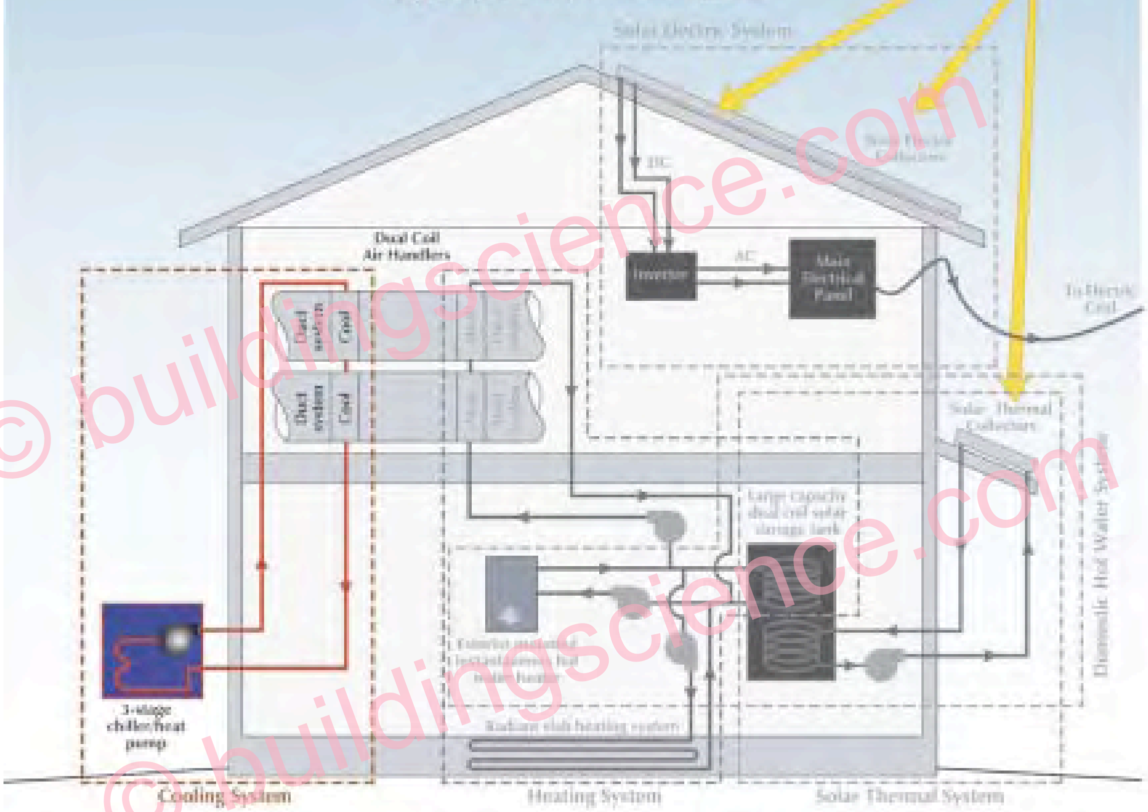
Cooling System

Cooling System Characteristics
System Advantages



- Chilled water can provide greater dehumidification by reducing airflow over cooling coil with no risk of freezing cooling coil
- Multi-capacity chiller system can more accurately match building and individual zone loads, therefore lengthening chiller cycle times (cooling systems take roughly 15 minutes to reach full efficiency; average DX unit cycle time is less than 15 minutes)
- Multi-zone system shares chiller capacity while giving individual zone control
- Refrigerant loop is completely contained within exterior heat pump/chiller unit; it therefore has less piping and is less prone to refrigerant leaks and less likely to be over/undercharged with refrigerant
- Chilled water system can be run in conjunction with heating system to provide dehumidification without cooling
- Chilled water system can also be used as air source heat pump heating system

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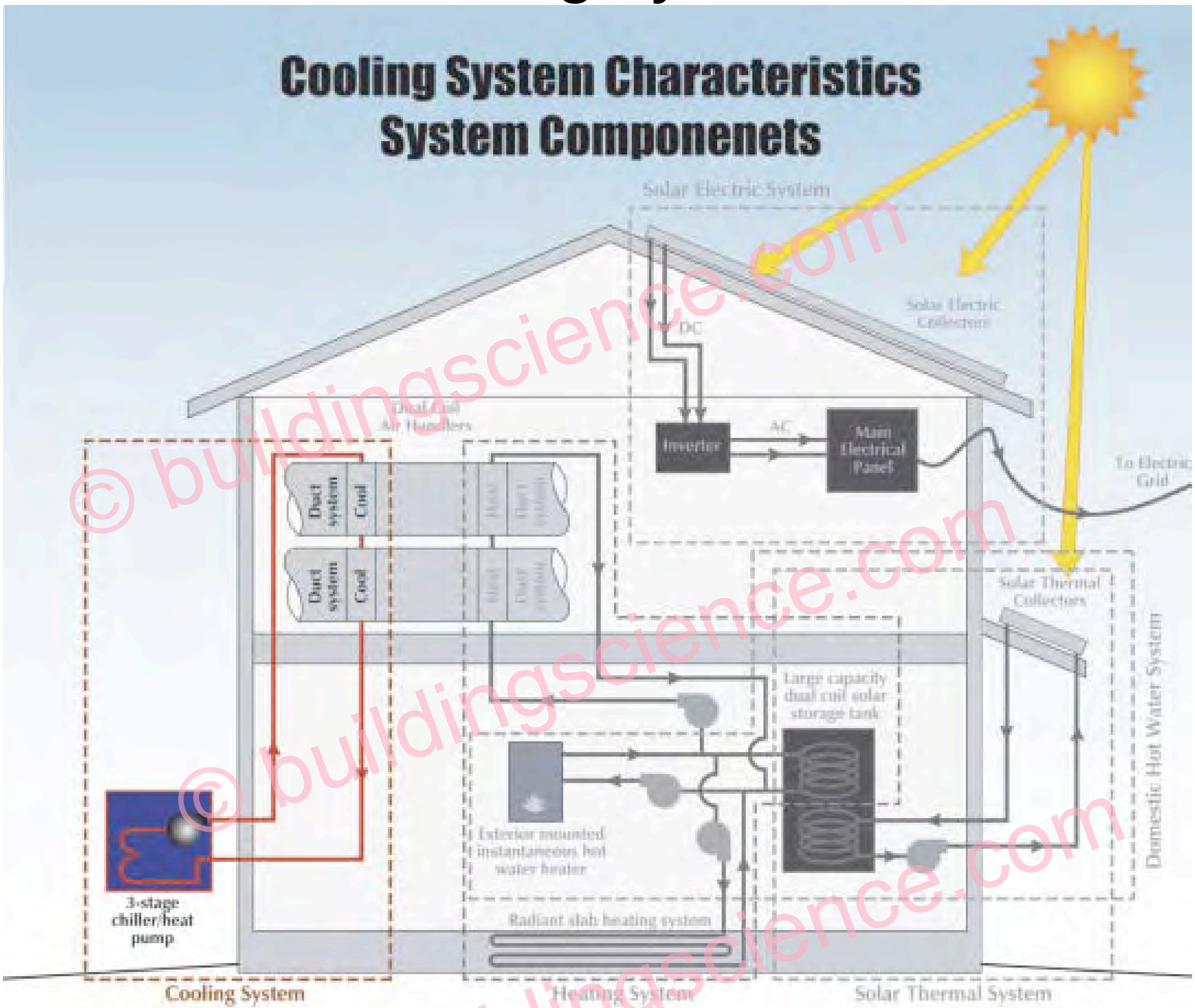
Cooling System



- 2 high efficiency heat pump condensing units (1.5 tons, 2.0 tons) yielding 3 stages of capacity (1.5 tons, 2 tons and 3.5 tons)
- Chiller barrel section with chiller pump and piping to three air handlers
- 3 dual coil fan-coil air handlers for zone control (master bedroom suite, first floor and second floor)

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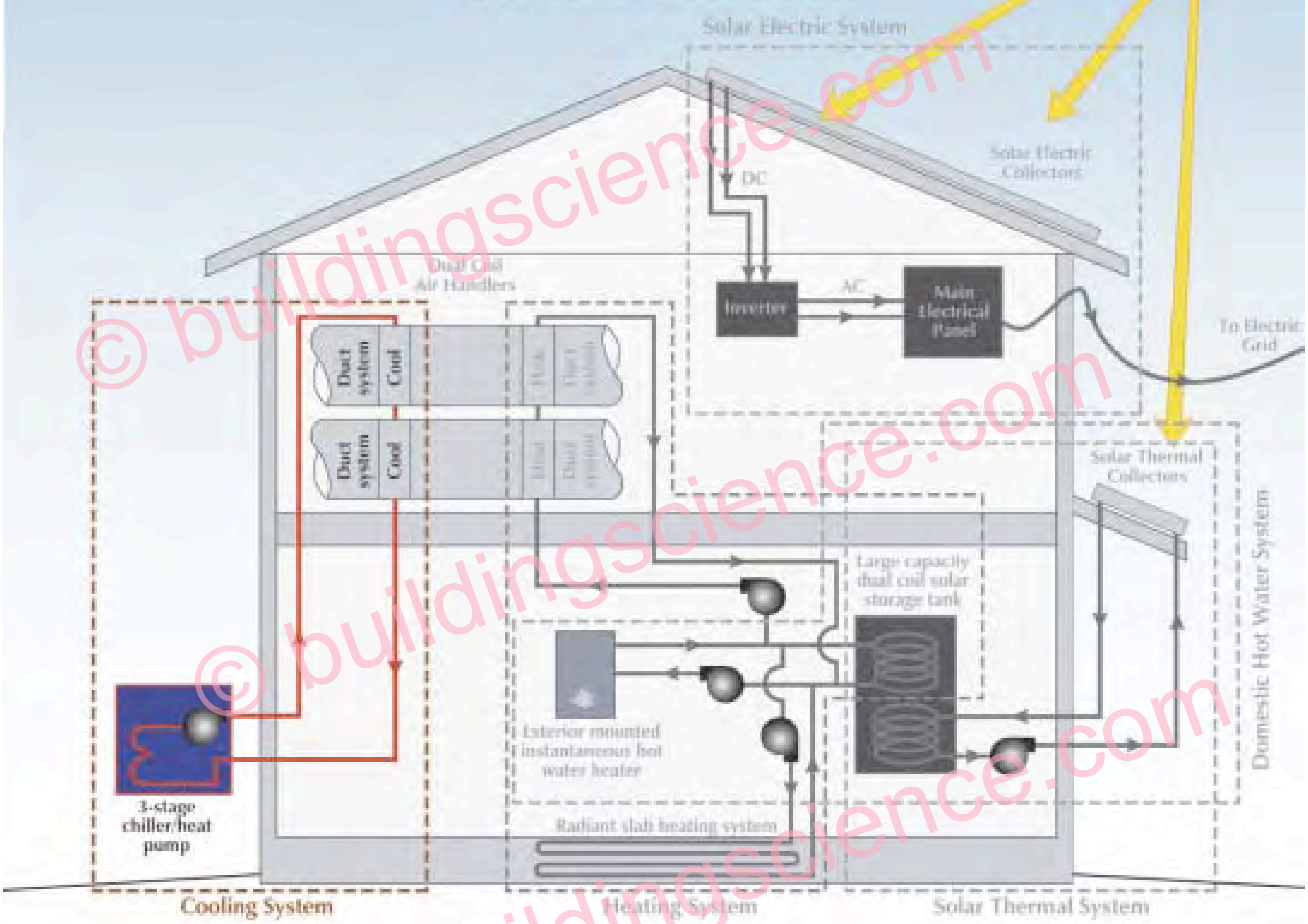
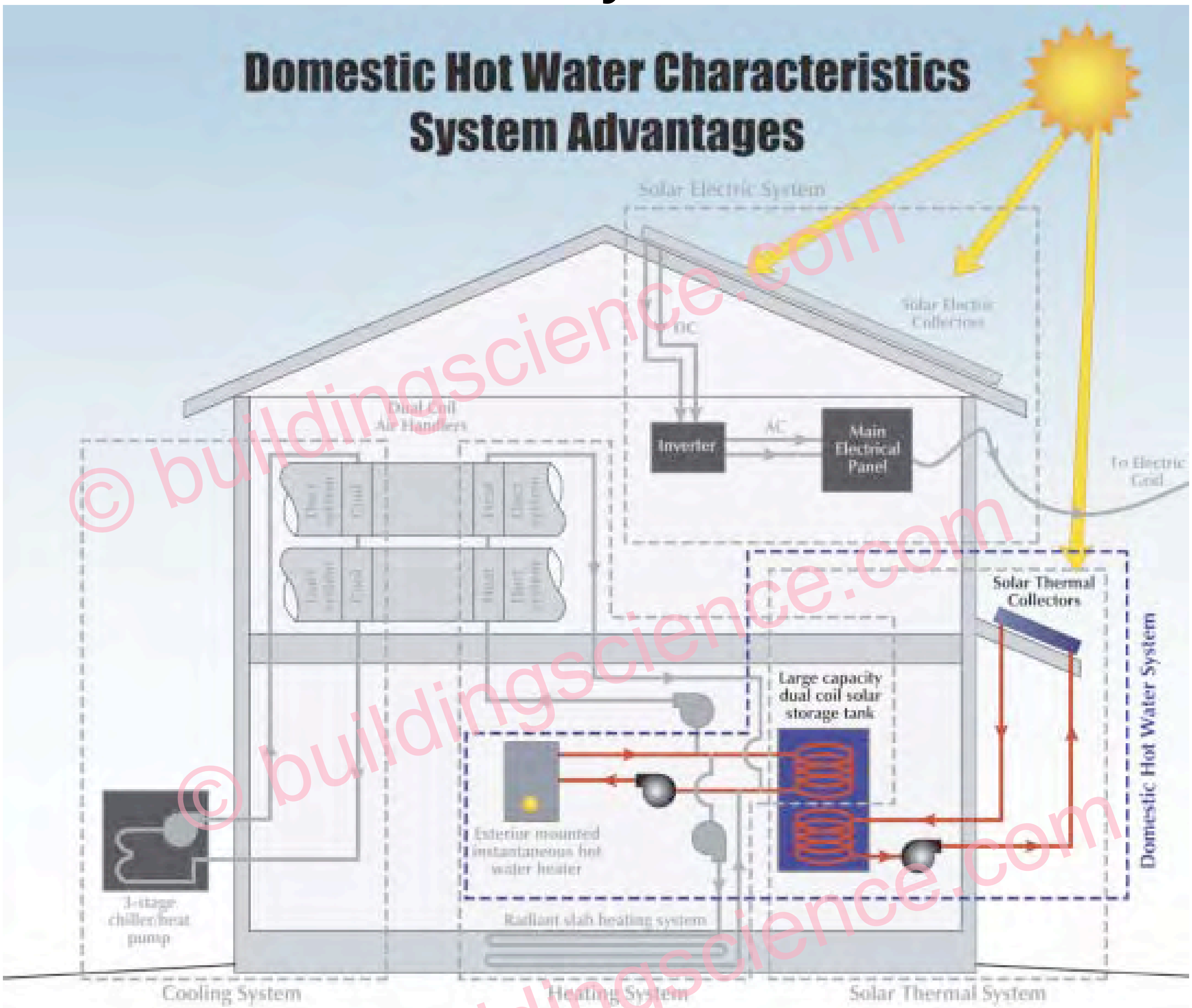
Cooling System

Cooling System Characteristics
System Operation



- Cooling system is activated by a temperature sensor in each zone
- On a call for cooling, chiller, chiller pump and air handler operate at appropriate levels to distribute cool air
- To reduce humidity levels, air handler fans operate at low speed to increase cooling coil dwell time and to remove more moisture

DHW System



- The domestic water heating is expected to be primarily by solar
- The key component providing flexibility is the large domestic water storage tank with separate coils at top and bottom of tank; heat can be added or removed from the tank based on the situation
- Bottom coil is for solar heat input; top coil is for gas back-up heat input or heat output

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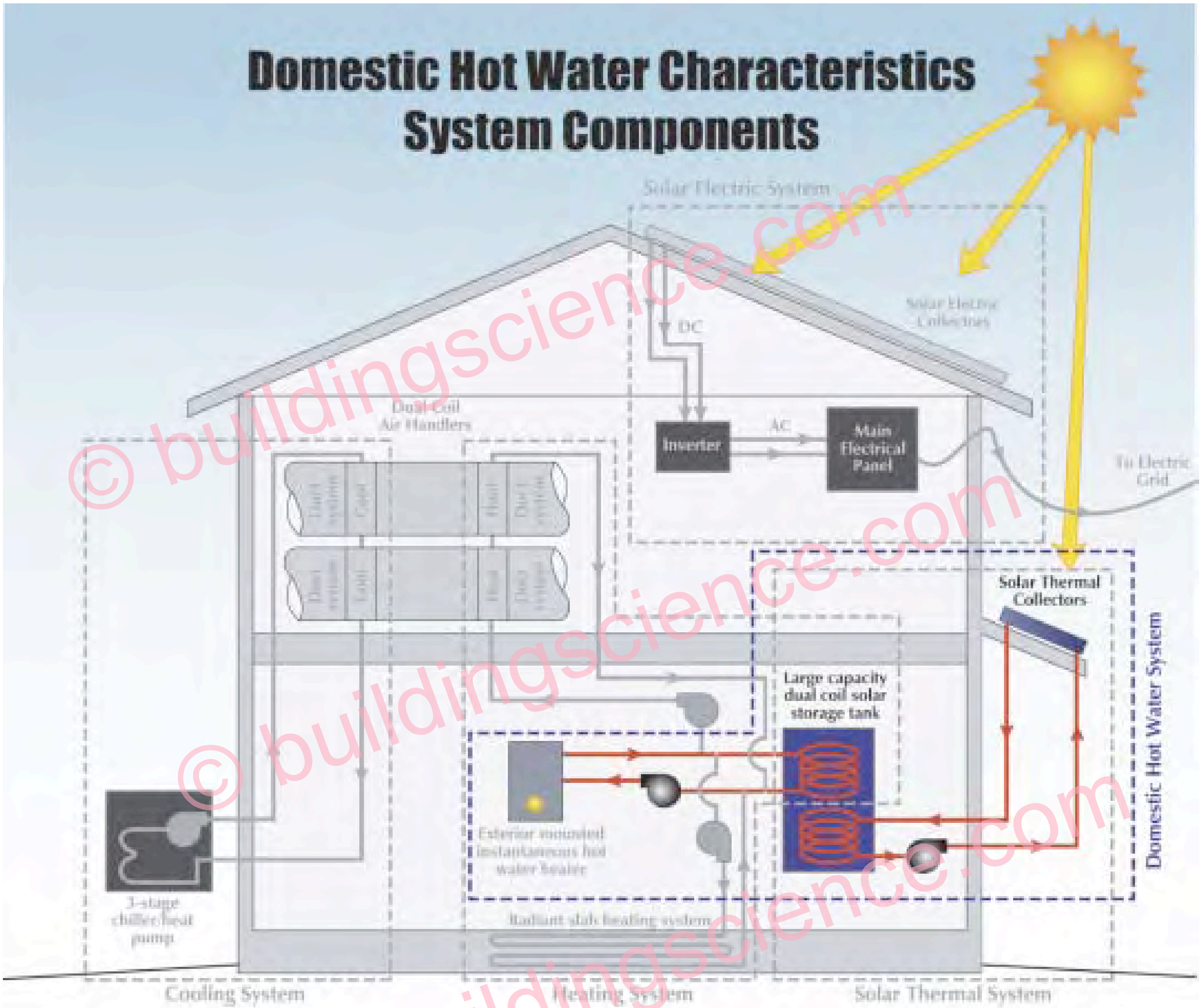
DHW System



- Large capacity (105 gallon) domestic water storage tank
- Lower coil heated by solar thermal system
- Top coil in domestic hot water tank can be heated by gas fired instantaneous hot water heater when necessary for back-up hot water heating

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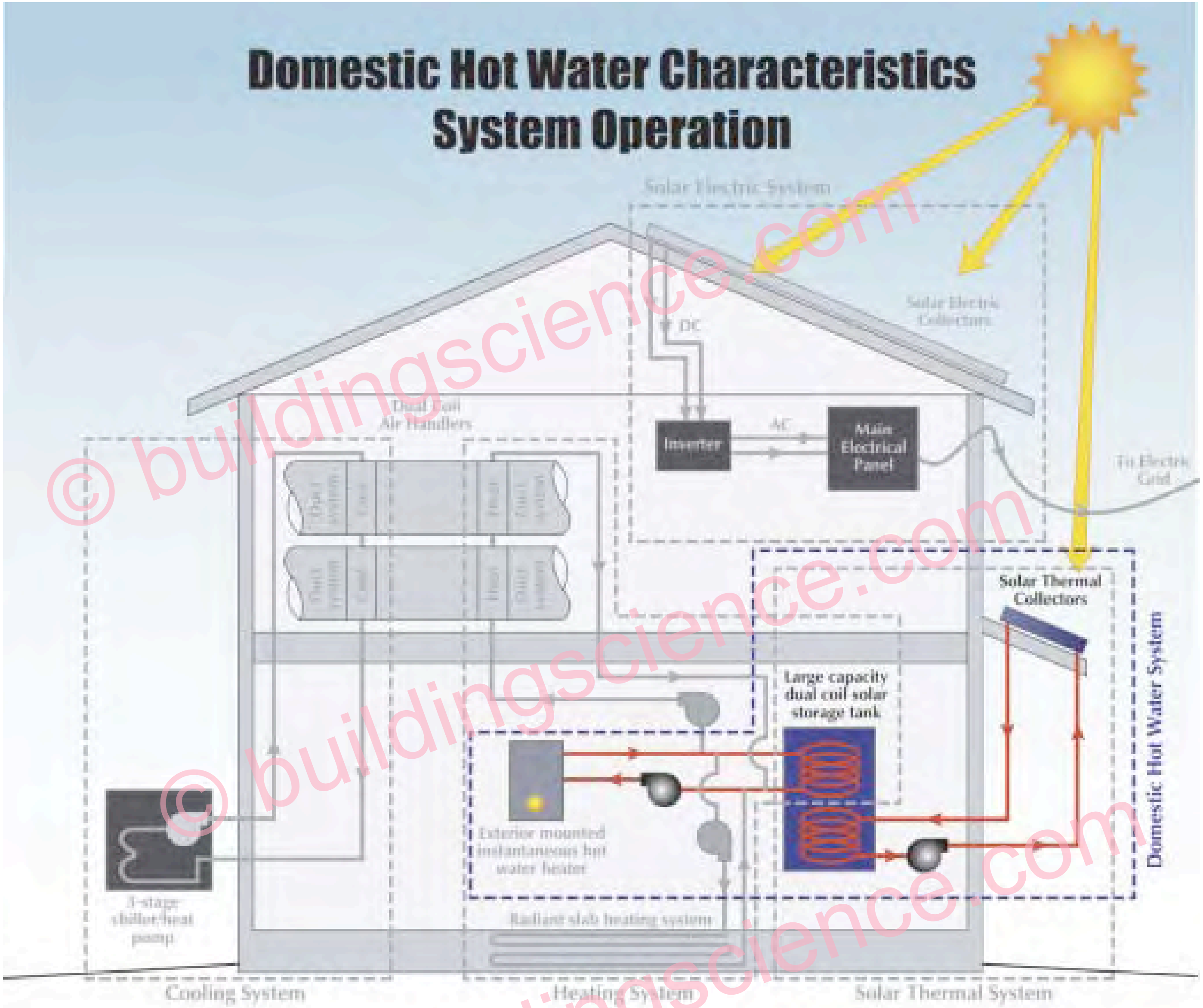
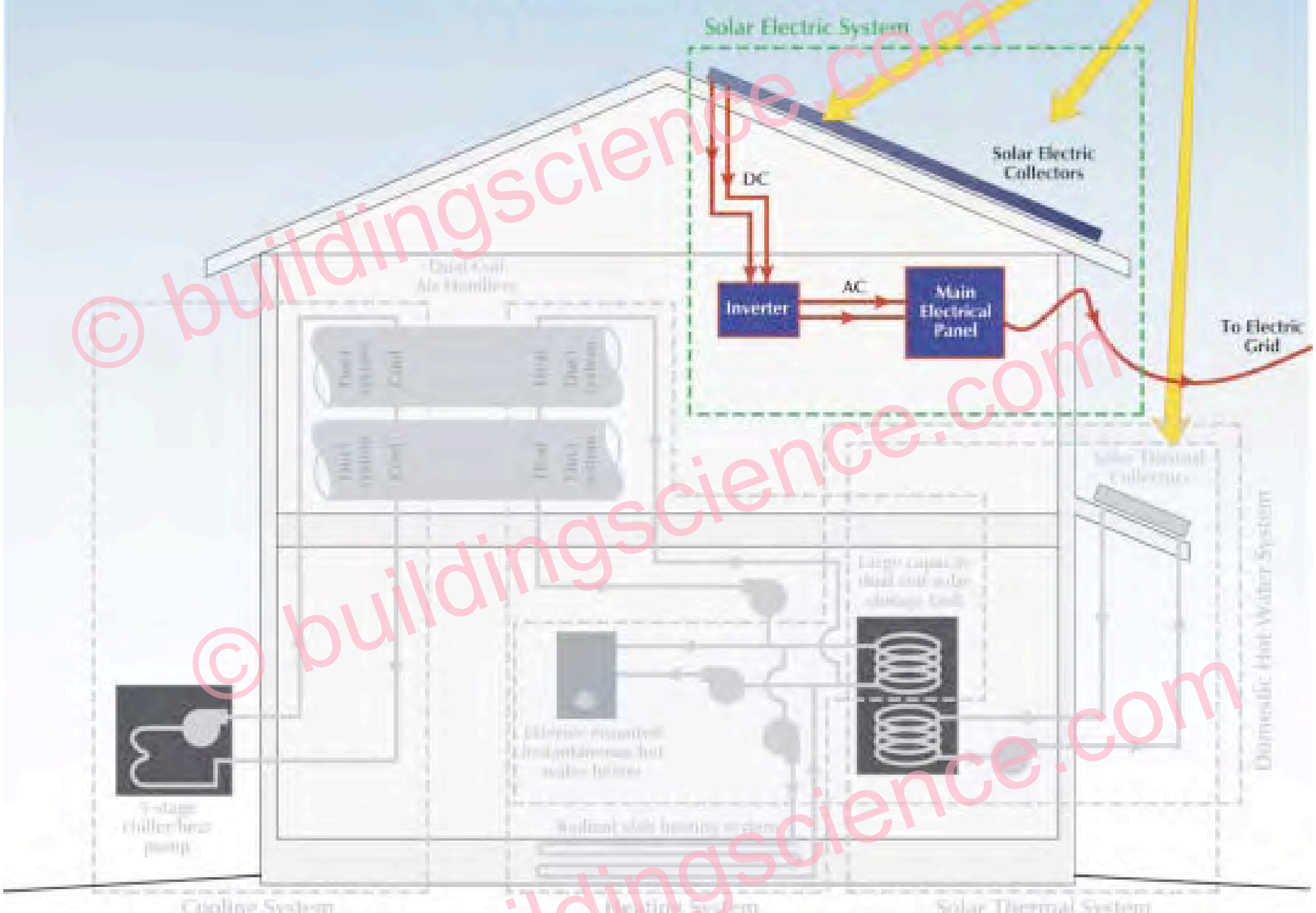
DHW System



- Domestic water is heated in the storage tank by the solar thermal collection system coil in the bottom of the tank as possible based on collector and tank temperatures
- If and when the temperature in the top of the tank falls below domestic water set-point, the gas-fired instantaneous hot water heater operates to re-heat the top of the storage tank using the same top coil

Solar Electric System

Solar Electric System Characteristics
System Advantages



- With proper sizing, overall energy use for the year can be made to equal zero
- Note that minimal gas usage BTU's for heating are also being offset by PV panels to reach zero energy
- Grid tied system does not require energy storage (batteries)

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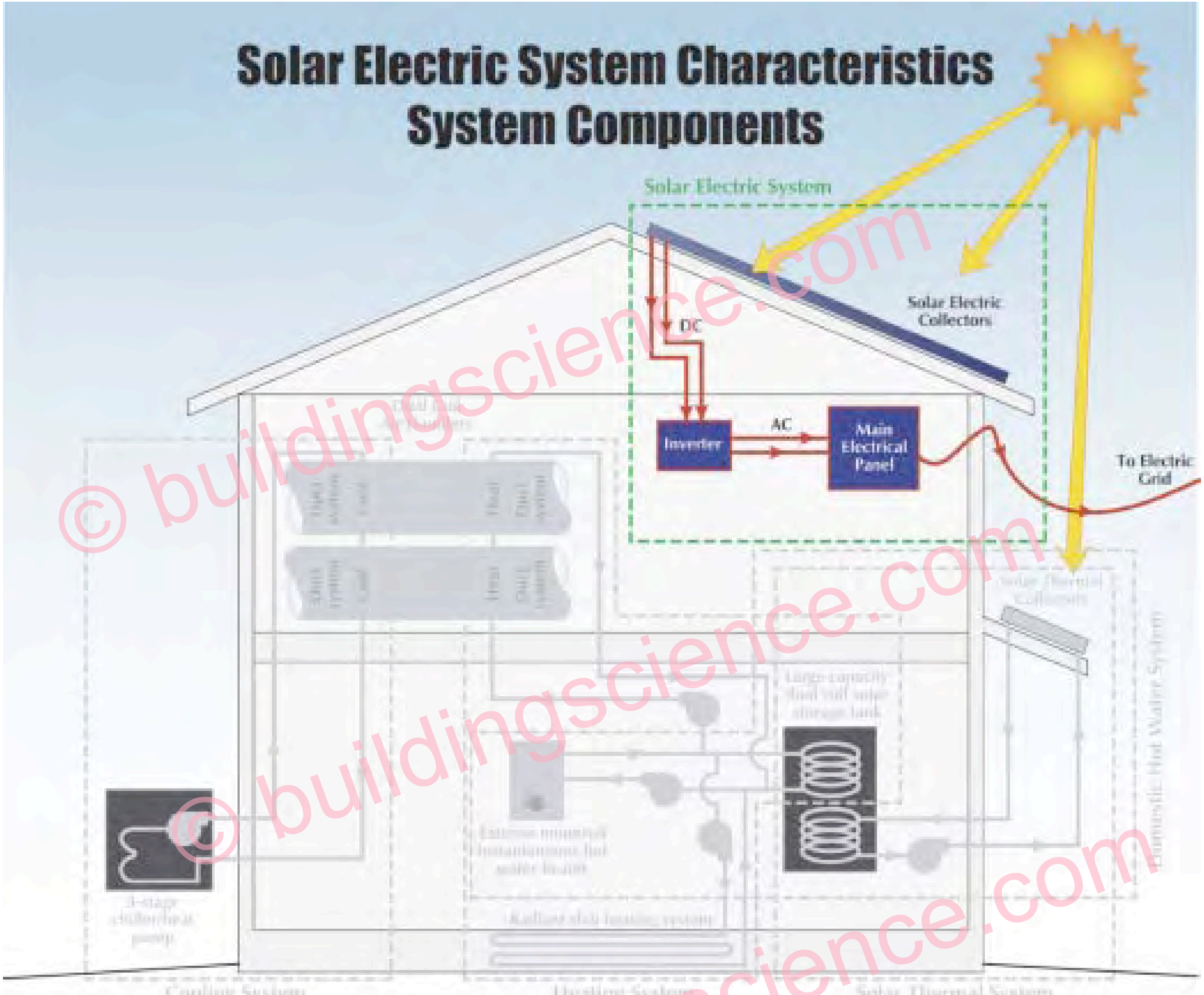
Solar Electric System



- 8.12 kW of Sharp photovoltaic panels split between south and west facing roof
- Two 3.5 kW of Sharp Sunvista grid-tied inverters; inverter is designed to synch up with utility supplied electricity waveform and disconnect power to the grid if there is a power failure
- Manual disconnects between panels and inverter and between inverter and main electric panel

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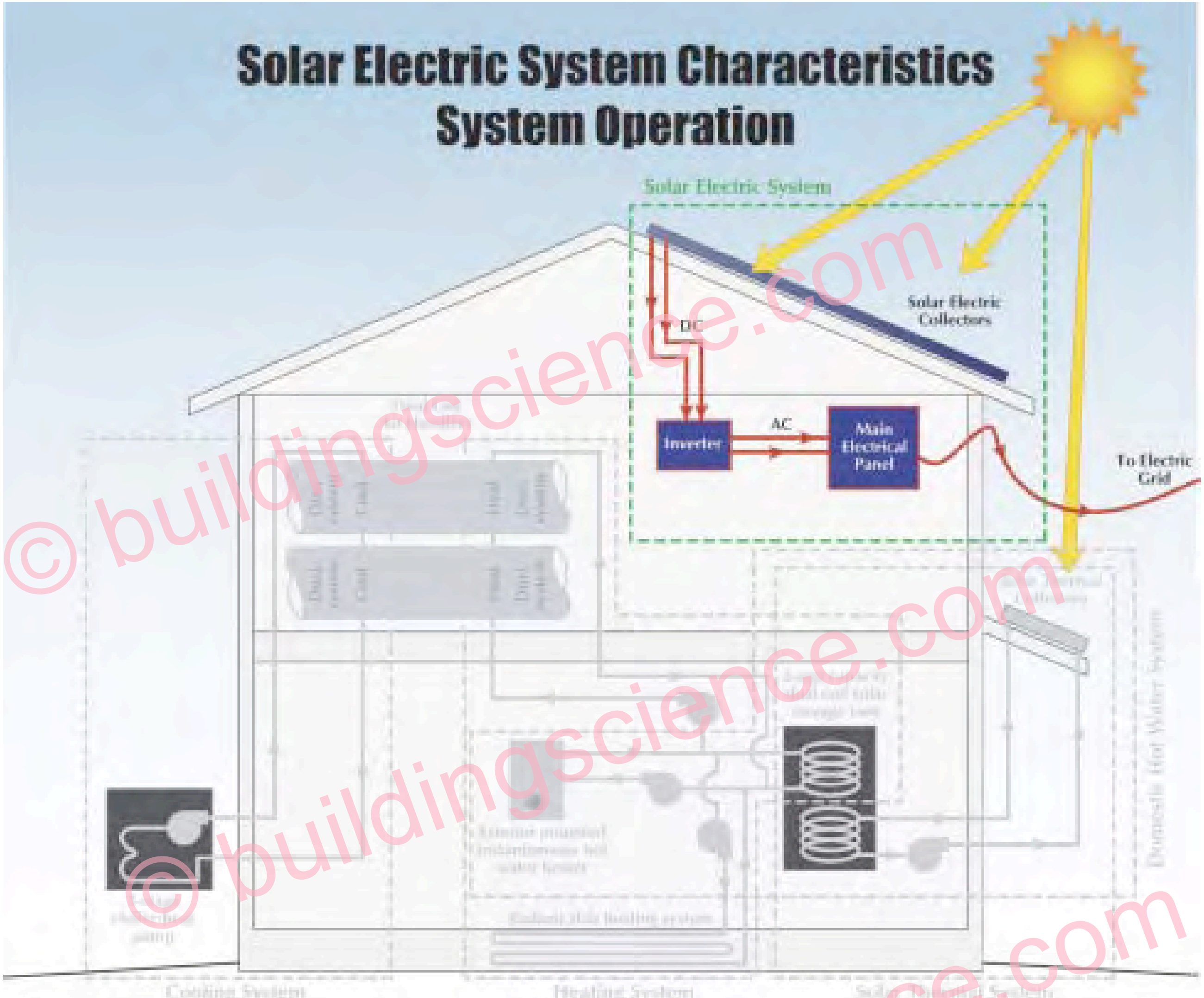
Solar Electric System



- Sunlight striking the panels produces DC electricity (similar to electricity from batteries)
- DC electricity is delivered to the inverter where it is converted to AC electricity (similar to electricity in wall outlets)
- AC electricity is sent to main electric panel where it either offsets electricity use in the house or flows back to the utility grid to supply electricity to the neighbors
- Electric meter turns backward when power generation exceeds house usage; at night or times of cloudy weather, meter turns forward; "net metering" is determined over the course of the year

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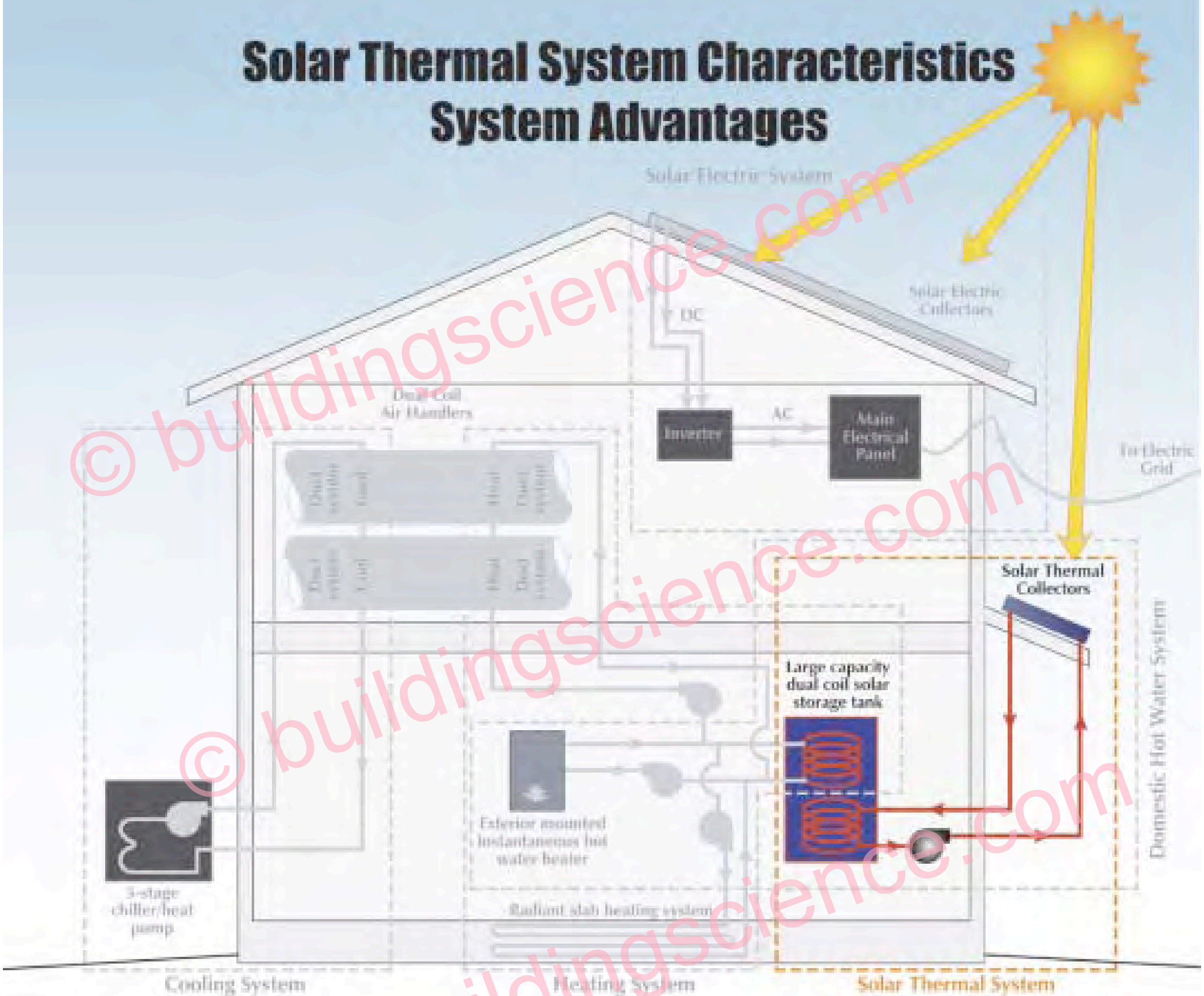
Solar Thermal System

Solar Thermal System Characteristics
System Advantages



- Glycol system eliminates risk of freezing and allows freedom in pipe routing
- Controller accurately measures ability to collect heat
- Tank stratification and sensor location allow maximum solar heat collection
- Stratification allows use of single tank, reducing number of components and complexity common with two tank systems

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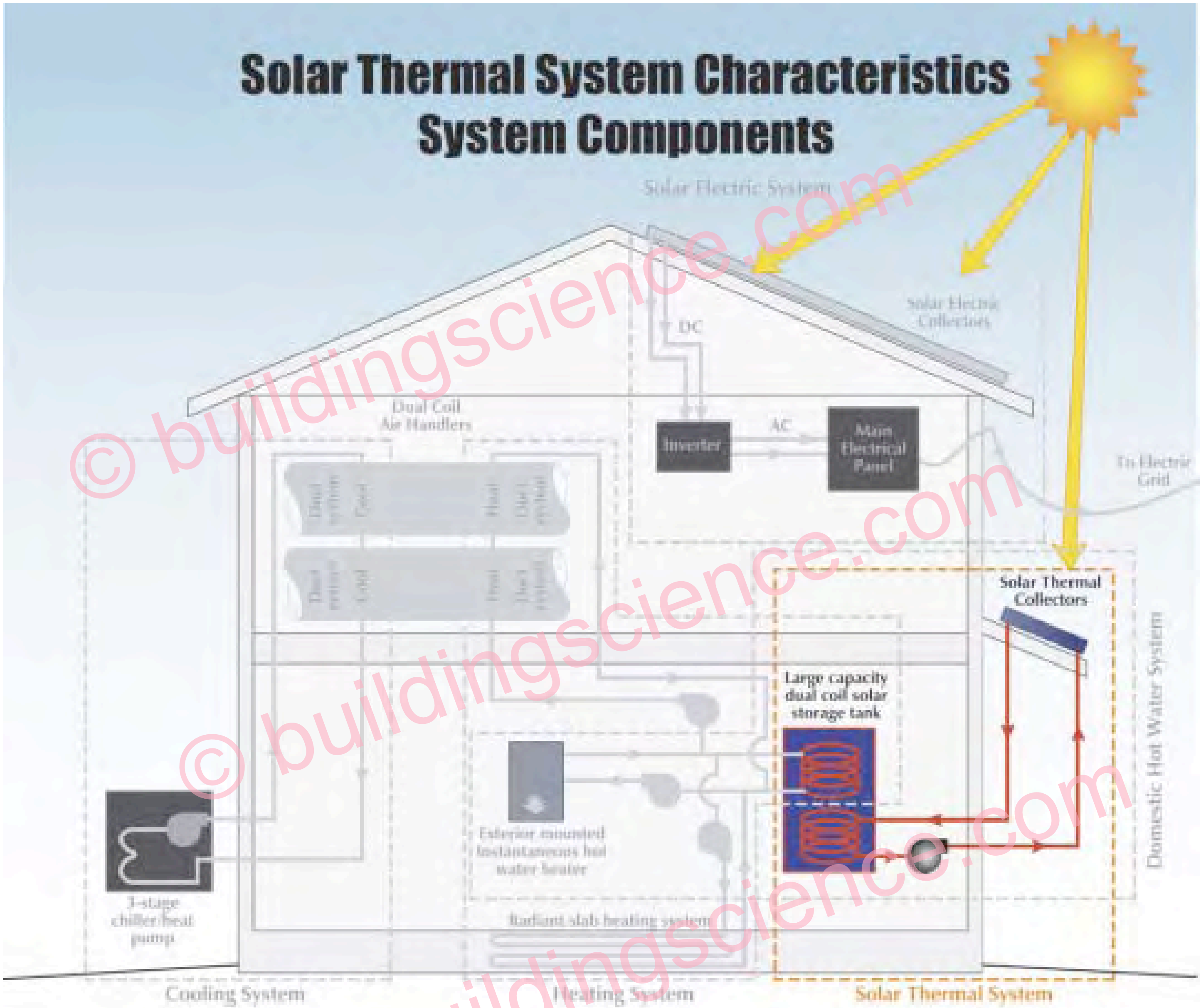
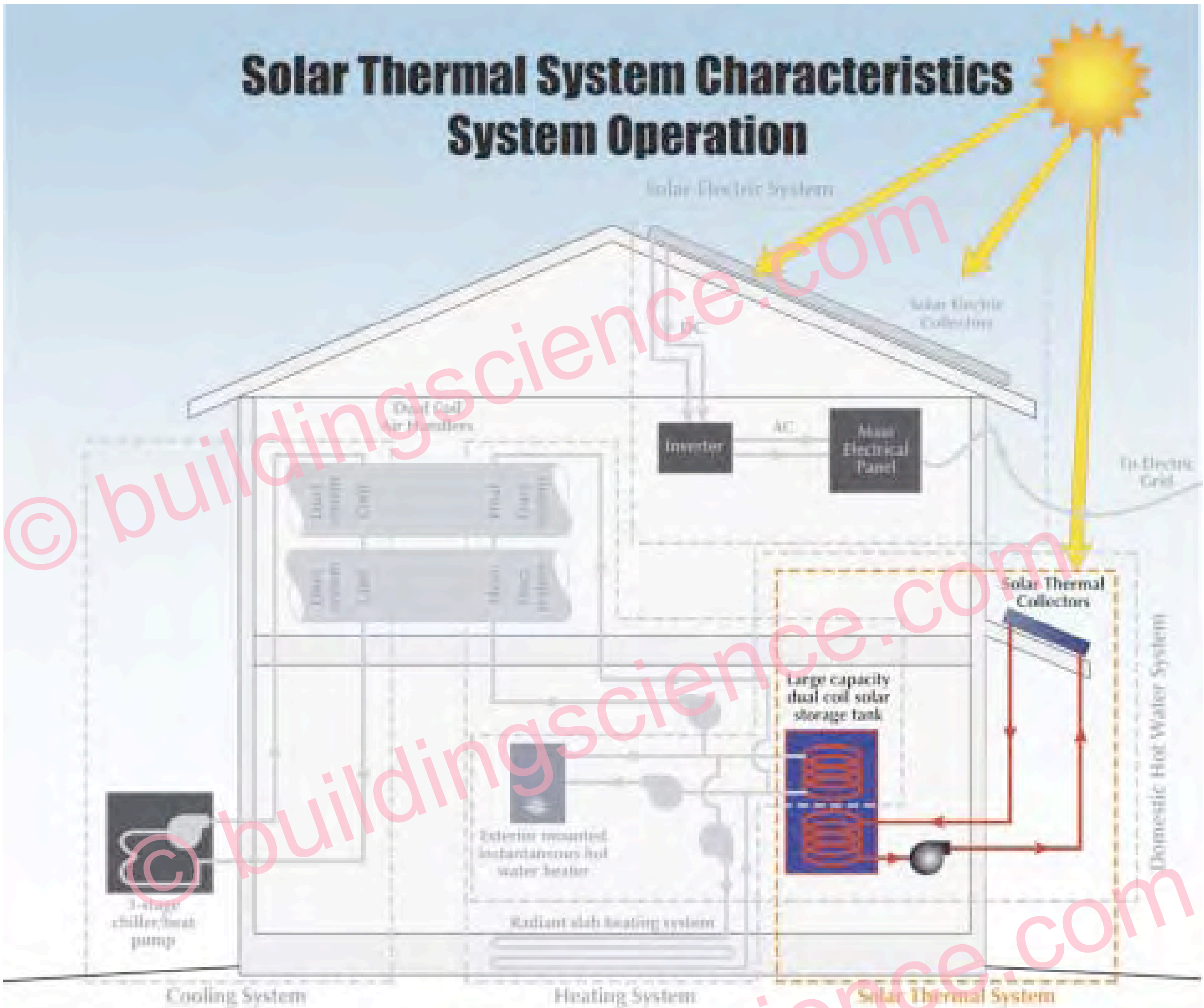
Solar Thermal System



- Two 4'x8' collectors mounted on porch roof
- Large capacity (105 gallon) dual coil storage tank located in garage
- Glycol loop with pump and controller

Solar Thermal System



- System controller measures temperature at panels and storage tank, and pumps glycol when panel temperature is 8°F greater than storage tank temperature near bottom of tank
- Pump circulates glycol between collectors and lower coil in storage tank, heating the domestic water in the storage tank
- When collectors are only 3°F hotter than storage tank, pump shuts down
- Domestic water is heated by lower glycol coil then heats upper coil in tank, potentially providing space heating

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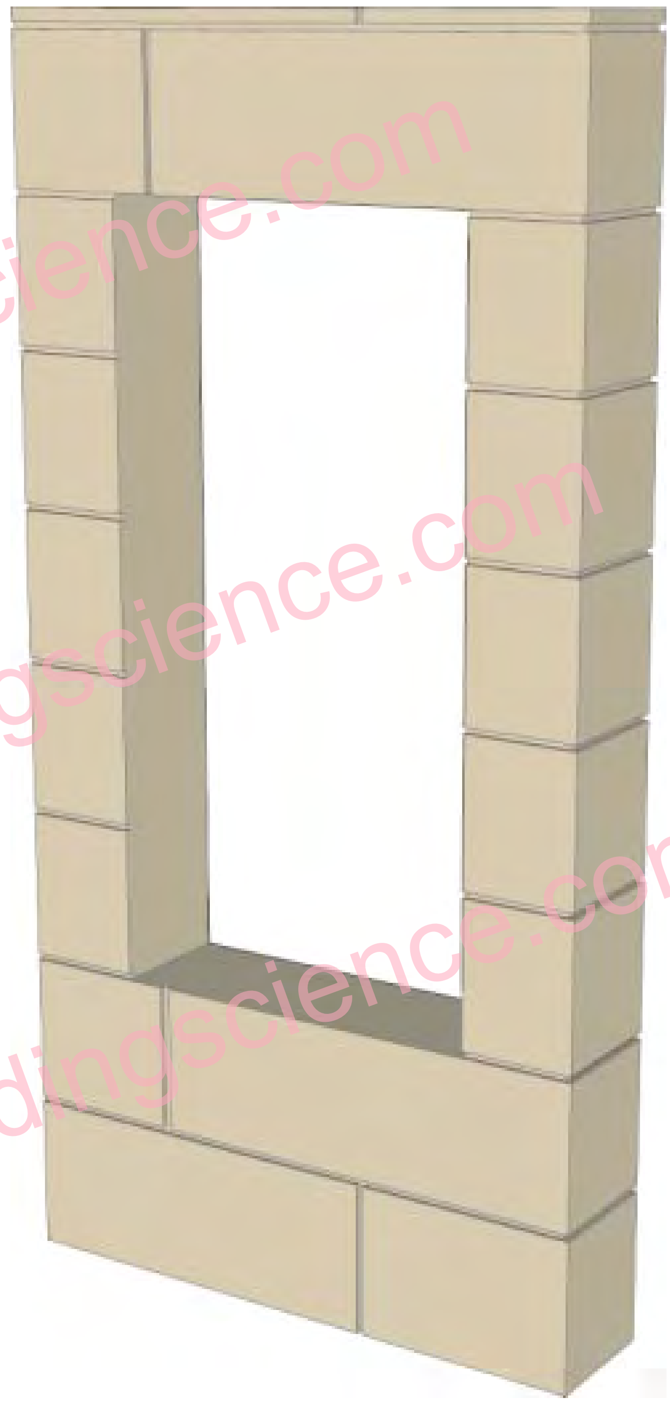
Installing window in Durisol wall with stone veneer

Step 1
Durisol block wall



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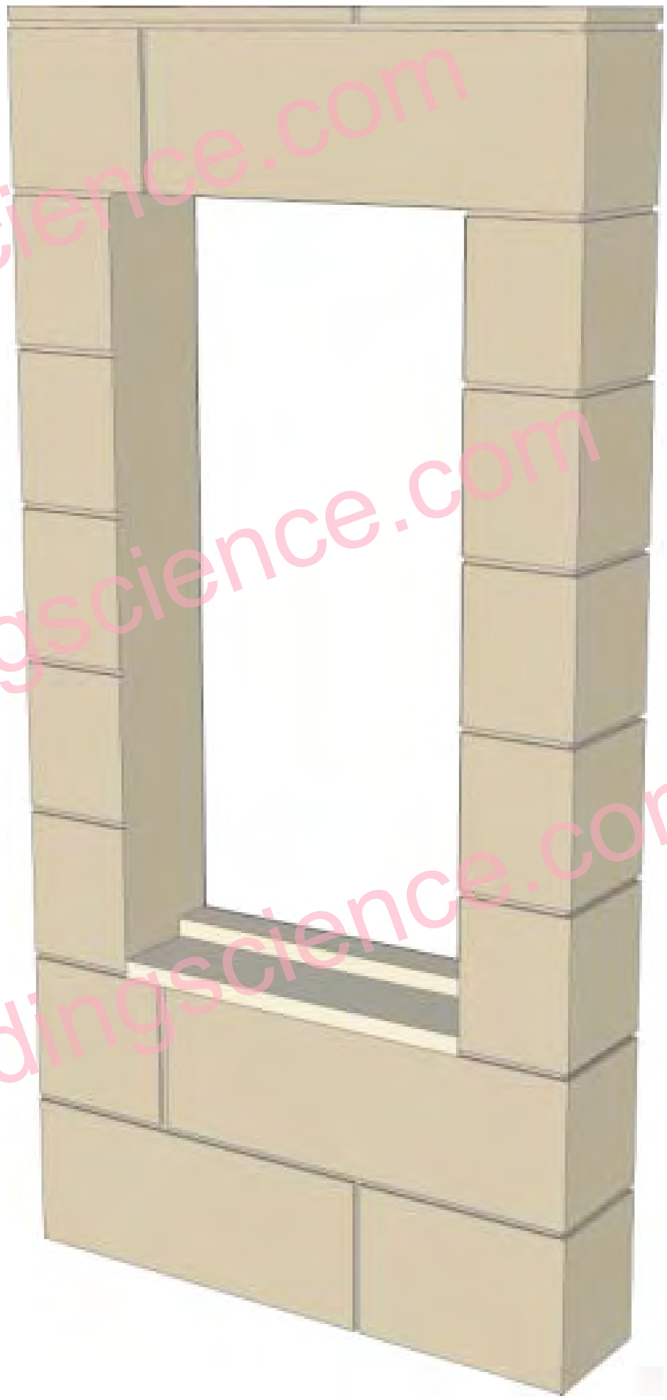
Installing window in Durisol wall with stone veneer

Step 2
Install sill with backdam



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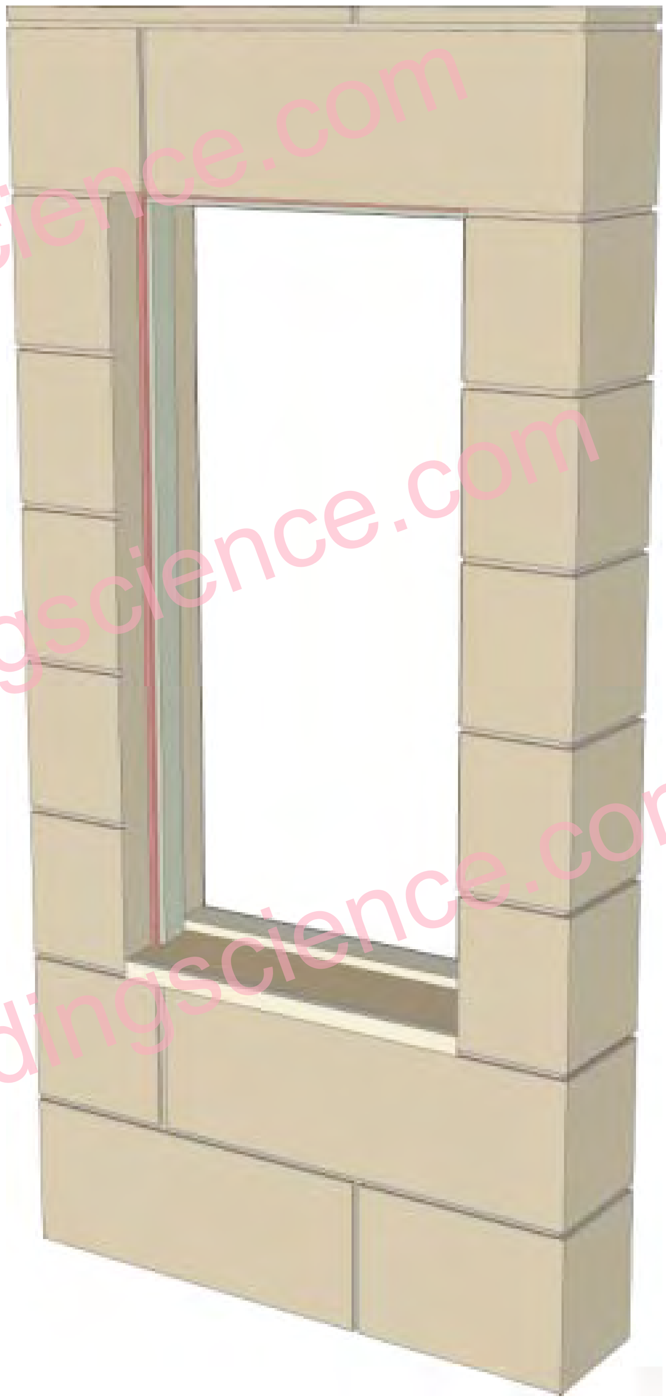
Installing window in Durisol wall with stone veneer

Step 5
Apply sealant over wood bucks



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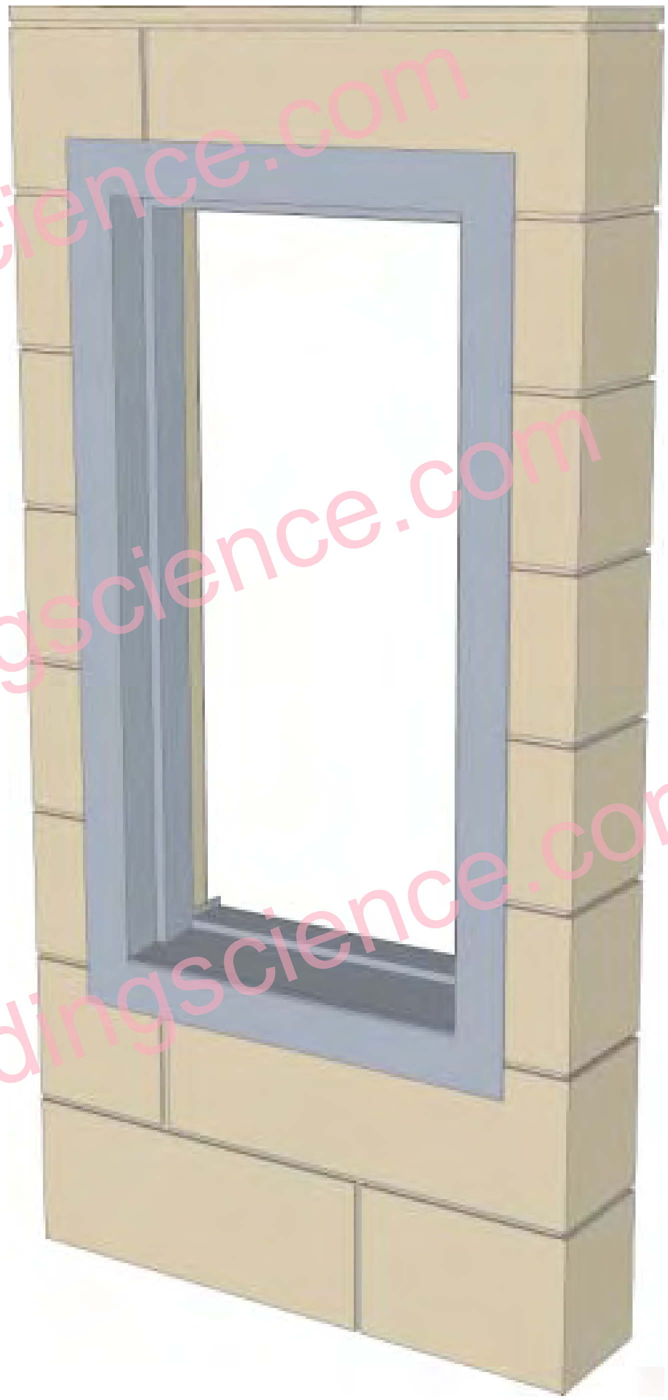
Installing window in Durisol wall with stone veneer

Step 6

Liquid applied elastic membrane over sill, bucks and face of block



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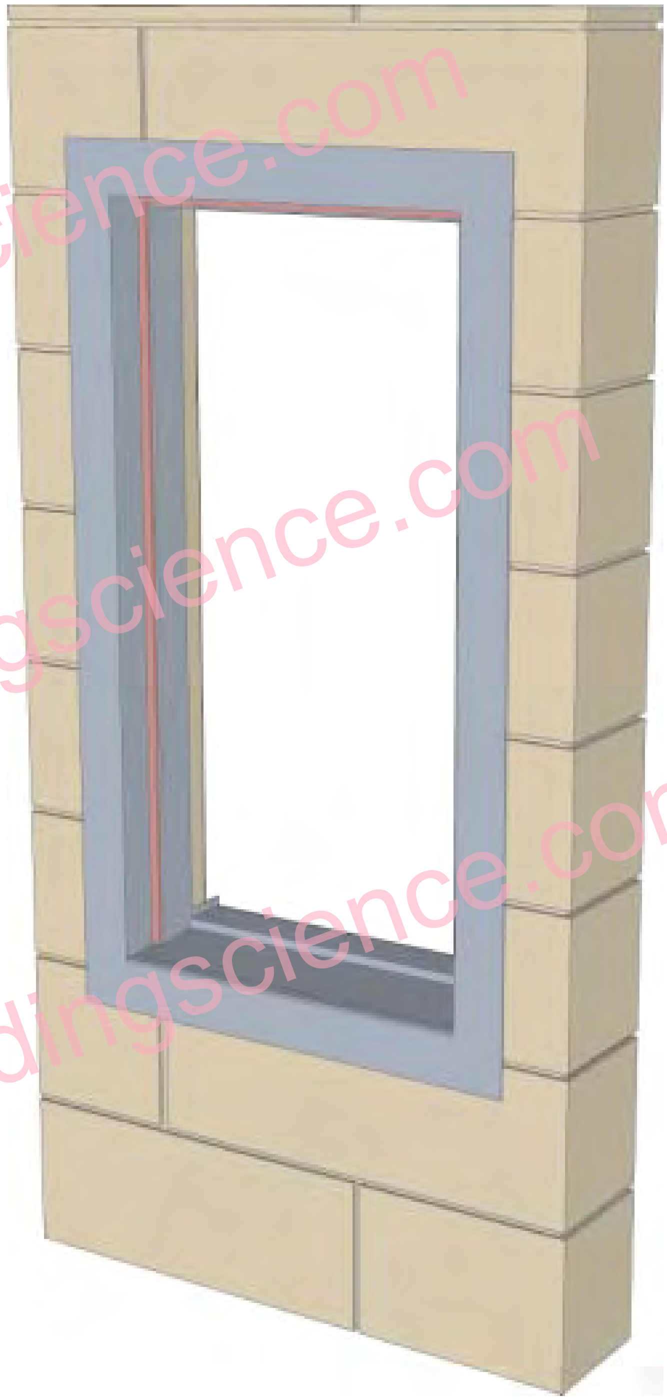
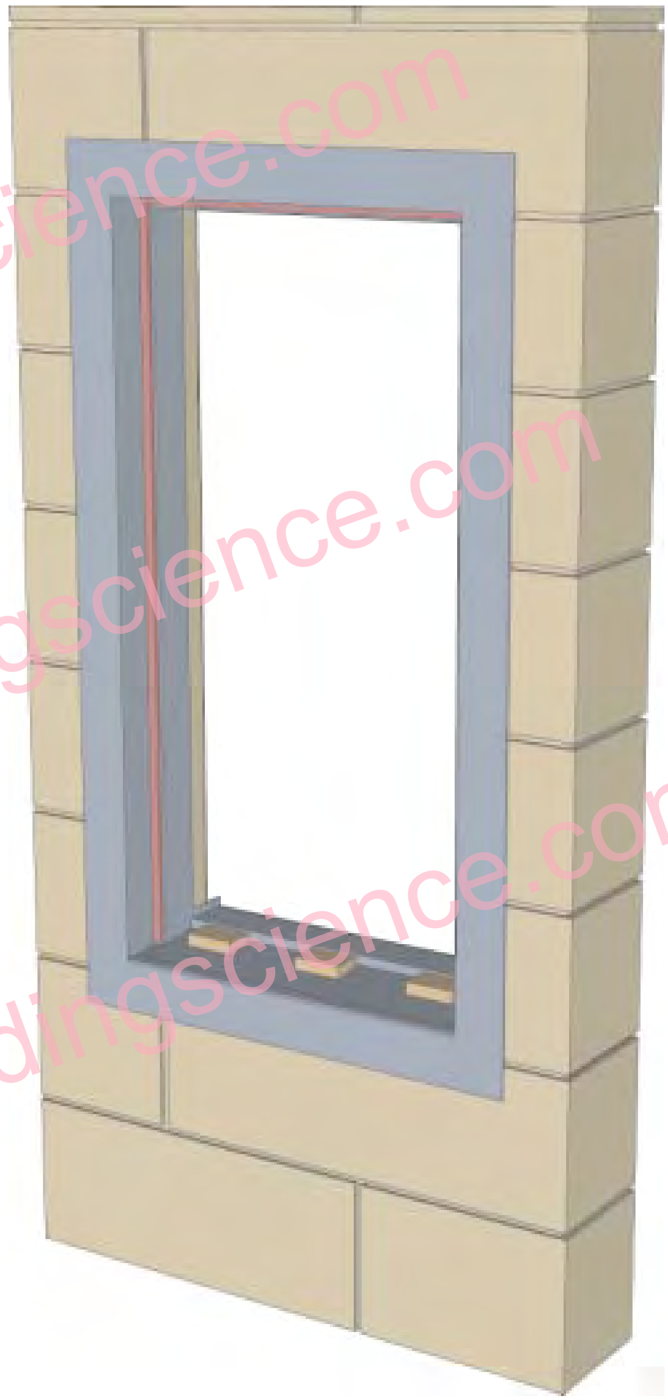
Step 7
Apply sealant at head and jambs



Installing window in Durisol wall with stone veneer

Step 8

Install sill blocking



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Installing window in Durisol wall with stone veneer

Step 9
Install window

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Installing window in Durisol wall with stone veneer

Step 10

Apply liquid applied waterproofing to bottom three feet of wall

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Installing window in Durisol wall with stone veneer

Step 11

Apply polymer-modified stucco rendering as stone veneer bed

Installing window in Durisol wall with stone veneer

Step 12
Install stone veneer

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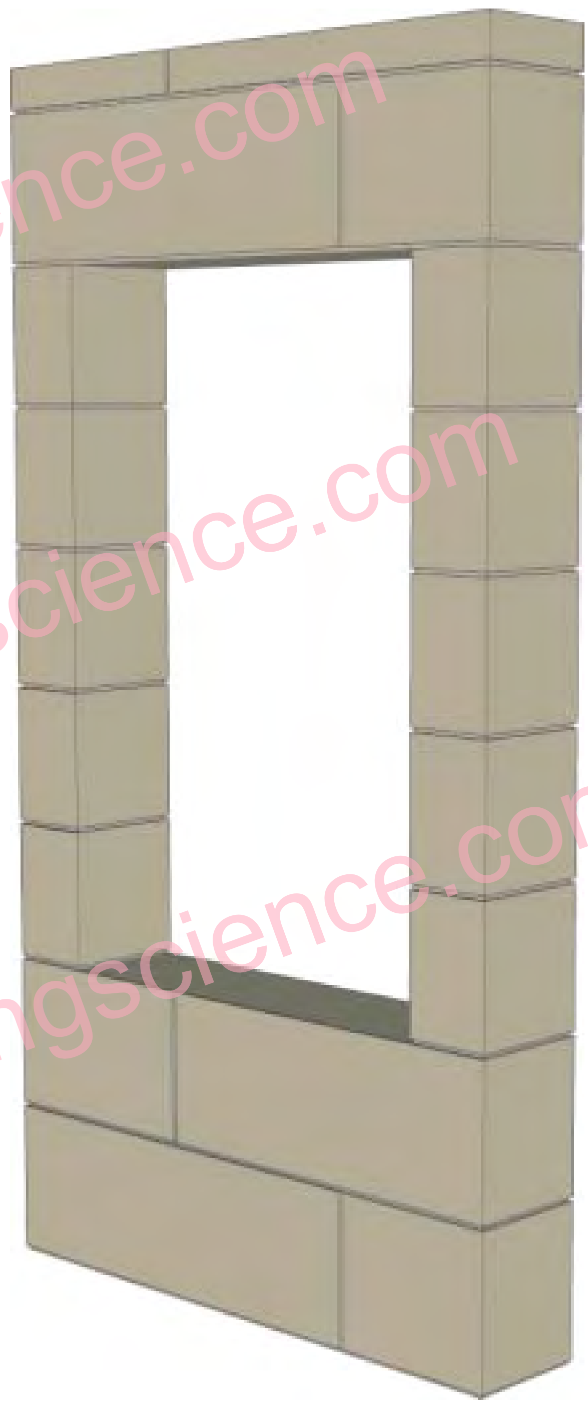
Installing window in Durisol wall with fibercement siding

Step 1

Durisol block wall



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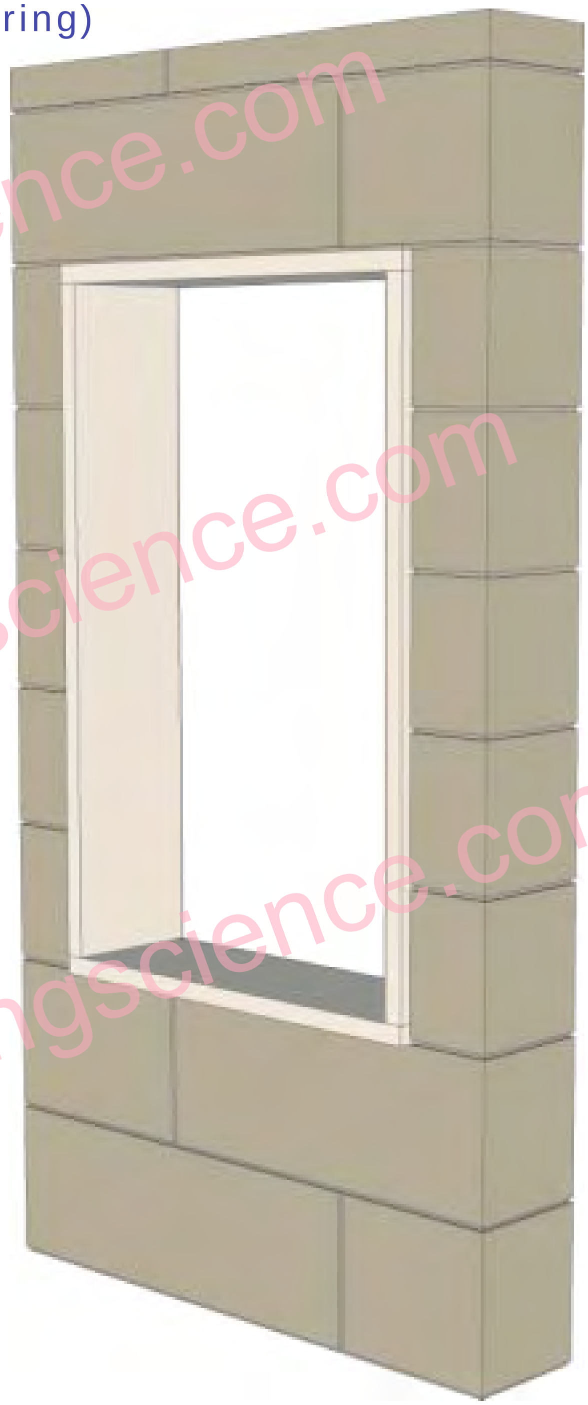
Installing window in Durisol wall with fibercement siding

Step 2

Install wood bucks at sill, head and jambs; ensure 3/4” overhang (which will align with face of furring)



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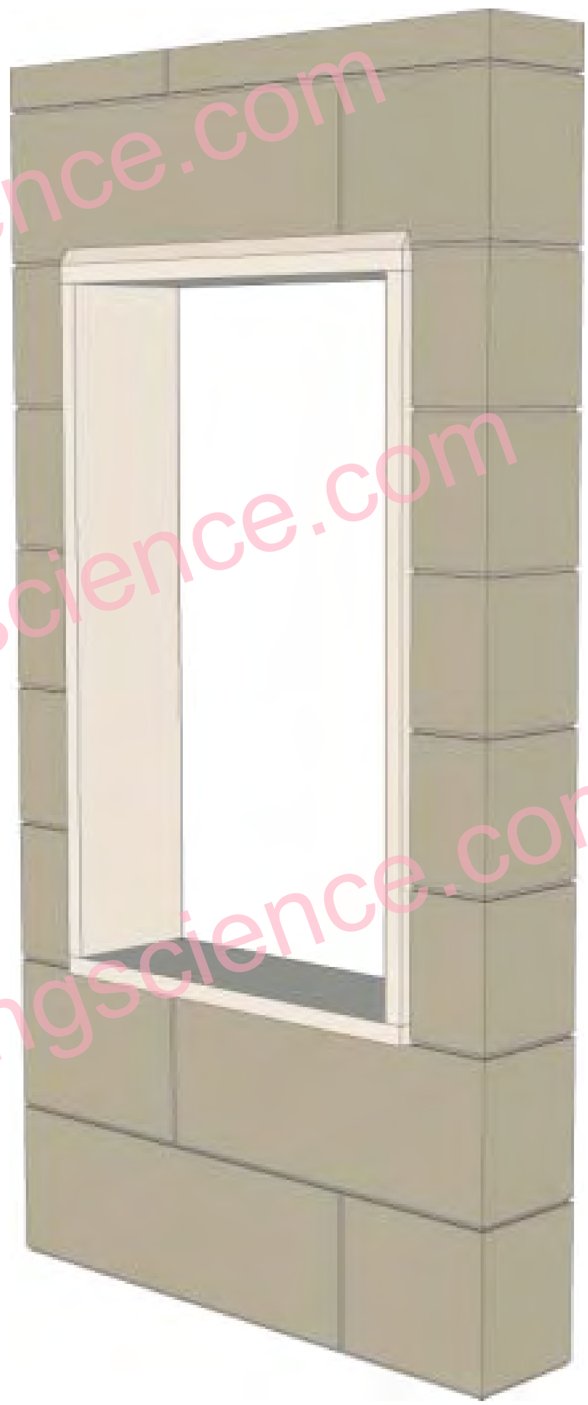
Installing window in Durisol wall with fibercement siding

Step 3

Install wood cant strip at head



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Installing window in Durisol wall with fibercement siding

Step 4

Install wood buck at sill

Installing window in Durisol wall with fibercement siding

Step 5
Apply sealant around wood buck at jambs and sill

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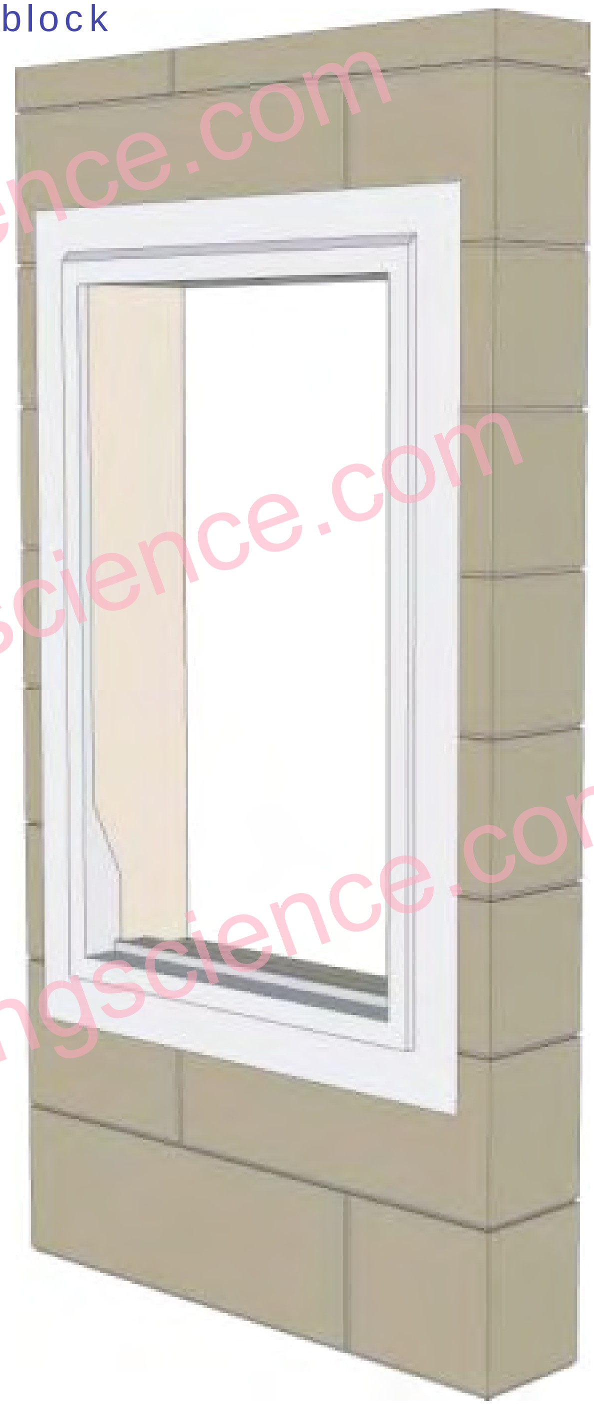
Installing window in Durisol wall with fibercement siding

Step 6

Liquid applied elastic membrane installed over bucks, cant strip, sill, face of sill dam and face of block



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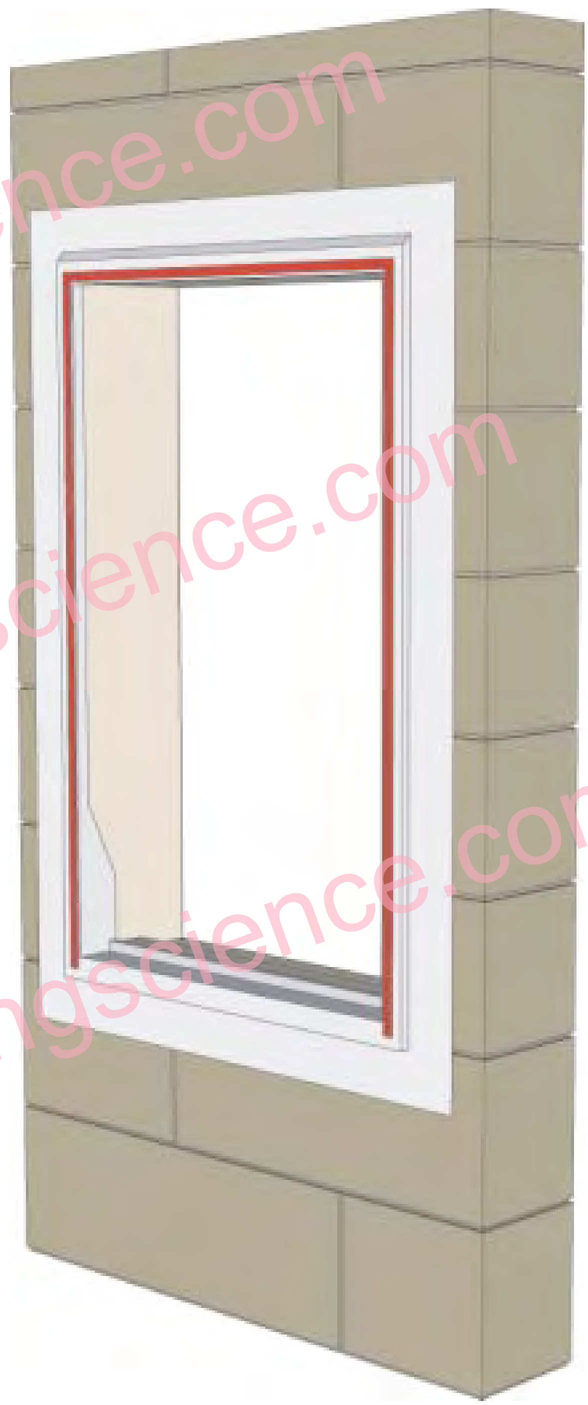
Installing window in Durisol wall with fibercement siding

Step 7

Apply sealant at head and jambs



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Installing window in Durisol wall with fibercement siding

Step 8

Position window for installation

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Installing window in Durisol wall with fibercement siding

Step 9
Install window

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Installing window in Durisol wall with fibercement siding

Step 10
Apply tape at jambs

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Installing window in Durisol wall with fibercement siding

Step 11
Apply tape at head

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Installing window in Durisol wall with fibercement siding

Step 12
Install furring strips

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Installing window in Durisol wall with fibercement siding

Step 13

Install fibercement siding over furring strips

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