PROJECT 4: Technical and Resiliency Technology

Identify at least 10 resiliency technical recommendations and 10 construction technology innovation details. Submit a description of each system and explain the advantages and disadvantages of each system with regard to cost, labor training, and aesthetics. Use images to provide evidence of both advantages and disadvantages. Prepare a source list of citations you used to research the project response.

Resiliency Technical Recommendations & Construction Technology Innovation Details

1. Rainscreen (See Detail A, Sheet 1)

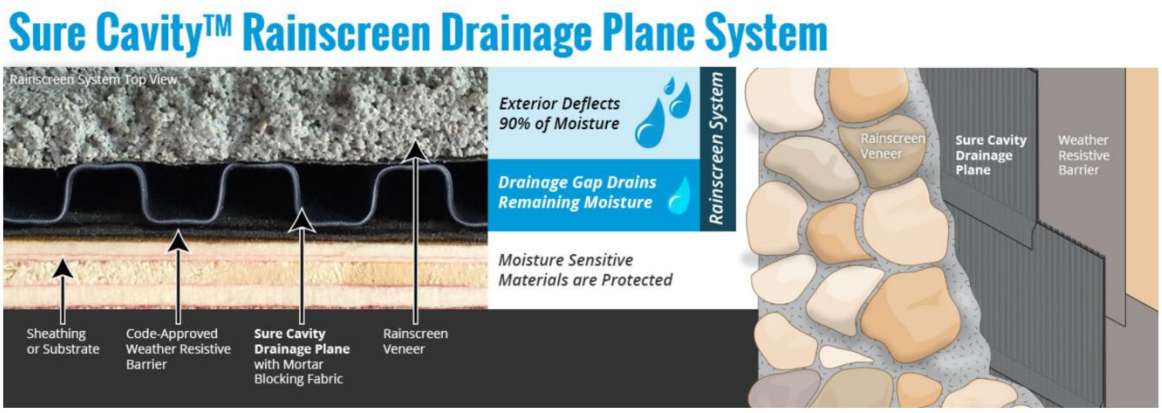
The rainscreen is similar to a shield that can protect you against most water attacks; it is the first line of defense against the effects of moisture on the wall detail. A rainscreen is the weather-facing surface of an exterior wall detail that stands off at least 1/8" (up to 3/8") from the moisture-resistant surface of the structural back up wall. A 1/8" gap is the minimum space to create a capillary break for drainage.

Many times the structural wall would be a brick veneer, stone veneer or other types of masonry veneers. An important, though frequently overlooked, point about rainscreens: A veneer that does not stand off from the moisture-resistant surface of the structural backup wall to create a cavity is NOT a true rainscreen; it is just a veneer.

No building envelope is 100% waterproof. Sealers, waterproofers, and other materials break down over time. Construction errors happen, the ground settles, and cracks form leading to water penetration. The addition of a drainage plane mitigates the risk of moisture intrusion from unavoidable imperfections in the wall materials and construction. A small amount of trapped moisture in the wall can lead to mold, rot, and negative effects on the sustainability of the building and health of its inhabitants.

Rainscreens are cost effective; typically adding one to two dollars per square foot to the construction cost, however, remediation of failed walls can cost more than sixty dollars per square foot. This makes the installation of this system a cheap insurance policy against water attacks.

All information noted above was obtained from www.mtidry.com. Please see image below.



2. Flood Vents (Smart Vents) (See Detail B, Sheet 1)

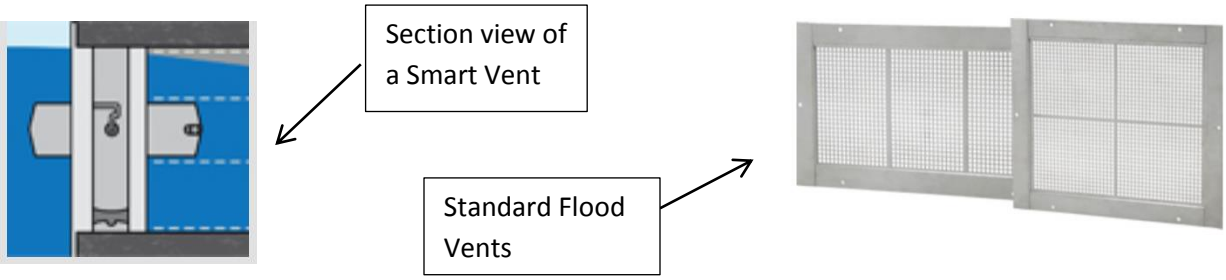
Smart Vent's line of ICC-ES Certified, Engineered Flood Vents protect houses and buildings during floods by preventing hydrostatic pressure buildup that can destroy walls and foundations. This mitigation technique, referred to as Wet Floodproofing, allows floodwater to freely flow through an enclosure such as a crawlspace or garage.

The NFIP Regulations and Building Codes require that any residential building constructed in Flood Zone Type A have the lowest floor, including basements, elevated to or above the Base Flood Elevation (BFE). Enclosed areas are permitted under elevated buildings provided that they meet certain use restrictions and construction requirements such as the installation of flood vents to allow for the automatic entry and exit of flood waters.

This wet floodproofing technique is required for residential buildings. With commercial buildings, elevation and the use of wet floodproofing techniques is the suggested form of mitigation. This technique can be a more cost-effective solution, and reduces the impacts the building has on surrounding floodplain in comparison to dry floodproofing techniques.

Advantages for the Smart Vent product are: Buildings need fewer Smart Vents than simple air vents because of the patented float system technology; the vents open and close automatically, instead of manually like other vents, via temperature change; the activation float system is rodent resistant unlike other vents that can be chewed through; Smart Vents are certified by the International Code Council and are compliant with FEMA and NFIP, therefore the extra cost of hiring an engineer is not incurred. Smart vents cost more than non-engineered openings, but you need less of them compared to air vents. Smart Vents are certified for 200 square feet of flood coverage, so on a building that may need 30-35 air vents, only eight Smart Vents are required, curtailing the extra cost acquired.

All information noted above was obtained from www.smartvent.com. Please see image below.



3. Open Foundation (See Detail B, Sheet 1)

In an open foundation, the building is supported by piles or piers, and the bottom of the first-floor framing is several feet above-grade to protect it from flooding and moisture. Piles and piers are constructed of concrete, masonry, timber, or steel. Some of the area below the first floor may be enclosed with walls for an elevator or to create a small storage area. Wood lattice is also often placed between piles/piers to provide a privacy screen. Manufactured housing is typically supported on an open foundation, but often a non-bearing wall (skirting) is installed around the perimeter of the home between grade and the floor.

The greatest advantage is the aforementioned protection from flooding, which creates a crawl space that allows access to plumbing and electrical units that can sit above the BFE. Issues that arise may be solved without breaking up concrete to get to broken or damaged pipes, which, in turn, saves money if repairs are needed. The air under the home also offers insulation, saving on energy costs. Homeowners may *have* to elevate to drastically reduce or simply receive flood insurance. Disadvantages include: the price to elevate the home can be costly; sagging and creaky floors can be of consequence to raised platforms; bugs and rodents nest in the crawl space below; the underside of the first floor can become ignited by direct flame, embers, or hot gases; crawl spaces can become dumping grounds for trash; lattice screens can trap combustible debris such as leaves and paper; and, aesthetically, elevated homes may be less attractive.

All information noted above was obtained from www.fema.com. Please see image below.

4. Hurricane Ties (See Detail J, Sheet 3)

A hurricane tie is used to help make a structure more resistant to high winds, or hurricanes, resisting uplift, racking, overturning, and sliding. Each of the crucial connections in a structure (that would otherwise fail under the pressures of high winds) have a corresponding type of tie, generally made of galvanized or stainless steel, and intended to resist hurricane-force and other strong winds. A connecting tie provides a continuous structural load transfer path from the top of a building to its foundation; helping to protect buildings from damage resulting from high wind. These devices are primarily used in areas affected by high winds (including hurricanes) and are generally suitable for any area that may be impacted by windstorm damage. They are also known as hurricane clips or strips. Hurricane clips meet the minimum requirements for code approval and are only as strong as their weakest install point; which is generally ½ the strength of the wood.

All information noted above was obtained from en.m.wikipedia.org. Please see image below.

5. Waterproof Membrane (See Detail F, Sheet 3)

A waterproofing membrane is a thin, continuous layer of watertight material that is laid over a surface. It ensures water does not pass into the structural slab. The membrane must be laid over a filler material that is sloped to ensure that water flows into sumps and drains. The membranes are composed of thin layers two to four mm thick. There are two types of membranes, sheet based and liquid applied membranes. It should be strong, flexible, tear resistant and elastic so it can stretch to cover cracks and move with the building. If it is exposed to the sun it should be UV stable. It would also be capable of turning up and over walls and other construction features.

The major advantage is that it prevents mold and mildew from getting into the walls and floor. This makes waterproofing essential to structural integrity and health. It also reduces maintenance costs and clean-up—with waterproof structures you have a lot less work to do when cleaning up after a heavy rainstorm or flood. Moreover, a home waterproofing system increases the value of a house. Unwanted moisture can negatively impact personal health by creating an environment that allows mold to grow. Additionally, water damage can ruin the structural integrity of a home by undermining its foundations as it erodes concrete or stone walls and destroys items in the home as the moisture causes metal machinery to rust and wood to decay. An unhealthy atmosphere or weak foundations will certainly negatively impact a home's resale value.

The greatest disadvantage to home waterproofing systems is the cost as the labor charges for installation are typically expensive. Minor interior waterproofing repairs may cost only a few hundred dollars -- for concrete repair or fillers -- but external waterproofing systems cost several thousand dollars due to the need for specialized excavating equipment to reach and repair the foundation footings. This cost would be greatly diminished in new construction as the footings are already exposed.

The above information was obtained from www.understandconstruction.com and www.hunker.com. Please see images below.

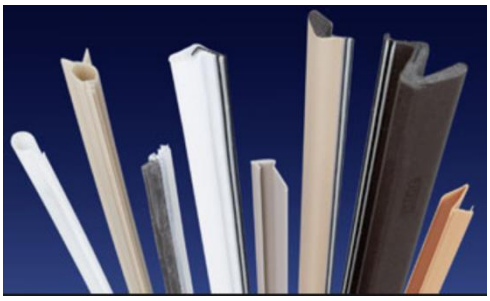

6. Door and Window Weather-Stripping (See Detail G, Sheet 3)

Weather-stripping seals air leaks around moveable building components such as doors and operable windows. There are varying types of weather-stripping that can withstand the friction, weather, temperature changes, and wear and tear associated with its location. For example, when applied to a door bottom or threshold, weather-stripping could drag on carpet or erode as a result of foot traffic. Weather-stripping in a window sash must accommodate the sliding of panes -- up and down, sideways, or out. The weather-stripping should seal well when the door or window is closed but allow it to open freely.

Felt and open-cell foams tend to be inexpensive, susceptible to weather, visible, and inefficient at blocking airflow. However, the ease of applying these materials may make them valuable in low-traffic areas. Vinyl, which is slightly more expensive, holds up well and resists moisture. Metals (bronze, copper, stainless steel, and aluminum) last for years and are affordable. Metal weather-stripping can also provide a nice touch to older homes where vinyl might seem out of place. Multiple weather-stripping types can be used to seal an irregularly shaped space. Durability can affect the cost.

Weather-stripping is inexpensive and easy to install yet can save a lot of money in energy preservation. So it has no key disadvantage.

The above information was obtained from www.energy.gov. Please see image below.



7. High Impact Windows

Impact-resistant windows and doors combine heavy-duty frames with impact-resistant laminated glass and a special silicone glazing process to keep the glass from breaking away from its frame. Impact-resistant glass is comprised of two panes of glass bonded together with a special interlayer of clear polyvinylbutyral. Although wind-borne debris may crack the glass on impact, the interlayer keeps the overall window and door intact, preventing destructive winds from entering the building. Replacing traditional windows with impact-resistant windows will help both to gain the best energy efficiencies and to protect the envelope of your building.

Impact windows can come with laminated insulating glass, heat-reducing glass tints, and hi-performance low-E selections. In addition to impact resistance, these windows also offer the benefits of reduced energy bills and protect furnishings, draperies and artwork from fading. They cannot be torn from the building like shutters and will not shatter regardless of the storm impact. Impact windows can also significantly reduce outdoor noise. They are much more expensive than shutters and other types of windows.

All above information was obtained from cdn2.hubspot.net and www.alphaimpactwindow.com. Please see image below.

Gunshots didn't penetrate this impact door.

8. Hurricane Shutters (See Detail D, Sheet 1)

Hurricane shutters are not needed with impact windows. These steel or aluminum shutters attach to the walls around windows and doors on bolts or tracks. Storm panels are corrugated, and each piece overlaps the next for maximum strength. There are several styles of storm panels to choose from. There are some advantages to choosing hurricane shutters to protect the openings of the building. They are much cheaper than impact windows yet still protect from high winds, wind borne objects and UV rays. They can also be removed if no impending danger is imminent—so the house doesn't look like a prison. Disadvantages include: Disallowing light into the home when closed; potential of incorrect fastening to the window can lead to window breakage or the shutters being torn off the building; and they require storage when not in use.

The above information was obtained from www.sun-sentinel.com and www.alphaimpactwindow.com. Please see image below.

This style is also called Bahama Shutters.

9. Vapor Retarders (Also called Vapor Barriers) (See Detail H, Sheet 3)

A vapor retarder is defined as a material or system that adequately retards the transmission of water vapor under specific conditions. Vapor retarders resist vapor movement into framed building assemblies and permit moisture penetrating the assembly to dissipate when conditions are cooler and dryer. They should *not* be used on both sides of the wall or ceiling assembly.

Treated paper or foil used as a vapor retarder typically comes in the form of kraft or foil-faced batt insulation. It is useful in situations where the wall finish has been removed and new exterior wall insulation is being installed, as well as in new builds. This type is most effective in mixed climates with low humidity, since the amount of unsealed edge will allow a path for moisture-vapor migration. This is a very cost-effective option, since batt insulation and a vapor

retarder can be installed in one step. However, it can be installed only during a new build or in a situation where the walls have been stripped to the rough framing. The number of joints and edges inherent in this installation don't allow for an extremely efficient vapor retarder, though it is sufficient for mixed climates or heating climates where humidity is controlled.

Clear polyethylene is the most basic, plastic barrier film available, as well as the most economical, and is best suited to interior wall applications over framing and insulation. It is also an environmentally friendly choice since it is comprised of up to 80% re-processed material, but this comes at a cost, as the quality can be uneven, making it prone to tearing and puncturing. This type of vapor-retardant material is not recommended for applications where it will be subjected to more than a limited amount of direct sunlight, as it will degrade over time. It is inexpensive and fairly easy to install. Because the material is translucent, it is easy to attach to framing members, and installing wallboard over the plastic is simple, as well. Clear polyethylene is most effective in severe heating climates. Cons again are that this material is fairly flimsy and can be easily damaged during installation. It incorporates limited resistance to punctures and tears. Any penetrations, such as for an electrical junction box, must be taped and sealed in order to form an effective barrier.

The above information was obtained from the "Build Better Guide" and www.nachi.org.

10. Metal Connectors with Galvanized Coating (See Detail J, Sheet 3)

Metal used in construction must be properly protected from corrosion. The potential for corrosion of fasteners (e.g. nails, screws, bolts, nuts and washers) and connectors (e.g. joist hangers, straps, hinges, post anchors and truss plates) in contact with pressure-treated wood varies by preservative system and end-use exposure.

The iron atoms in steel will readily oxidize in the presence of oxygen. If kept dry, and within reasonable humidity levels (between 30 to 50 percent, with the ideal level being about 45 percent), a thin surface layer of iron oxide, referred to as "stable rust", will form and to a large degree protect the steel. Conversely, high, relative outdoor humidity can accelerate corrosion,

leading to a prevalence of hydrated iron oxide, also known as “cancerous rust”. This is due to an increased exposure of atmospheric pollutants such as salt and man-made compounds that are distributed through pooling dew, condensation, and rainwater. Forensic Inspectors have evaluated corrosion of steel connectors and fasteners for decades, with many being in areas that are surprisingly well-protected from wind-driven rain. The common denominator at most of these locations is their proximity to a saltwater, coastal environment. An often-repeated conclusion is that the salt spray from the waves washing onto the shore is the primary causation of the corrosion problem. While this may be true along the immediate shoreline, the issue of accelerated corrosion is also found many miles inland and on the top floors of tall structures. The catalyst for the accelerated corrosion of steel in this circumstance is not airborne salt, but airborne chloride ions.

The above information was obtained from www.qualitybuilt.com and www.southern pine.com. Please see image below.

Here are examples of corroded metal connectors. The corresponding detail (mentioned above) is labeled with galvanized connectors which protect against corrosion.

11. Energy Efficient Toilets (See Detail E, Sheet 2)

A low-flush toilet (or low-flow toilet or high-efficiency toilet) is a flush toilet that uses significantly less water than a full-flush toilet. Low-flush toilets use 4.8 liters (1.3 US gal; 1.1 imp gal) or less per flush, as opposed to 6 liters (1.6 US gal; 1.3 imp gal) or more. They came into use in the United States in the 1990s, in response to water conservation concerns. Low-flush toilets include single-flush models and dual-flush toilets, which typically use 1.6 US gpf for the full flush and 1.28 US for a reduced flush.

Recent advancements have allowed toilets to use 1.28 gallons per flush or less while still providing equal or superior performance. This is 20 percent less water than the current federal standard of 1.6 gallons per flush. The WaterSense label is used on toilets that are independently

certified to meet rigorous criteria for both performance and efficiency. Only water-saving toilets that complete the certification process can earn the WaterSense label.

The primary pro of a low-flush toilet is water conservation. A low-flush toilet is designed to have two flushing operations – one flush for liquid wastes and one flush for solid wastes. Each flush uses a different amount of water. You can save a considerable amount of water each year by using the appropriate flush every time you use the toilet.

The cons of a low-flush toilet include ease of use, maintenance, and sanitation. Some low-flush toilets can be confusing. If you use the wrong flush button, you will have to flush again – defeating the purpose of the toilet, which is to save water. Make sure you choose a low-flush toilet that is easy to use, even for small children. The maintenance of a low-flush toilet is another possible negative. These toilets are not as simple to maintain as a traditional toilet because they have dual flushing mechanisms. This can lead to more costly repairs down the road. Finally, some dual flush owners find that their toilet requires more cleaning because the lower flush option uses less water. Not only does the water help with the flushing process, it helps keep the toilet clean. Less water means less rinsing of the interior of the bowl, which can lead to more frequent cleaning of the toilet.

The above information was obtained from www.epa.gov, www.plumbinghelptoday.com, and en.m.wikipedia.org. Please see image below.

Low flush and dual flush toilets are made by multiple companies.

12. Energy Star Appliances and High Efficiency Appliances (See Detail E, Sheet 2)

Energy Star qualified appliances incorporate advanced technologies and use 10-50% less energy than standard appliances. Appliances are labeled to indicate purchase and operational costs. These appliances can include refrigerators and freezers, dishwashers, and clothes washers. Energy Star certified appliances help consumers save money on operating costs by reducing energy use without sacrificing performance. While most energy-efficient

appliances cost more than their less-efficient counterparts, the small amount they'll save you monthly in lower utility bills will eventually add up. By replacing a pre-1994 washer with a new Energy Saver model, the average family of four can save about $110 per year on utility bills. Oversized air conditioners, water heaters and refrigerators waste both energy and money.

A high-efficiency washing machine, known to most people as a front-loading washer, reduces water use by 40 to 60 percent and energy use by 50 to 60 percent per load, according to Energy Star and the National Geographic Green Guide. There are a few top loading high efficient machines.

The Energy Star label on the machine lets you know that it is 37 percent more efficient than a standard washer, but you also have to look for "high efficiency" in the name to get more water and energy savings. The Energy Star label just means it is at least 37 percent more efficient; it can be higher. If the washer is high-efficiency, it will say right in the name.

The above information was obtained from www.energystar.gov and www.foxbusiness.com and www.motherearthnews.com. Please see image below.

13. Energy Efficient Lighting (See Detail E, Sheet 2)

The most popular light bulbs available are halogen incandescents, compact fluorescent lamps (CFLs), and light-emitting diodes (LEDs). Although they can initially cost more than traditional incandescent bulbs, during their lifetime they save you money, because they use less energy. Controls such as timers and photocells save electricity by turning lights off when not in use. Dimmers save electricity when used to lower light levels. Products should be compatible with the energy-efficient bulbs.

Using CFLs or LEDs in fixtures that will be left on for long periods will save a lot of energy. Most bare spiral CFLs can be used in enclosed fixtures that protect them from the weather. CFLs and LEDs are available as flood lights. These models have been tested to withstand the rain and snow so they can be used in exposed fixtures. Also look for ENERGY STAR-qualified fixtures that are designed for outdoor use and come with features like automatic daylight shut-off and motion sensors.

All above information was obtained from www.energy.gov. Please see image below.

The corresponding detail (mentioned above) was drawn as an LED light bulb, but CFL's also save money over incandescent bulbs.

14. Snow and Ice Melt Systems (See Detail C, Sheet 1)

Snow and ice melt systems are used to remove snow and ice from walkways, driveways and roof eaves through embedded electric cables or hydronic piping. This system should be equipped with controls that either automatically shutoff when the pavement temperature is above 50 degrees Fahrenheit and no precipitation is falling or have an automatic or manual shutoff when the outdoor temperature is above 40 degrees Fahrenheit. The shutoffs should be readily accessible and turned off when not needed.

Electric snowmelt systems require less maintenance than hydronic snowmelt systems because there are minimal moving parts and no corroding agents. However electric snowmelt systems tend to be much more expensive to operate. Some building codes require the high limit thermostat to prevent energy waste. Total environmental impact depends on the energy source used.

Advantages include no removal of snow, safer walks and pathways decreasing liability, no need for chemical or salts that can deteriorate walk surfaces, and longevity of the walks due to even heat distribution. Disadvantages include the cost to install and maintain these systems, as well as the costly potential for ripping up surfaces if a repair is needed.

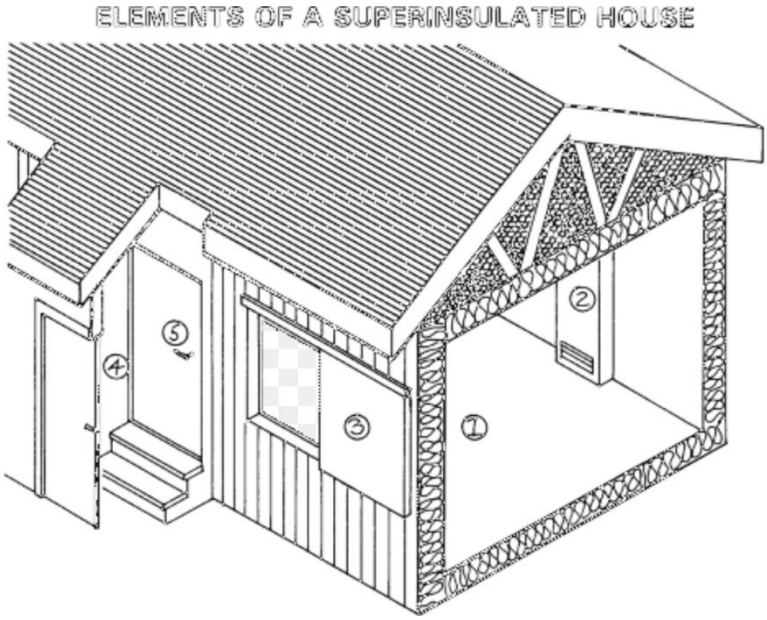
All of the above information was obtained from the “Build Better Guide,” and www.therma-hexx.com. Please see image below.

15. Super Insulated House (See Detail E, Sheet 2)

Superinsulation is an approach to building design, construction, and retrofitting that dramatically reduces heat loss (and gain) by using much higher levels of insulation and airtightness than normal. Superinsulation is one of the ancestors of the passive house approach. A superinsulated house is intended to reduce heating needs very significantly and may even be heated predominantly by intrinsic heat sources (waste heat generated by appliances and the body heat of the occupants) with very small amounts of backup heat. This has been demonstrated to work even in very cold climates but requires close attention to construction details in addition to the insulation.

In new construction, the cost of the extra insulation and wall framing may be offset by not requiring a dedicated central heating system. During a power failure, a superinsulated house stays warm longer as heat loss is much less than normal, but the thermal storage capacity of the structural materials and contents is the same. Adverse weather may hamper efforts to restore power, leading to outages lasting a week or more. When deprived of their continuous supply of electricity, either for heat directly, or to operate gas-fired furnaces, conventional houses cool rapidly, and may be at greater risk of costly damage due to freezing water pipes.

The above information was obtained from en.wikipedia.org. Please see image below.



16. Zero Energy Building (See Detail E, Sheet 2)

Zero energy buildings combine energy efficiency and renewable energy generation to consume only as much energy as can be produced onsite through renewable resources over a specified time period. Achieving zero energy is an ambitious yet increasingly achievable goal that is gaining momentum across geographic regions and markets. Private commercial property owners have a growing interest in developing zero energy buildings to meet their corporate goals, and in response to regulatory mandates, federal government agencies and many state and local governments are beginning to move toward zero energy building targets. There is mounting evidence that zero energy can, in many cases, be achieved within typical construction budgets.

Most zero-energy buildings use the electrical grid for energy storage but some are independent of the grid. Energy is usually harvested on-site through energy producing technologies like solar and wind, while reducing the overall use of energy with highly efficient HVAC and lighting technologies. The zero-energy goal is becoming more practical as the costs of alternative energy technologies decrease and the costs of traditional fossil fuels increase.

The development of modern zero-energy buildings became possible largely through the progress made in new energy and construction technologies and techniques. These include highly insulating spray-foam insulation, high-efficiency solar panels, high-efficiency heat pumps and highly insulating low-E triple-glazed windows. These innovations have also been significantly improved by academic research, which collects precise energy performance data

on traditional and experimental buildings and provides performance parameters for advanced computer models to predict the efficacy of engineering designs.

Advantages include: Not having to deal with future energy price increases; increased comfort due to uniform interior temperatures; reduced cost of living; reliable photovoltaic systems last a long time; new construction prices are much less than a retrofit; higher resale value as demand for zero energy buildings increase; and future legislative restrictions may force expensive retrofits for insufficient buildings. Disadvantages include: Initial cost can be higher; few designers and builders have the needed skills and experience to build zero energy buildings; struggle to recover high initial cost on resale from ununiformed appraisers; and climate-specific design may limit ability to respond to future ambient temperature changes.

The above information was obtained from www.energy.gov and en.wikipedia.org. Please see image below.

The detail (mentioned above) used in the construction drawings was imported due to better visual understanding of all components working in unison. A CAD original would be difficult to emulate in this situation.

17. Spray Foam Insulation

Spray polyurethane foam (SPF) is a spray-applied plastic that is widely used to insulate buildings and seal cracks and gaps, making the building more energy-efficient and comfortable. SPF insulation is known to resist heat transfer extremely well, and it offers a highly effective solution in reducing unwanted air infiltration through cracks, seams, and joints. High density spray foam is usually used on exterior and roofing applications. Medium density is often used for continuous insulation, interior wall cavity fill, and unvented attic applications. Low density is often used for interior wall cavity fill and unvented attic applications.

Spray foam is available in two different types: open-cell spray foam which is usually $0.44 to $0.65 per board foot and closed-cell spray foam which is about $1 to $1.50 per board foot.

Open-cell is also known as half-pound foam. It has an R-Value of 3.5-3.6 per inch, and its density is about 0.5 pounds per cubic food. Low-density foams like these are made partially from raw biological materials—carbon dioxide or water is also used in the makeup. Open-cell uses far less material than closed-cell, but its R-Value is lower. Also, open cell requires a vapor retarder (like gypsum wallboard) and is riskier when used for roof sheathing. It's not highly recommended that you use open-cell insulation if you live in a cold climate unless you have that extra barrier.

Closed-cell (aka two-pound foam) is denser than open-cell at about 2 pounds per cubic foot. Its R-Value is between 6-6.5 per inch. As a result, this kind of foam is much more expensive than its counterpart. The reason closed-cell doesn't need a vapor retarder is because it already has one. Its permeance is 0.8 perm, which means it can handle cold climates without the use of an additional board or drywall. Closed-cell uses hydroflurocarbons (HFCs) as part of its makeup. However, this material has been known to have a high global warming effect.

Spray foam insulation helps lower utility costs because it blocks heat and cold from the outdoors. Recent studies by the U.S. Department of Energy state that around 40 percent of all energy is lost through poor insulation. Spray foam insulation is able to insulate homes at least 50 percent more than traditional insulation products. Spray foam insulation can also provide protection against moisture, which otherwise leads to the unwanted development of mold and mildew. And it can also be used for noise reduction as well. In fact, spray foam is good for homes and buildings in which outdoor noise can be a distraction.

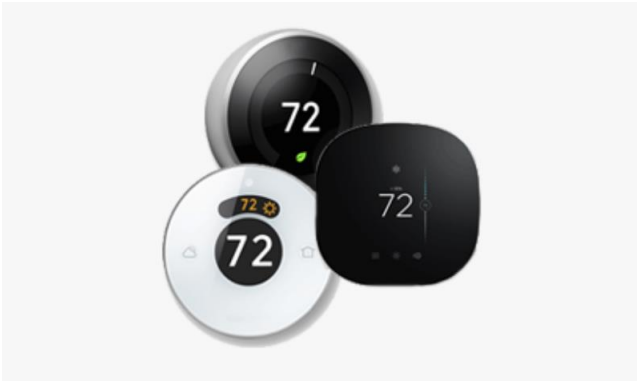
The drawback to spray foam insulation is it has been known to cause certain health issues such irritation of the eye and the gastrointestinal and respiratory tracts. Direct contact can cause inflammation to the skin, and some individuals have been known to break out in a rash on the arms, chest and neck area. Spray foam insulation has also been linked to a few cases of hypersensitivity pneumonitis.

The above information was obtained through www.whysprayfoam.org and www.homeadvisor.com.

18. Smart Thermostat (See Detail E, Sheet 2)

A smart thermostat is a Wi-Fi enabled device that automatically adjusts heating and cooling temperature settings in a building or home for optimal performance. Smart Thermostats that earn the Energy Star label have been independently certified to deliver energy savings. Many smart thermostats learn your temperature preferences and establish a schedule that automatically adjusts to energy-saving temperatures when you sleep or are away. Geo-fencing allows your smart thermostat to know when occupants are about to return and automatically adjusts the temperature. Energy star certified smart thermostats quickly enter a low-power standby mode when inactive. They are also designed to be compatible with the programs that some local utilities offer, providing home owners in their service territory with incentives to help them manage reliability. Some negatives to this device is it may not be compatible with all heating and cooling systems, they are more expensive than standard thermostats, and they can be tricky to set up an install properly—and if not installed properly, the savings won't be reaped.

The above information obtained from www.energystar.gov and shiptons.ca.



Smart Thermostats come in a variety of makes and colors. However, most use low voltage hookups.

19. Heat Pumps (See Detail E, Sheet 2)

For climates with moderate heating and cooling needs, heat pumps offer an energy-efficient alternative to furnaces and air conditioners. Heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into your warm house and during the cooling season, heat pumps move heat from your cool house into the warm outdoors. Because they move heat rather than generate heat, heat pumps can provide equivalent space conditioning at as little as one quarter of the cost of operating conventional heating or cooling appliances.

There are three types of heat pumps: air-to-air, water source, and geothermal. They collect heat from the air, water, or ground outside your home and concentrate it for use inside.

The most common type of heat pump is the air-source heat pump, which transfers heat between your house and the outside air. The heat pump can reduce your electricity use for heating by approximately 50% compared to electric resistance heating such as furnaces and baseboard heaters. High-efficiency heat pumps also dehumidify better than standard central air conditioners, resulting in less energy usage and more cooling comfort in summer months. Air-source heat pumps have been used for many years in nearly all parts of the United States, but until recently they have not been used in areas that experienced extended periods of subfreezing temperatures. However, in recent years, air-source heat pump technology has advanced so that it now offers a legitimate space heating alternative in colder regions.

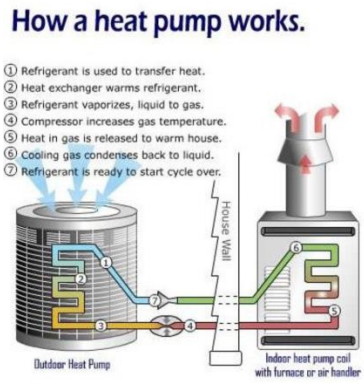
Air-source heat pumps are also available in a ductless version called a mini-split heat pump. In addition, a special type of air-source heat pump called a "reverse cycle chiller" generates hot and cold water rather than air, allowing it to be used with radiant floor heating systems in heating mode.

Geothermal (ground-source or water-source) heat pumps achieve higher efficiencies by transferring heat between your house and the ground or a nearby water source. Although they cost more to install, geothermal heat pumps have low operating costs because they take advantage of relatively constant ground or water temperatures. Geothermal (or ground source) heat pumps have some major advantages. They can reduce energy use by 30%-60%, control humidity, are sturdy and reliable, and fit in a wide variety of homes. Whether a geothermal heat pump is appropriate for you will depend on the size of your lot, the subsoil, and the landscape. Ground-source or water-source heat pumps can be used in more extreme climates than air-source heat pumps, and customer satisfaction with the systems is very high.

A new type of heat pump for residential systems is the absorption heat pump, also called a gas-fired heat pump. Absorption heat pumps use heat as their energy source, and can be driven with a wide variety of heat sources.

Advantages of heat pumps include: Energy efficiency; and environmentally friendly because it requires no fossil fuels to heat building. Disadvantages include: They are more expensive to operate than furnaces; and heat pumps only work well above freezing temperatures—ideally over 40-50 degrees Fahrenheit.

The above information was obtained from www.energy.gov and asm-air.com.



20. Rainwater Harvesting (See Detail E, Sheet 2)

Rainwater harvesting is the accumulation and storage of rainwater for reuse on-site, rather than allowing it to run off. Rainwater can be collected from rivers or roofs, and in many places, the water collected is redirected to a deep pit (well, shaft, or borehole), a reservoir with percolation, or collected from dew or fog with nets or other tools. Its uses include water for gardens, livestock, irrigation, domestic use with proper treatment, indoor heating for houses, etc. The harvested water can also be used as drinking water, longer-term storage, and for other purposes such as groundwater recharge.

Rainwater harvesting provide the independent water supply during regional water restrictions and, in developed countries, is often used to supplement the main supply. It provides water when a drought occurs, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable groundwater levels to be sustained. It also helps in the availability of potable water, as rainwater is substantially free of salinity and other salts. Applications of rainwater harvesting in urban water system provides a substantial benefit for both water supply and wastewater subsystems by reducing the need for clean water in water distribution

systems, less generated stormwater in sewer systems, and a reduction in stormwater runoff polluting freshwater bodies.

A large body of work has focused on the development of life cycle assessment and its costing methodologies to assess the level of environmental impacts and money that can be saved by implementing rainwater harvesting systems. The best thing about rainwater, as mentioned before, is that it is free from pollutants as well as salts, minerals, and other natural and man-made contaminants. In areas where there is excess rainfall, the surplus rainwater can be used recharge ground water through artificial recharge techniques.

Advantages include: Ease of maintaining; reducing water bills; irrigation usage; reduces damage on groundwater; reduces floods and soil erosion; and can be used for flushing toilets and washing clothes and vehicles. Disadvantages include: Unpredictable rainfall; initial high cost to install; regular maintenance; certain roofs seep chemicals; and storage limitations.

The above information was obtained from en.wikipedia.org and www.conserve-energy-future.com. Please see image below.

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