Quick Notes on Achieving Energy Efficiency

A Five-part Series

by

Louisiana Department of Natural Resources
Technology Assessment Division
State Energy Office

www.dnr.louisiana.gov

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or contact:
Louisiana Department of Natural Resources
Technology Assessment Division
617 N. 3rd Street – Rm. 1150
Baton Rouge, LA 70802
Phone: 225-342-1399
Toll Free: 800-836-9589
Fax: 225-342-1397

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PREFACE

The Louisiana Department of Natural Resources, Technology Assessment Division (TAD) is the state's energy office. On behalf of Louisiana's citizens, TAD has been promoting, educating, and implementing projects relating to conservation, energy efficient technologies and processes, and renewable energy resources for more than 25 years.

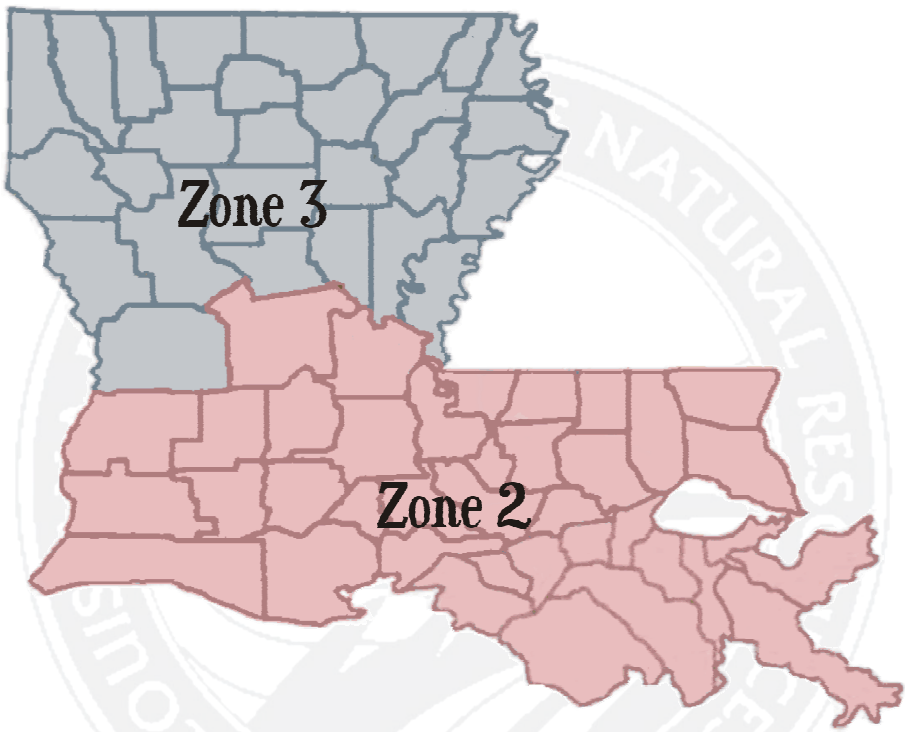
This booklet was taken from a TAD series of workshops and is intended to provide information to the homeowner that will enable them to make informed decisions about energy efficiency.

Our residential programs include:

- Legislative responsibility for providing training and quality control oversight for energy raters throughout the state
- Providing financial incentives to homeowners through our Home Energy Loan Program and the Home Energy Rebate Option
- Promoting the Department of Energy and Environmental Protection Agency's Energy Star program
- Elevating tens of thousands of Louisiana residences to Energy Star standards and earning the nationally recognized Energy Star award for five years in a row
- Providing up-to-date educational materials and training via our website, public service announcements, billboards, radio talk shows, trade shows, and other venues
- Providing energy code compliance training

2006 International Residential Code

As a result of the damage caused by hurricanes Katrina and Rita, Act No.12 of the first Extraordinary Session of 2005 was adopted to provide for a mandatory statewide uniform construction code. Effective January 1, 2007, the state uniform construction code included several national, international & state codes. The applicable code for residential construction is the 2006 International Residential Code (IRC). The chart below represents the minimum requirements for the two climate zones in Louisiana:



Louisiana Climate Zones

Climate Zone	Window U-Factor	Skylight U-Factor	Window & Skylight SHGC	Ceiling R-Value	Wood Frame Wall R-Value
2	0.75	0.75	0.40	R-30	R-13
3	0.65	0.65	0.40	R-30	R-13

A study conducted after Hurricanes Katrina & Rita by an international consulting firm concluded that the additional costs of building a 2,000 square foot home to 2006 IRC standards would be paid back from energy savings in approximately 8 ½ years. The study used MEC 93 as the baseline. Most of the homes destroyed by the hurricanes were probably built below this standard so the payback time may be less than expected and savings to the homeowner will be realized for many more years to come.

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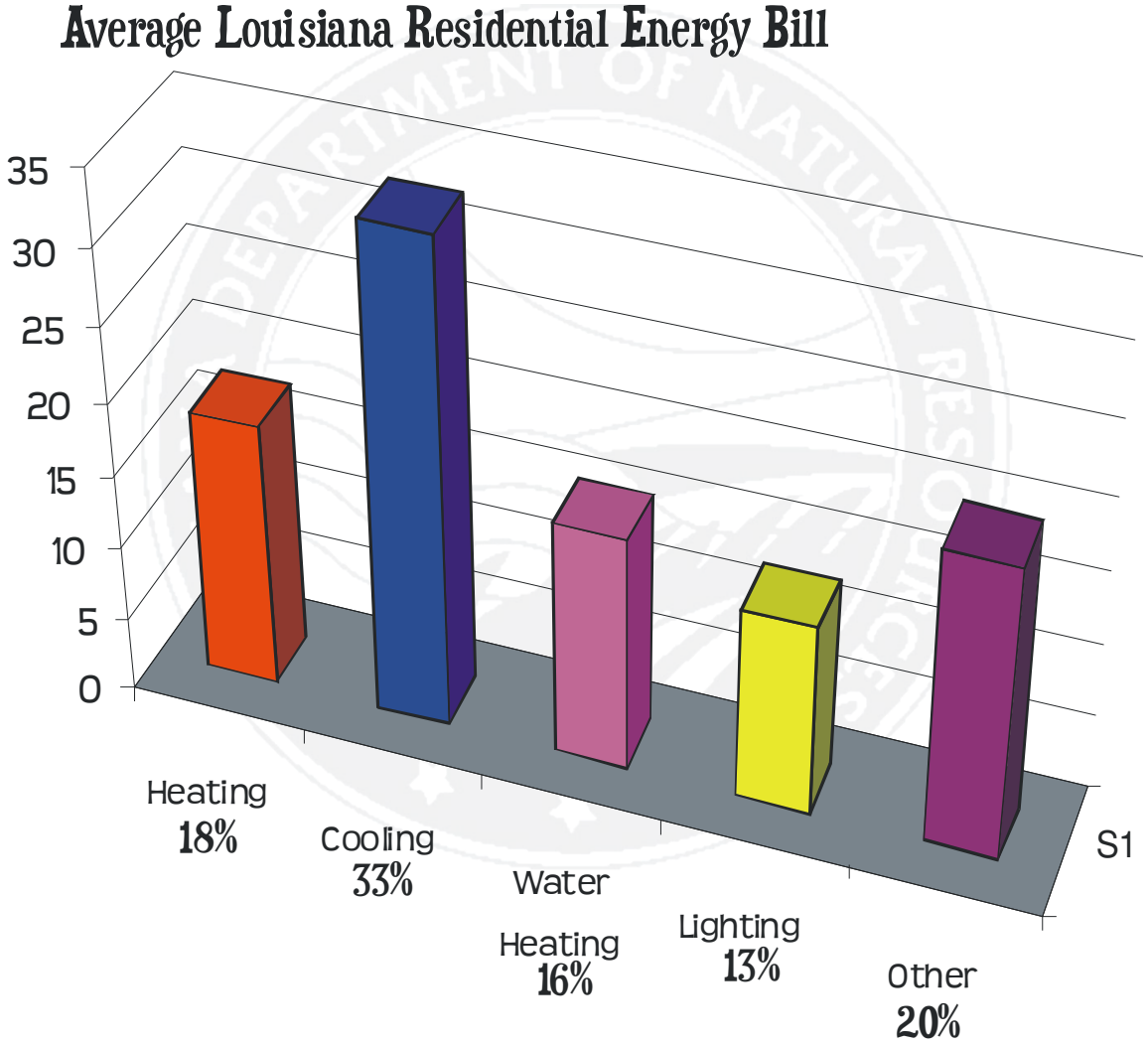
Lighting & Appliances

Lighting & Appliances

- The key factors that drive residential energy use in Louisiana are shown in the figure below. The area called out as "Other" includes everything plugged into an outlet in the home (otherwise known as Plug Load). All of the home's appliances fall under this category called "Other". The combination of "Lighting" and "Other" make up over 30% of the energy used in a typical residence in Louisiana. Other than the HVAC system, reducing the energy use of the Lighting and Appliances is an area that can dramatically affect the overall energy used in a home.



- Past studies that have looked at typical plug loads in homes have made assumptions as to average number of lights and appliances in a typical home, but it is important to consider how much a typical residence has changed over the past several years. Our taste for multiple TVs, refrigerators, computers, and audio/video systems has increased to the point that it is not all that uncommon to find five or even six TVs, and three PCs in a 3 bedroom home. The figure below shows a list of items that fall under the "Other" category.

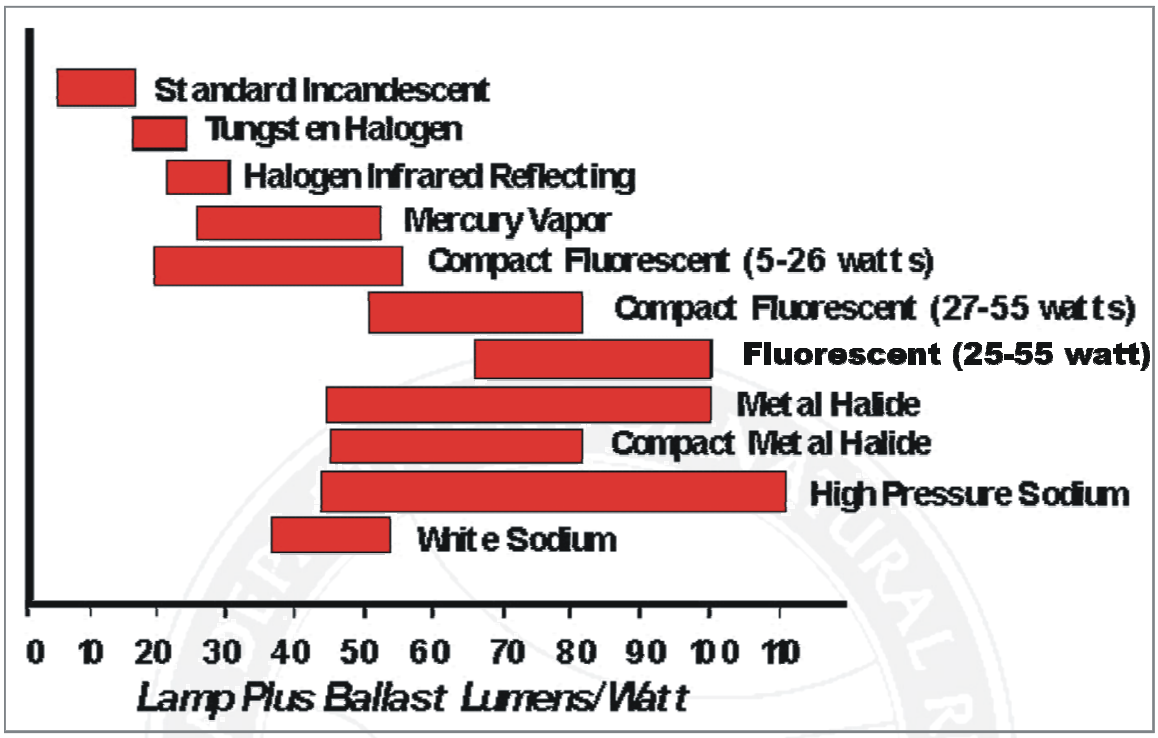
??? Other: 20% ???

Typical Plug Loads	Typical Plug Loads that also add Heat to the Home	Typical Plug Loads that also add Moisture to the Home
Exhaust Fans Ceiling Fans Cordless Phones Garage Door Opener Outside Pool	Refrigerator Freezer TVs DVD VHS Recording Equipment Stereo CD Home Theatre Video Game PC Printer Monitor Scanner Lights	Clothes Washer Dish Washer Clothes Dryer Hair Dryer Garbage Disposal Coffee Maker Microwave Aquarium

- Another very important consideration that is often overlooked is that as the number of lights, appliances, entertainment, and convenience items increase in a home - the latent load (amount of moisture/humidity in the home), and thermal load (amount of heat in the home) both increase as well. When these loads are added to the home, the HVAC system must run longer to remove them. In the figure above, many of the items that fall under the "Other" category are listed. Notice which items also increase the home's thermal and latent loads. Note also that homes containing multiple items of the type that add to both latent and thermal loads will increase these loads even more. Individually, these loads may not seem like much of an additional load on the home, but when combined, they can significantly increase the amount of time the HVAC system will have work to remove them.

Lighting

- When purchasing lighting it is important to purchase bulbs with the highest lumens per watt (brightest output of light per watt) available. The figure below shows "efficacy" or how bright per watt typical lighting types produce.



To get the most efficient lighting - try to purchase lighting with an Efficacy of at least 60 to 80 lumens per watt

- A compact fluorescent bulb (cfl) is simply a fluorescent bulb with a screw thread that mounts in a standard household lighting fixture.

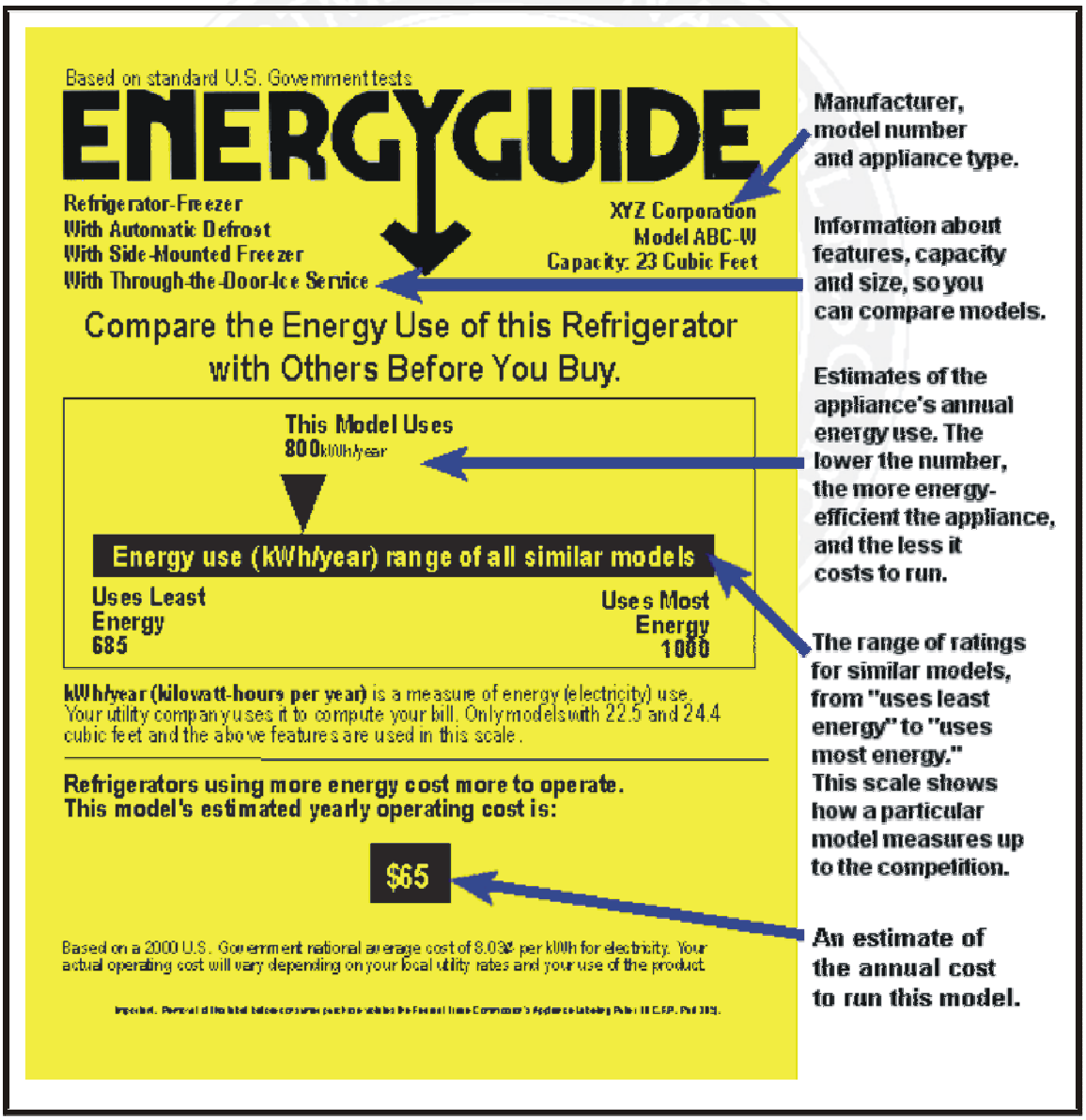
- Notice in the figure above that standard incandescent bulbs have an efficacy of around 15 lumens per watt and compact fluorescents (cfl's) are available in an efficacy of around 80 lumens per watt. What this means is that an 18.75 watt cfl produces as much light as a 100 watt incandescent bulb without adding the extra 81.25 watts worth of thermal load to the home that the HVAC system has to remove (reduces the thermal load by 48.75 watts for 60 watt bulbs, 32.5 watts for 40 watt bulbs, and 20.31 watts for 25 watt bulbs). If you multiply these reductions in watts per bulb needed as well as the reduction in thermal load – you can quickly see the substantial savings attributed to replacing incandescent bulbs with high efficiency lighting.

  EXAMPLE of equivalent lumens of lighting (***brightness***) from the chart above
  A 100 watt Standard Incandescent Bulb
  100 watts X 15 lumens per watt = 1,500 lumens of brightness
  Equivalent lumen (brightness) output in a Compact Fluorescent
  1,500 lumens / 80 lumens per watt = 18.75 watts

- The addition of lighting controls such as occupancy sensors, multi-step dimmers, and timers can also provide greater efficiency and convenience by automatically turning lights on for convenience and off when they are not needed.

Appliances

- When purchasing appliances, it is also important to purchase those that have been tested and proven to operate at a higher level of efficiency than an average appliance. The way to determine how an appliance stacks up against other appliances of the same type is to look at the yellow "Energy Guide Tag" attached to the appliance before you purchase it. The yellow tag compares the performance of the specific appliance to which the tag is attached to other appliances of the same type. This allows you to make an informed decision as to how this appliance will perform (in terms of costs to operate) once you get it home. Look at the tag carefully and purchase the one that uses the least amount of energy to operate. The figure below shows the information on a typical yellow "Energy Guide Tag".



- The figure below shows the savings attributed to purchasing energy efficient appliances over average/standard appliances. Note that the savings in utility bills will pay back the added cost for upgrading to the more efficient model over a short period of time.

Typical Energy Costs for Appliances

Appliance	Average Model ($/yr)	High Efficiency Model ($/yr)	10-Year Savings
Refrigerator (manual defrost)	56	36	$200
Refrigerator/freezer (frost free)	96	56	400
Freezer (frost free)	108	60	480
Electric range	48	40	80
Gas range	36	28	80
Electric clothes dryer	56	44	120
Gas clothes dryer	24	20	40
Dishwasher	56	36	200
Color Television	20	8	120
Lighting	60	28	320

Note: How many TVs, stereos, DVDs, refrigerators, computers, lights, and loads of clothes we have going at one time dramatically affect how much energy a home uses, but all of these things are driven by lifestyle, and lifestyle is impossible to be taken into consideration under these notes, since lifestyle is so varied among individual families. However, purchasing appliances that carry the Energy Star Logo will insure that the homeowner is purchasing items that will perform at peak efficiencies, as well as dramatically reduce the amount of added load to the home.

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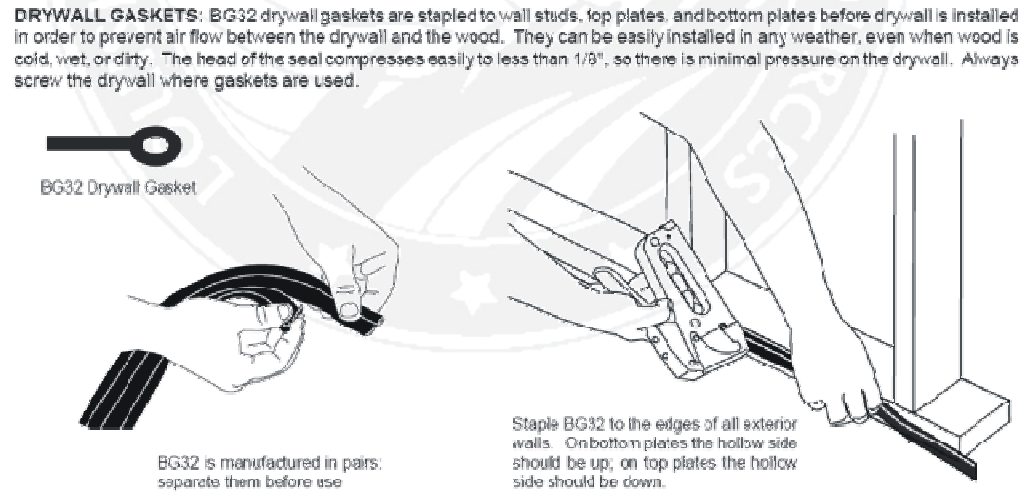
Guide #Two
Insulation & Infiltration

Insulation & Infiltration

- Regardless of what type of insulation you choose to install in your home, controlling infiltration through the walls and ceiling is one of the most important, if not the most important measure that can be taken to increase energy efficiency in your home.

- When installing any type of insulation, it is extremely important that you have your contractor install a bottom plate seal gasket. This is installed between the bottom plate and the slab and goes completely around the perimeter of the exterior wall framing.

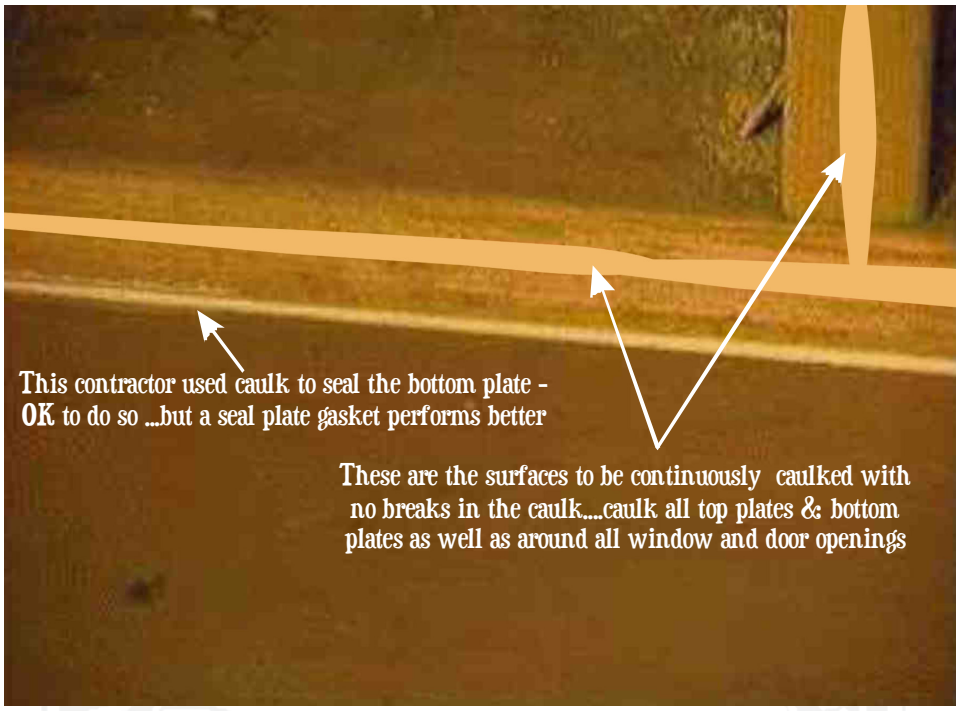
- When using any type insulation other than an expanding foam type insulation, get the drywall installers to run a ***continuous, unbroken*** bead of caulk along the entire edge of the bottom, and top plates, and around all window and door openings on all exterior walls. Also run a bead on both sides of every top plate of interior walls prior to the drywall being installed. Caulking these areas can only be done within about a 72 hour window of time prior to the drywall installation, due to the curing time of most caulks. This caulk is applied to the nailing surfaces for the drywall that faces to the inside of the home. ***(This is not to hold the sheets up but instead will make a very effective air seal for the entire inside wall surface,)*** There is a product available called ***drywall gasket*** that is applied to these areas before drywall is hung that accomplishes the same task as the caulk and can be applied well in advance of the drywall being hung, because it does not dry out.



Drywall Gasket Material can be installed well in advance of hanging the sheetrock to eliminate the problem of caulk drying before the drywall is hung. Drywall gasket material will cost 30 cents per ft^2 of floor space (well worth the costs)

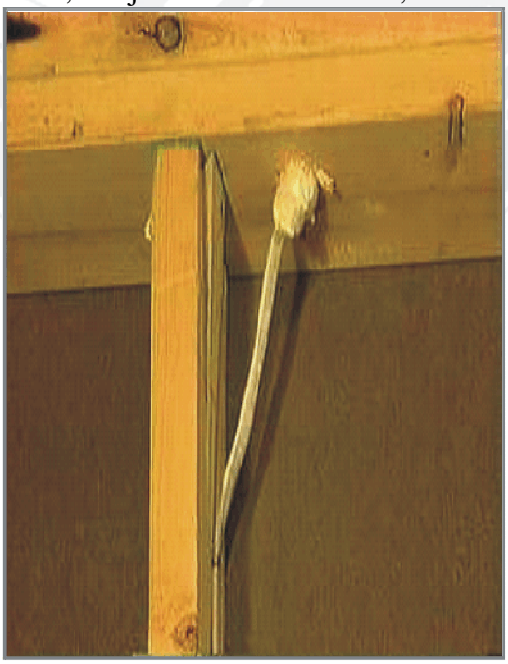
Available from:

Resource Conservation Technology, Inc.
2633 N. Calvert Street
Baltimore, MD 21218
(410)366-1146
www.conservationtechnology.com



Example of caulking behind drywall

- Either have both your plumbing and electrical contractors, or yourself plug every penetration in every stud that is made to run pipe and electrical wiring using canned expanding form. Plug all the holes in top plates as well as wall studs that are cut into the vertical, not just on exterior walls, but also on interior walls.



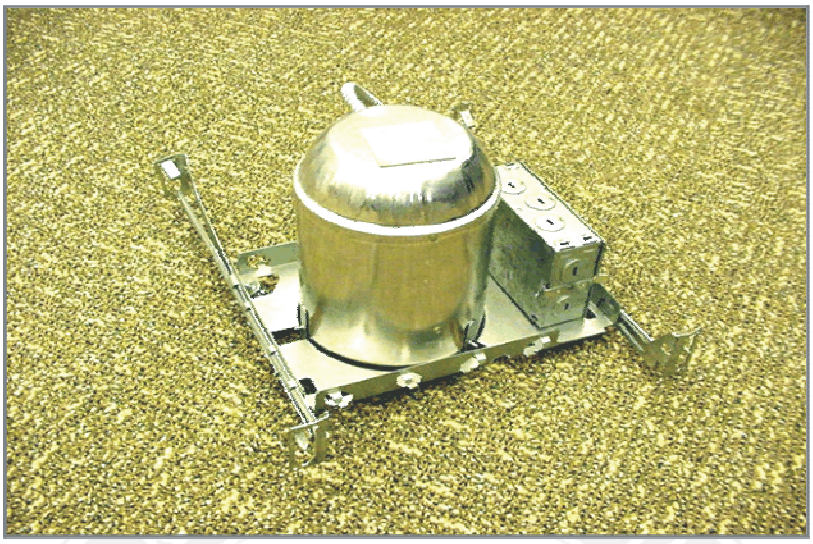
Fill all holes made by contractors, even those through un-insulated stud walls

- If you have your contractors fill the holes be sure that you schedule your drywall and insulation installers so that you will have time to do an open wall inspection on all areas before the insulation is installed or the drywall is hung, in case any areas were missed.

- After the ceiling drywall is installed and the electrical wiring is run, seal around all of the ***wiring boxes*** on the attic side, where **non-recessed** lights and fans will be installed. The wiring will be done from the inside so it will not affect the installer's work. The wire box is just a termination point, so it will not be generating heat. ***(It will not be a fire hazard to place the wire box under insulating foam – but it would be a fire hazard to seal a recessed light under insulating foam so do not do that)***

- If you are planning to install any recessed lighting be certain that all recessed lights are both ***IC Rated*** ***(rated for insulation contact – means that they can touch insulation without being a fire hazard)***, and ***Air Tight*** ***(not to be confused with sealed).*** ***Air Tight*** means that the recessed light is air tight as is and requires no special sealing insert. This allows them to be used with any trim you desire thus opening your options for the trim look you want. ***Sealed*** cans require a special insert in order to make them air tight. The special inserts costs as much as, or more than the can itself. You can not depend on your electrical contractor to make this distinction – you should find the ones you want to use, yourself, and either purchase them yourself, or give the contractor the name and model number of the specific ones you want. Be sure that you put your eyes on them before the first one is installed.

Sealed can (only air tight with an insert) – note holes in side where air can enter the home through the attic (attic temps in summer can be >140 degrees)



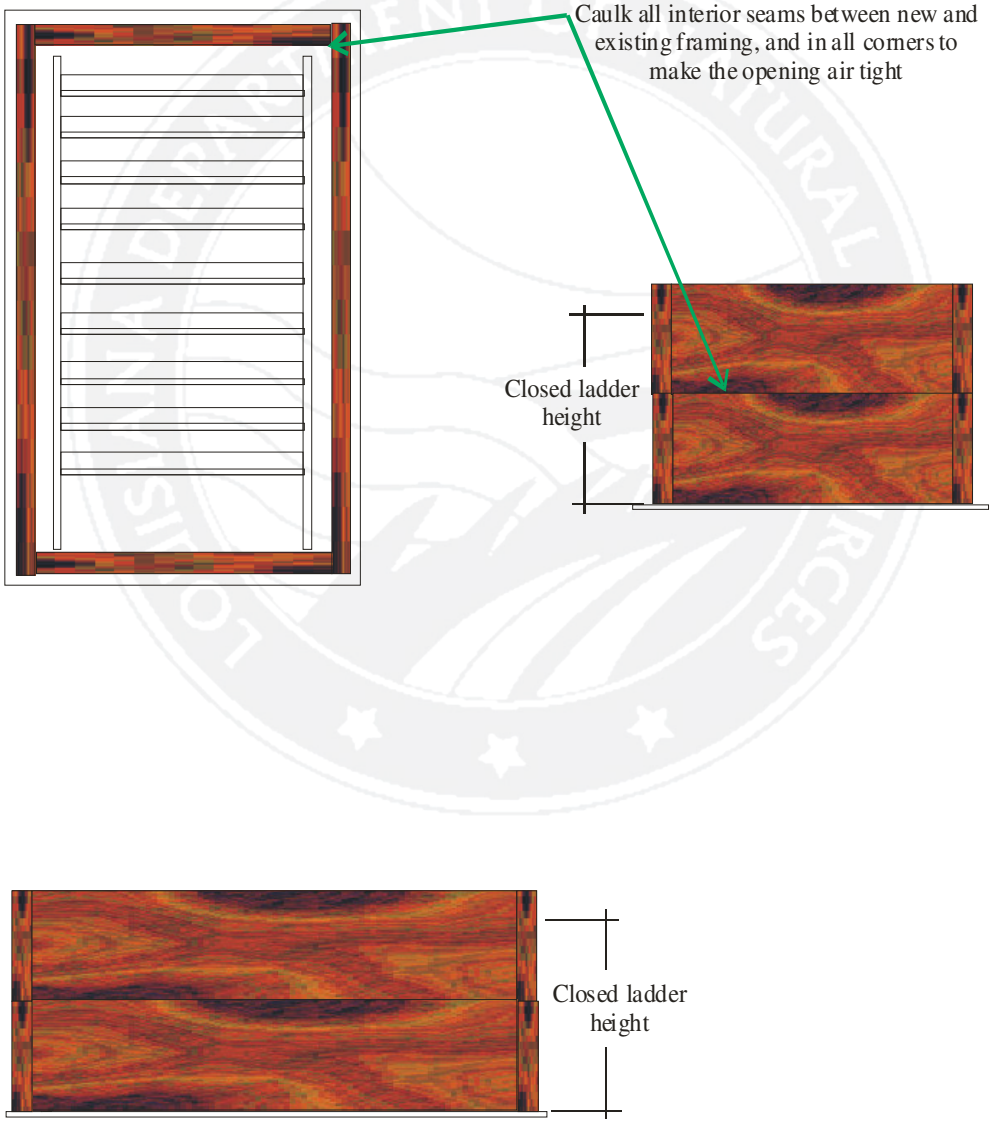
Air tight can (air tight as is) – note that there are no holes in side wall of can

- If the attic access is located inside the conditioned space – be sure that this access is both fully insulated and sealed from the attic ***(rubber gaskets don't do this).*** You must install either an attic tent ***{$125 to $150 online}*** or build an air lock

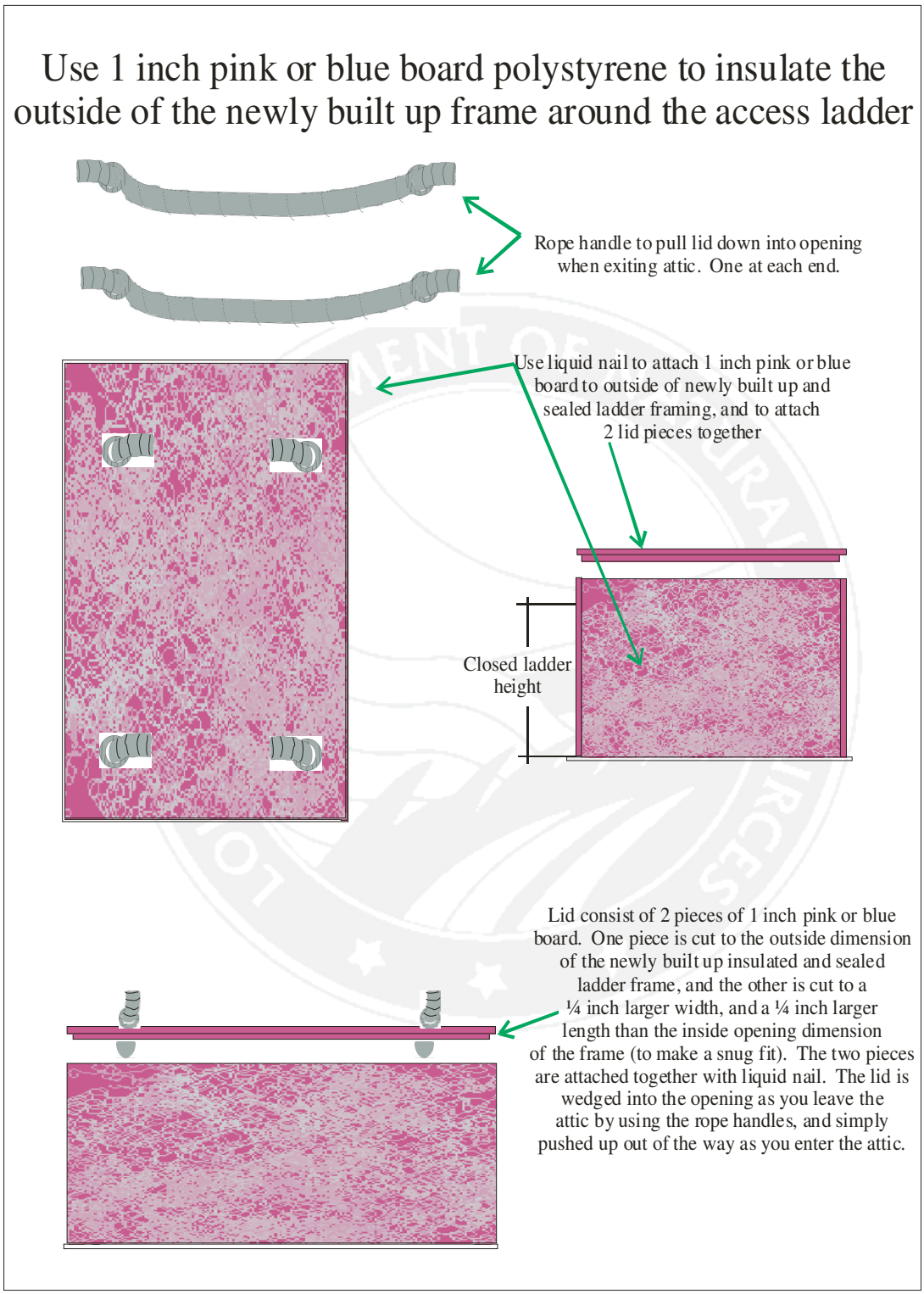
Attic tent

{easily constructed for about $25} over the opening on the attic side. If you have walk through doors to the attic from inside the home they will need special attention as well – construct air locks for each access – ***(since attic tents do not work very well in this application).***

Build up the existing frame of the attic access door to at least 2 to 3 inches higher than the height of the closed stairs



Step 1 - Attic Hatch / Air Lock Assembly that you or your contractor can build for 1/3 cost of an attic tent



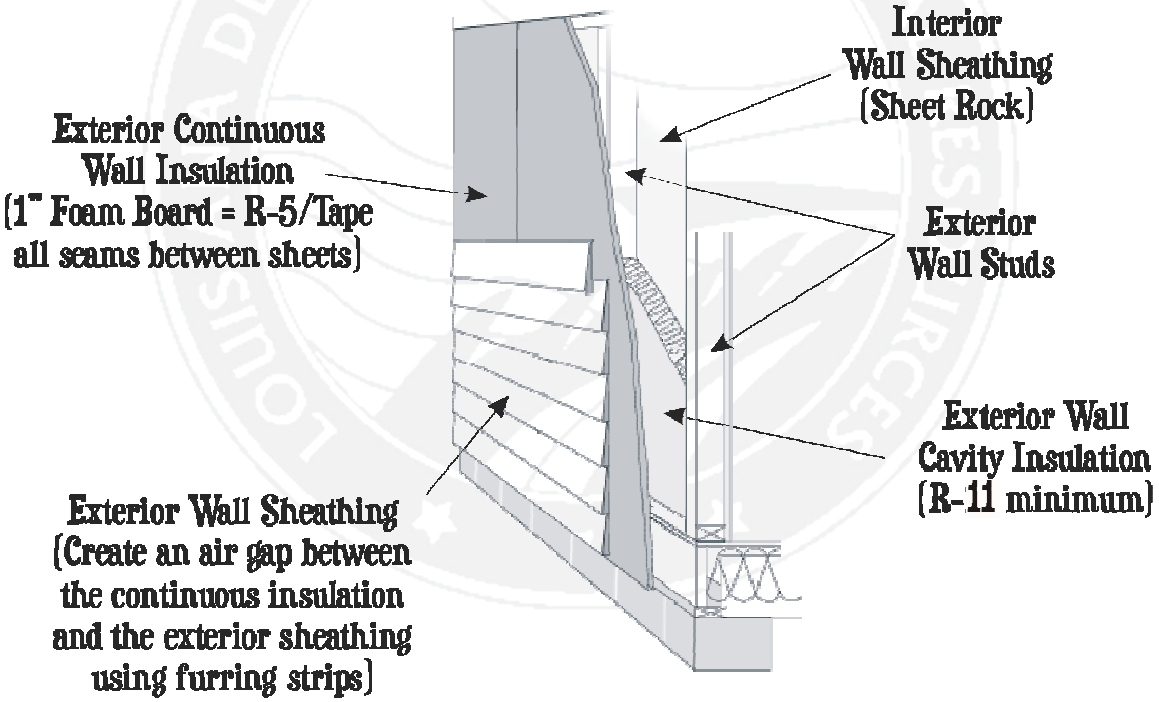
Step 2 - Attic Hatch / Air Lock Assembly – This assembly provides good insulation as well as a complete infiltration barrier to the hatch. A full thermal barrier will be achieved by attaching an additional R-30 insulated batt to the outside of the entire assembly.

- If the home will have a fireplace chimney that penetrates the ceiling, be sure that this penetration opening is both fully insulated and sealed in the attic ***(the opening in the attic must be closed in, sealed, and insulated while maintaining a 3" insulation clearance from the chimney flue to eliminate the chance of fire).***

In the above view from the attic, looking down, the fireplace opening doesn't have a chimney, but was left open to the attic. Note that there is no insulation on these walls, which are located in the center of the home. This is a common mistake on many homes and exposes superheated attic temperatures of 140 degrees to walls with no insulation.

The above photo shows proper closing off of the hole through the ceiling and insulation properly positioned at a 3" minimum distance from the fireplace flue. (Metal flange against flue under the insulation keeps the insulation away from the heat of the flue.)

If all of the infiltration measures listed above are incorporated into the home, choosing an insulation material will be easy. Sprayed expanding insulation products perform well, because they seal as well as they insulate, and if you plan to use such a product, you can bypass all of the ceiling, top, and bottom plate infiltration control measures. These spray application insulation materials, however, are very expensive but the measures called out in these notes are far less expensive. If you have done a great sealing job, any insulation will perform well. You may want to get pricing on cellulose, insul safe, batts, and rock wool. Rock wool is an excellent wall insulation material. It is a moderately priced product that can be blown into wall cavities that packs into the cavity and does not settle. Wet blown cellulose is another good inexpensive wall insulation material that does not settle - just be sure that your contractor has lots of experience with wet blown cellulose. In all of Louisiana, you should have nothing less than an R-30 in the attic and try to get to an R-15 in all of the exterior walls. You can reach the R-15 by having a 1" layer of pink or blue foam board installed to the outside of the studs.



Cut-away view of exterior wall showing placement of continuous insulation

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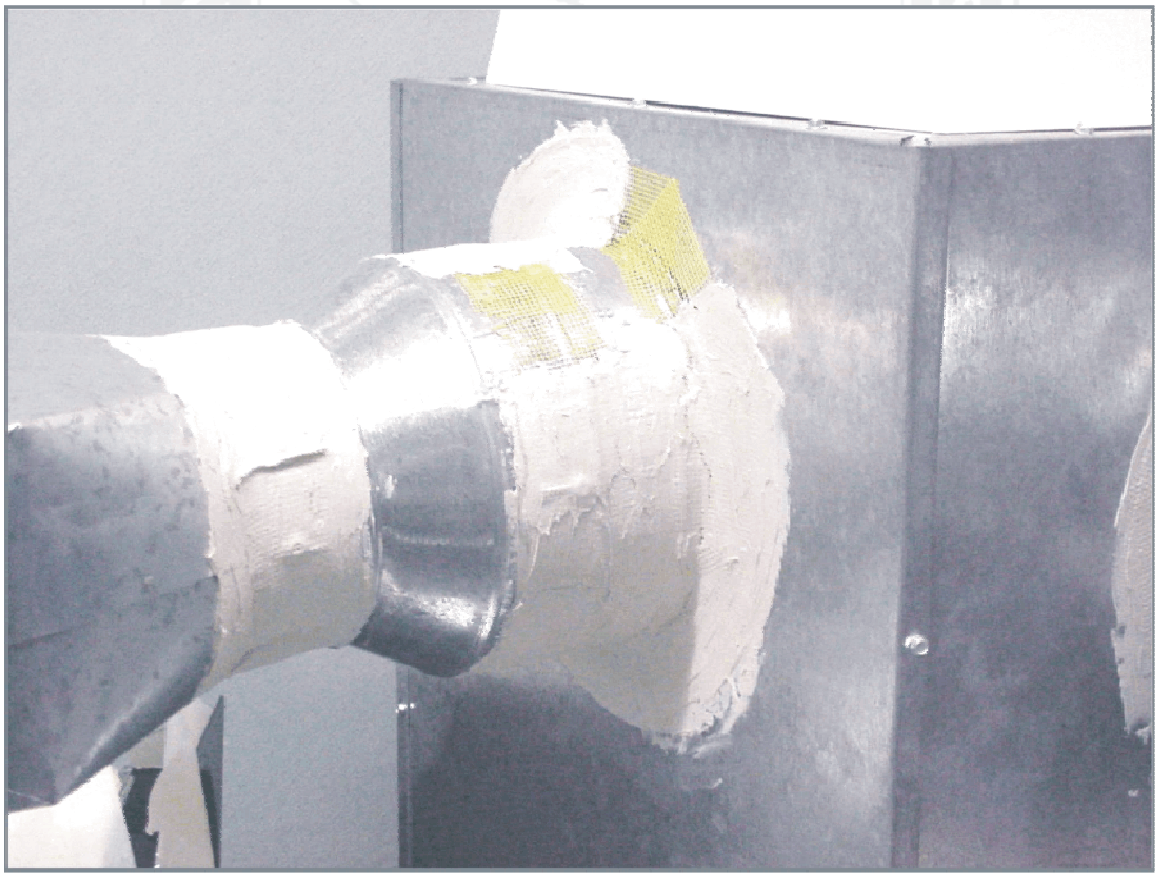
Guide #Three
HVAC & Water Heating

Air Conditioning, Heating & Ductwork

- Have your AC contractor perform a Manual J Load calculation on your home to insure that the proper sizing of your air conditioning system has been determined before you settle upon the size, performance, and price of your system. ***(Tell him you want to see the calculation and have him explain it to you, so that you can be sure it was done on your specific home.)***

- Regardless if you use rigid or flex ductwork, conventional AC or heat pump, have your AC contractor install all ductwork with the straightest and shortest runs possible, making sure the ducts are properly supported and secured. If you decide to use flex ducts, make certain that the ducts are set at their fully extended position, as they are being installed to minimize internal duct frictional losses. ***Duct Tape*** is disallowed in virtually every energy code currently in publication, so ***do not*** use ***duct tape*** on your duct system. Again, regardless if you use rigid or flex ductwork, make sure that all the ductwork is sealed, using mastic ***(mastic compound over glass-coat membrane)*** on all takeoffs, intersections, registers, plenums, and air handler penetrations ***(except for the service panels on the air handlers – use 181A listed silver back tape on the service panels)***



Cut-away of mastic compound over glass-coat membrane

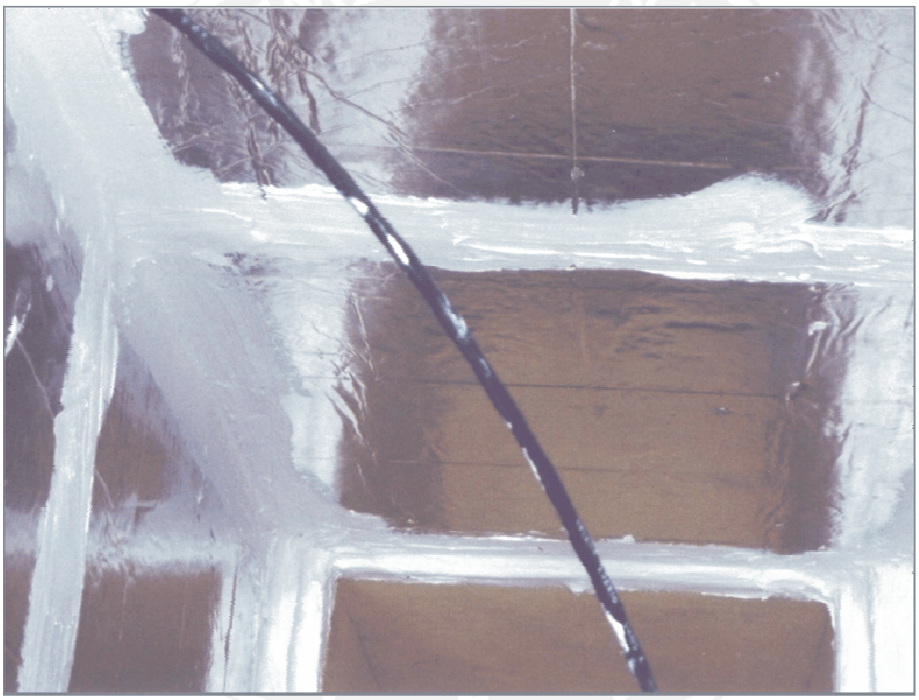
Example of a good flex duct installation (straight, fully extended, properly secured, and sealed with mastic)

- Use an R-8 insulation on the ductwork instead of R-5 ***(may have to look to find the R-8 insulation)***

- If the home has any area, such as a master bedroom suite with a bath, that will have a door between ***more than one*** single supply register and the return for that system, have your AC contractor provide a return from the space that is supplied by those ducts back to the return that feeds those ducts. If you never close interior doors, then this is not an issue, but as interior doors close, it creates a negative pressure in certain areas of the home, while creating positive pressures in others. This unbalanced pressure in the home intensifies any air leakage and can even accelerate aging of the equipment, as well as damage it. One supply behind a door is OK as long as the door is undercut. ***(In other words, if when you close any door, inside the conditioned space, and separate more than one supply register from the return for the unit that supplies those ducts, install jumper returns to get that air back to its return).*** Keeping these jumpers inside the envelope will cut down on costs as well as potential heat gain and loss from and to the attic. If you place these returns in interior walls be sure to keep in mind privacy and noise issues by considering baffled wall inserts.

- After the ceiling drywall and AC registers are installed, seal around the entire perimeter of every register where they penetrate the ceiling using canned foam **(*Do this on the attic side).***

- If any of the HVAC systems in your home will have a chase return rather than a return in the ceiling, make sure the chase itself is completely sealed, and if the chase is located on an exterior wall, be certain it is insulated as well. Special attention should be paid to chase assemblies that house combustible appliances such as gas furnaces. If your home calls for such a chase, be certain that the installation provides adequate combustible air needed for the system, as well as provides properly sized venting for the flue gases.



Example of a well sealed and insulated chase

- If you plan to use gas heating, go with the highest efficiency furnace that you can obtain – 90 AFUE, minimum; 92 AFUE, better, but you may have to wait for delivery on a 92 AFUE gas furnace, so plan time for that.

- If you plan to install a conventional AC and electric strip heating (not recommended), be sure that you go with a high SEER on the cooling side (15 or 16 min.) to counteract the poor performance you will get on the heating side, or consider a heat pump. If you install an air source heat pump, remember that air source heat pumps are a little sluggish on the heating side and will take a little longer to get the home up to temperature on really cold days. It will get the home to about 20 to 25 degrees warmer than the outside temperature very efficiently on its own, without the aid of any additional auxiliary heat, however when outside

temps drop below 45 degrees, air source heat pumps usually incorporate electric strip heaters to get the rest of the heat needed to warm the home. If you do decide to go with an air source heat pump, with auxiliary electric strip heat backup, be certain that the heating side has a remotely installed ***(outside)*** temperature switch. This switch samples outside temperature and won't allow the resistive strip heaters to kick in until the heat pump can no longer keep up with the needed heat demand. This prevents the heat strips from kicking in on 60 degree days when someone is impatient and cranks the thermostat up to 90 degrees so that the house warms up quicker. This feature will give you a much better performance on the heating side of the heat pump by only allowing the auxiliary heat to come on when the air source heat pump can not handle the heating demand on its own. A better approach would be to install an efficient gas furnace as the auxiliary heat back up for the air source heat pump.

- Sluggish performance on the heating side of a heat pump goes away with a geo-thermal, or ground source heat pump. A ground source heat pump performs efficiently in both winter and summer, because it takes advantage of the lower temperatures available in underground mass when using the earth as a heat sink. Ground source heat pump efficiencies are unmatched, SEER for SEER, by any other cooling or heating equipment, but this efficiency comes at a price. The added costs associated with ground source heat pumps come from the need for a well or trench to be dug, to act as the heat sink. Deciding which type of system you install will have to be a personal decision. Conventional AC systems with gas heat can perform well, if of a high enough efficiency, but cost $$. Air source heat pumps are very efficient on the cooling side at a lower cost but can be sluggish on the heating side when it is very cold outside, and if you use the wrong type of backup auxiliary heat, with an air source heat pump, they can eat up the efficiency gains provided on the cooling side. ***(Remember to consider that we don't get a whole lot of days in south Louisiana that are below 45 degrees. On those days that it is below 45 degrees, with an air source heat pump, the home will not get up to temperature as fast as with a gas heated or electric heated home, but it will get up to temperature. Also, keep in mind that, with a conventional HVAC system that uses electric heat, on the days that you are bringing up the temperature either rapidly, or not, it is very expensive.)***

Solar Water Heating

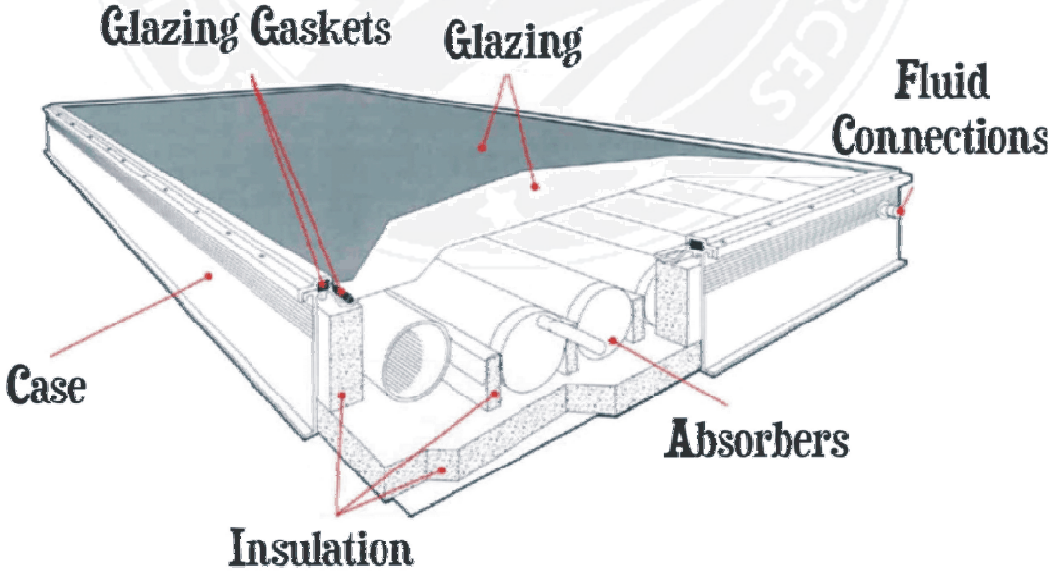
There are tax credits available from both the federal government, and the state of Louisiana that can be applied towards the purchase of solar water heaters. Visit http://dnr.louisiana.gov/sec/execdiv/techasmt/energy_sources/index.htm for details

- If the correct type of system is installed, and installed by a qualified installer, Louisiana's climate can be highly suited to the use of solar collectors for hot water generation. Louisiana's winters are milder than that of our neighbors in the

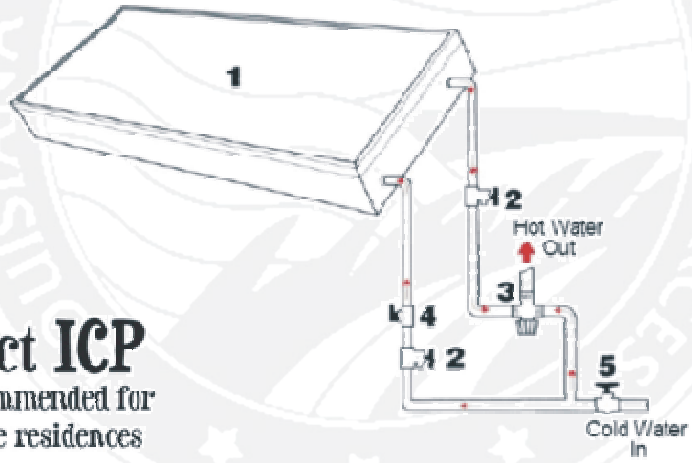
northern United States, in most areas of Louisiana, particularly south of Interstate 10/12. Because of this, a solar collector system can be installed for much less than in most northern parts of the country. Our winters are much milder with temperatures rarely falling below freezing for any extended period of time; therefore, the need for elaborate, very expensive freeze protection measures, which are needed in the North, and with specific types of collectors, are not as critical in Louisiana. Even in northern Louisiana, where the temperatures generally fall lower during winter than they do in south Louisiana, minimal freeze protection measures will sustain a solar collection system. Without the need for expensive freeze protection systems, the cost for installing a solar collector water heater can have dramatic pay back.

- Domestic hot water falls only behind heating and cooling as the highest energy consumers in residences. Integrated Collection Panels or ICPs are solar collectors that integrate water storage capacity into the collector. ICPs perform extremely well in Climate Zone 2 (southern Louisiana) with no freeze protection, and perform extremely well in Climate Zones 3 (northern Louisiana) with minimal freeze protection,. ICPs perform well without freeze protection, simply due to their mass and size. The ICP absorber tubes are large (4" diameter), and the tube case maximizes heat retention. The ICP's design of mass and volume simply protect it very effectively from freezing.

Integrated Collection Panel

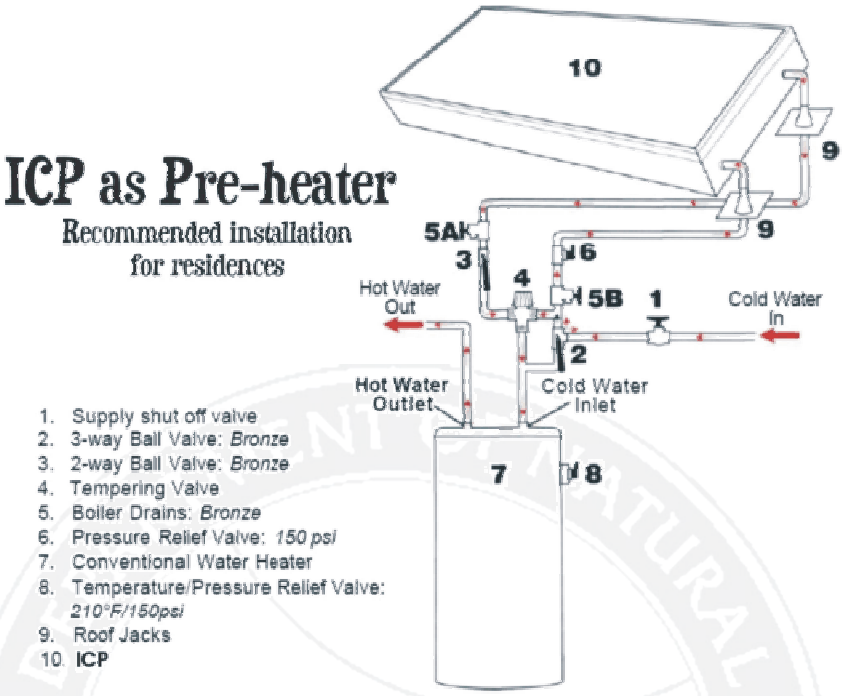


- ICPs serve as the hot water storage tank, therefore they are purchased according to capacity as you would purchase a conventional electric or gas water heater (30 gallon, 40 gallon, 50 gallon). This also means that the amount of hot water available is as predictable as with a conventional water heater. ICPs can be configured in many ways, even as a direct system where it alone provides the only source of hot water; however the recommended installation for the ICP is to be used as a pre-heater for your existing water heater. With ICPs properly sized and installed as pre-heaters, they alone can handle total home hot water needs, except on those rare occasions where high demand may call for the use of the existing water heater to supplement the water heating output of the ICP. This means that you will only pay for hot water during those rare occasions when you exceed the output capacity of the ICP (the rest of the time heating your water costs nothing), and since the ICP serves as a storage tank – you double your hot water capacity and should never run out of hot water.



Direct ICP
Not recommended for full time residences

1. ICP
2. Boiler Drains: *Bronze*
3. Tempering Valve: *Set between 140°F and 160°F*
4. Pressure Relief Valve: *150 psi*
5. Supply shut off valve.



- A 50 gallon ICP system will cost about three and a half times as much as a conventional 50 gallon electric water heater, and about two times as much as a conventional gas water heater (before applying the tax credit incentive) but will pay for itself in about three years in the way of saved utility. Based on a 10 cent per Kwh rate, after the three year payback you can expect to save about $25.00 per month or $300 per year over electric water heating utility. A 30 gallon ICP will yield about one third less savings or about $200 per year.

Performance Data for ICP

Florida Solar Energy Center
(FSEC - GP - 5 - 80)
(FSEC - GP - 6 - 80)
(FSEC - GP - 7 - 80)

ASHRAE 95-87
Thermal Performance
Standard
for
Solar Water Heaters

Solar Ratings &
Certification Corp.
SRCC Standard 200 - 88
(RA 92)
SRCC OG - 300

Uniform Solar Energy Code
International Association
of Plumbing &
Mechanical Officials

	FSEC Qnet		Florida Energy Factor			SRCC Solar Energy
MODEL	(BTU/day)	(KWH)	North	South/Central	Efficiency	Factor
30 Gallon	22,100	6.48	2.6	2.9	67.0%	1.4
35 Gallon	22,400	6.56	2.6	2.9	67.9%	1.4
40 Gallon	28,400	8.33	4.1	4.9	63.4%	1.6
50 Gallon	28,700	8.42	4.2	5.7	64.1%	1.6

Instantaneous Water Heating

- Domestic hot water is one of the highest contributors to energy consumption in residences due to the fact that most residences use conventional gas or electric water heaters to heat their water. Although gas water heaters use the energy to heat water much more efficiently than do electric water heaters, both gas and electric water heaters use the majority of their energy for standby. It takes a lot of energy to keep a 30 or 50 gallon tank of water hot and ready to be used on a 24/7 basis. All of the energy used to keep the tank of water hot when it is not being used is called standby losses, or a better term would be wasted energy. A much more sensible way to provide hot water would be to heat it up instantly at the time you use it - eliminating all of the energy needed to make water hot except when you actually use it. This is done by using ***instantaneous water heaters***. Like conventional water heaters, instantaneous water heaters also come in gas and electric models. For large capacity applications, such as showers, washing machines, and bath tubs, a gas model will perform better than an electric model. For smaller capacity applications, such as bathroom sinks, an electric model will perform well. Instantaneous water heaters do not heat water until the homeowner calls for it, and only as the water passes through the unit, then stops heating water as soon as it is no longer called for. Don't be confused by claims throughout the industry that state instantaneous water heaters are not as efficient as the most efficient conventional gas water heaters. It is true that the most efficient gas water heaters available on the market do use the heat energy provided by the gas more efficiently (recover more of the thermal energy from the gas), but instantaneous water heaters are not burning gas except during the time that they are flowing water through the pipe. Think about efficiency as money not spent to keep that big 50 gallon plug of water hot in the attic – just heat it as you use it.

Small capacity electric instantaneous water heater

Large capacity gas instantaneous water heater (note that the circuitry for the instantaneous water is basic wall power – low current)

- Instantaneous water heaters are sized according to their flow capacity in gallons per minute (GPM). As long as you do not exceed their rated capacity in GPM's they will deliver unlimited hot water.

- Although instantaneous water heaters initially cost one and one third to one and one half times as much as conventional water heaters, instantaneous water heaters cost far less to operate and will pay for themselves quickly in saved utility costs. Additionally, instantaneous water heaters are modular built which means that if any component fails, it can simply be replaced. This is in contrast to the failure of a conventional water heater, which means total replacement. Also, conventional water heaters generally last no more than 15 years.

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Quick Notes on Energy Efficiency

Guide #Four
Windows & Doors

Windows

- In Louisiana, during the summer, most of the heat gain entering our homes through the windows is attributed to radiant heat gain through the glass – not from conductive heat gain, through the frame. Many home owners are rightfully confused by window manufacturers' claims that boast that their windows are great insulated windows and will save the homeowner 30% in their utility bills.

- The important thing to remember is that in order for windows to provide energy efficiency they need to perform differently in the northern United States than they do in the southern United States. Heat always tries to move from the hotter side of the window to the colder side of the window.

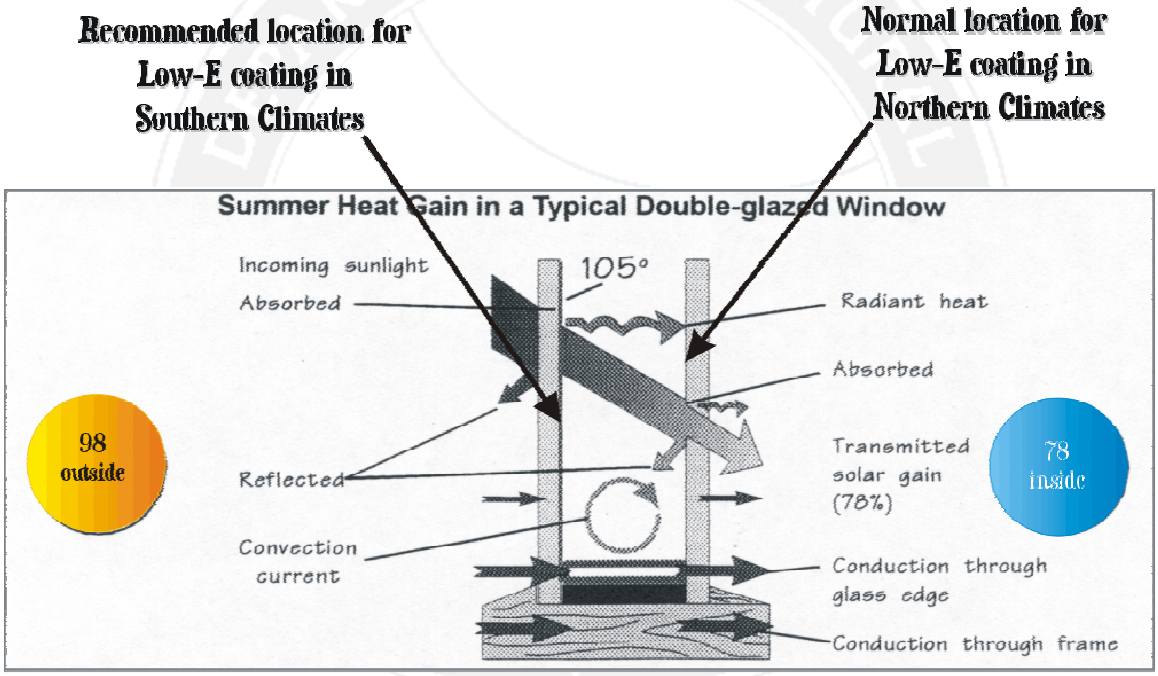
- In the South we want to keep the heat outside during the summer, and in the North they want to keep the heat inside during the winter. Heat moves through windows in three ways: ***1) conduction*** – heat moving through the window materials (wood, glass, metal, and vinyl) as heat travels from a pot of boiling water through the metal spoon placed in it, ***2) convection*** – heat moving through leaks and by the movement of hot air rising and replacing the colder air that was there, and ***3) radiant heat*** – on a cold day when the sun is shining, and you sit in the sunlight and feel the warmth of the sun – that warmth is radiant heat. You can guess that radiant heat is present during the summer. ***Radiant heat*** travels through glass away from the source and not back toward the source, so once radiant heat gets inside the home it stays there until it can be removed by the air conditioning system.

- Tightly constructed and installed windows are desirable in both the North and South to control ***convective heat.***

- Well insulated windows are also desirable in both the North and South to control ***conductive heat.*** The ability of a window to control ***conductive heat*** is rated by the window's ***U-factor.*** ***U-factor*** gives no indication of how well the window controls ***radiant heat***. The lower the ***U-factor*** rating of the window, the better it performs at controlling ***conductive heat***. Keep in mind that the ***U-factor*** rating of Northern windows is more critical than for Southern windows. This good ***U-factor*** rating is what is referred to when window manufacturers boast of great insulated windows. During northern winters, outside temperatures can fall to minus 10 or minus 20 degrees F. A typical temperature inside the home would be around 70 degrees F; this difference in temperature between inside and outside is 90 degrees. During southern summers, outside temperatures can reach 100 to 110 degrees F on really hot days but usually stay around 90 to 95 degrees F. A typical temperature inside the home would also be around 70 degrees F, as well. In the South, this difference in temperature between inside and outside is only 20 to 40 degrees. This difference in temperature, or ***conductive heat flow***, is what ***U-factor*** controls. In the North, ***conductive heat flow*** through windows (90 degrees F) is twice as high as in the South (40 degrees F).

- ***Radiant heat*** is the heat that is radiated away from the heat source through open space and passes straight through glass, unless it is acted upon by the glass in some way, and in the South, this type of heat gain is the greatest heat gain attributed to windows. The ability of a window to control ***radiant heat*** is rated by the window's ***Solar Heat Gain Coefficient (SHGC)***. A window's ***SHGC*** gives no indication of how well the window controls ***conductive heat.*** The lower the ***SHGC*** rating of the window the better it

performs at controlling ***radiant heat.*** A window with a good ***SHGC*** will reflect the ***radiant heat*** back toward the source of the ***radiant heat***. In a northern climate, during the winter, they want this ***radiant heat*** to be reflected back toward the inside of the home where the heat source is the furnace, and in a Southern climate, during the summer, we want this ***radiant heat*** to be reflected back toward the outside, where the heat source is the sun. A good ***SHGC*** rating on a window is accomplished be applying a ***Low-E*** coating to one surface of the glass. Whatever glass surface that this ***Low-E*** coating is applied to determines at which climate the window performs the best. In a southern climate, to insure that the ***Low-E*** coating is installed on the proper glass surface specify ***soft coat Low-E***. This tells the window manufacturer that the ***Low-E*** coating is applied to the inside surface of the outermost glass and will reflect ***radiant heat*** back toward the outside of the home.



Recommended windows for Louisiana;

U-factor = .65 or below

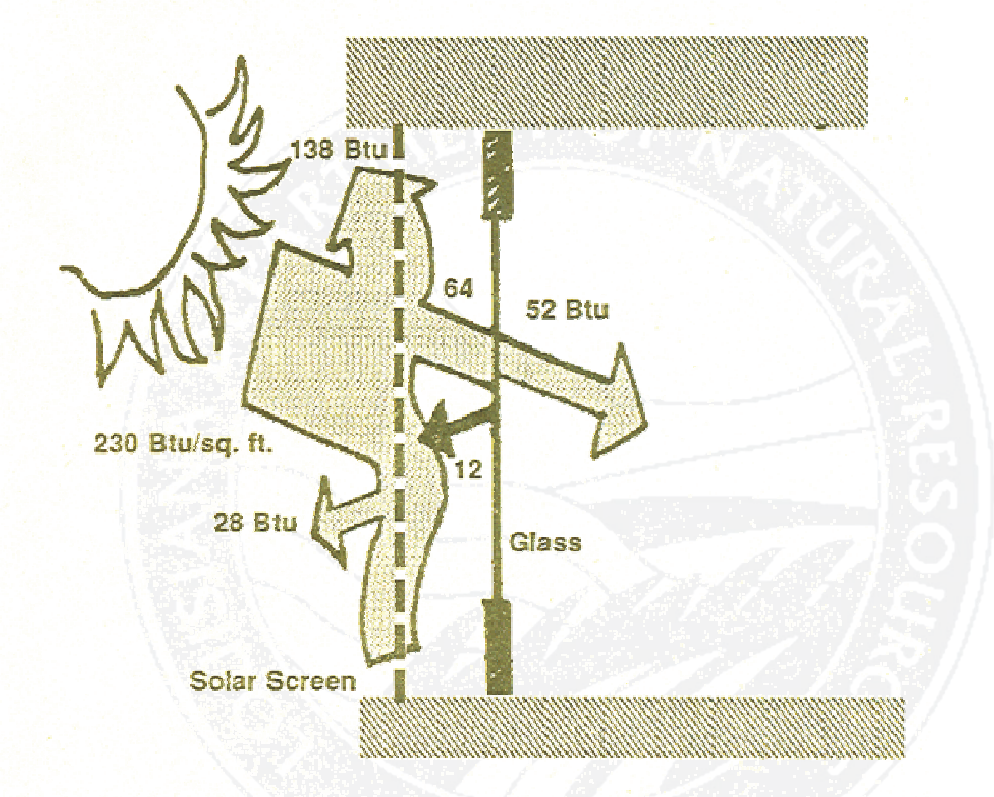
SHGC = .40 or below (*specify soft coat Low-E*)

(windows with these ratings will perform best in our climate)

- Windows that are gas filled have an inert gas, usually argon, installed between the glass panes to further control ***conductive and convective heat flow***. Gas filled windows are usually much more expensive than non-gas filled windows. It is a matter of personal choice weather a home owner chooses to purchase gas filled windows, but again, conductive heat flow is much more critical in a northern climate than it is in the South, so why pay more for windows that are better suited for a northern climate.

Exterior Solar Screens

- Exterior Solar Screens are an economical way to reduce the total amount of radiant heat gain through east and west facing glass. They effectively reduce both direct solar rays and indirect, reflected solar energy. Indirect solar rays are a large part of the total solar radiant energy that strikes windows and walls. Solar screens are much less expensive than awnings and do not block the view, yet they increase interior privacy.



- Fiberglass solar screens double as insect screens, reduce solar heat gain by up to 70%, and do not rust.

Advantages of Exterior Solar Screens

- Highly effective on east and west facing windows
- Reduce both direct and indirect solar radiation
- Very economical
- Increased privacy
- Effective whether the window is open or closed
- Double as insect screens
- Can be installed by do-it-yourselfers

Disadvantage of Exterior Solar Screens

- Decreased visibility to the outside
- Should be replaced every 10 years

Solar Film

- Solar film can be applied to glass as an alternative to solar screens. Solar film's effectiveness depends on many factors, including the type of film. There are many types, but they can be grouped into two basic categories.

- **Solar control films** are designed to keep out solar gain and glare. They block nearly as much solar gain as do solar screens but have highly reflective, mirror-like, surfaces. The newer types of solar control films appear non-reflective and provide almost as much benefit as the mirrored films, but come with a much higher price tag than do the mirror or tinted films.

- **Low-E films** or low emissivity films provide good solar heat gain control and are available with various levels of reflectivity (mirroring), tint, and costs.

- To choose the most appropriate window film, you must consider three primary factors:
    1. Shading Coefficient – percentage of solar gain it admits as compared to clear glass. The lower the number, the less solar gain it admits.
    2. Visible Light Transmittance – percentage of light (not heat) that passes through it (clear glass is about 85%). The higher the number the more visible light it lets through.
    3. U-Factor – the ability of the material to conduct heat. The lower the number the better it reduces the heat flow. (Remember that U-factor is not as critical in our southern climate as it is in a northern climate – see Window U-Factor above)

- You will have to weigh cost against feature when deciding what criteria are most important to you. If you want clarity of the glass (high visible light transmittance) along with low solar heat gain it will cost more than a film that has a lower visible light transmittance that stops solar heat gain.

- As discussed under windows above, windows are rated in their effectiveness at controlling radiant heat by their Solar Heat Gain Coefficient, and window films are rated in their effectiveness at controlling solar heat gain by their Shading Coefficient. The two ratings signify different factors. To interpret between the two rating systems, use the calculations listed below:
  Shading Coefficient X .87 = Solar Heat Gain Coefficient
  Solar Heat Gain Coefficient / .87 = Shading Coefficient

  Advantages of Solar Films
    - Highly effective on east and west facing windows
    - Reduce both direct and indirect solar radiation
    - More economical than window replacement
    - Less of a decrease in visibility to the outside than solar screens

  Disadvantage of Solar Films
    - Not for the average do-it-yourselfer
    - More costly than solar screening

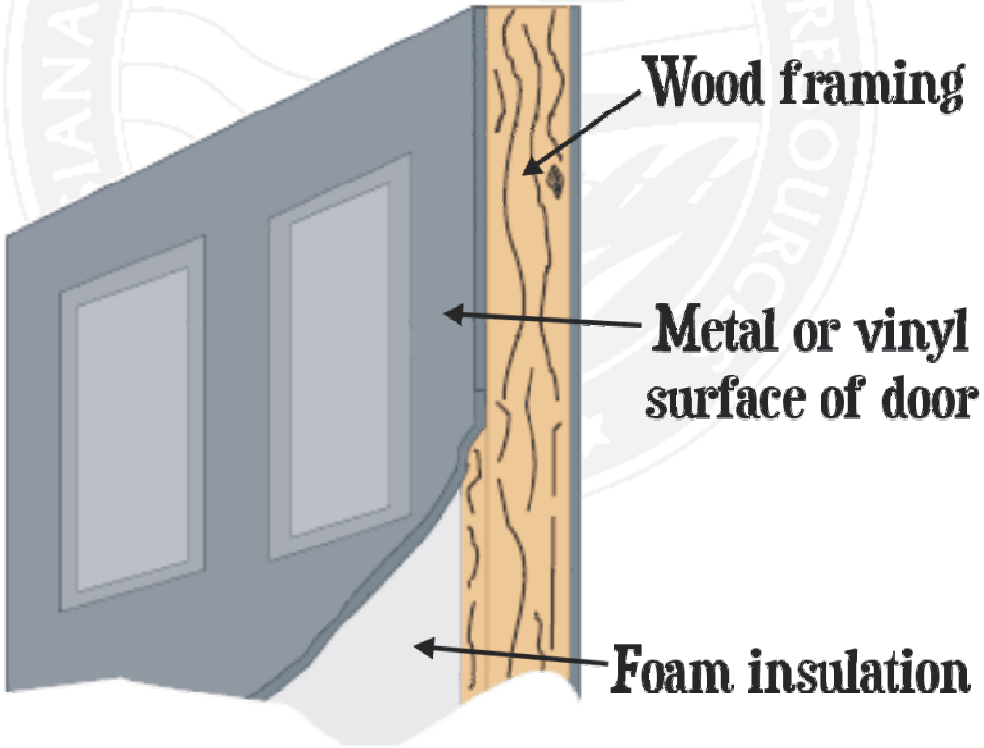
NOTE: ALTHOUGH WINDOW FILM WILL KEEP MOST OF THE SHARDS FROM A BROKEN WINDOW ATTACHED TO THE FILM, WINDOW FILM WILL NOT PREVENT FLYING OBJECTS FROM PENETRATING TO THE INTERIOR OF A HOME

Doors

- Insulated exterior doors typically have an insulating value of R-5 compared to R-2.2 for standard solid wood doors. Insulated exterior doors are double weather stripped and have energy efficient thresholds. Insulated exterior doors have infiltration rates of .35 cfm per linear foot of door. Double weather stripping and low infiltration rates greatly enhance insulated exterior door performance at controlling unwanted air infiltration into the home.

- Insulated exterior doors cost no more than standard doors, come in many decorative styles, complete with raised panels and energy efficient glass. They provide long life, will not warp, and increase security.

- It is OK to use a solid wood front door to meet zoning criteria, as long as it has been properly hung and weather stripped. All other exterior doors should be either metal or vinyl insulated doors.



- Careful installation is required when installing insulated exterior doors because they are difficult to trim.

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Quick Notes on Energy Efficiency

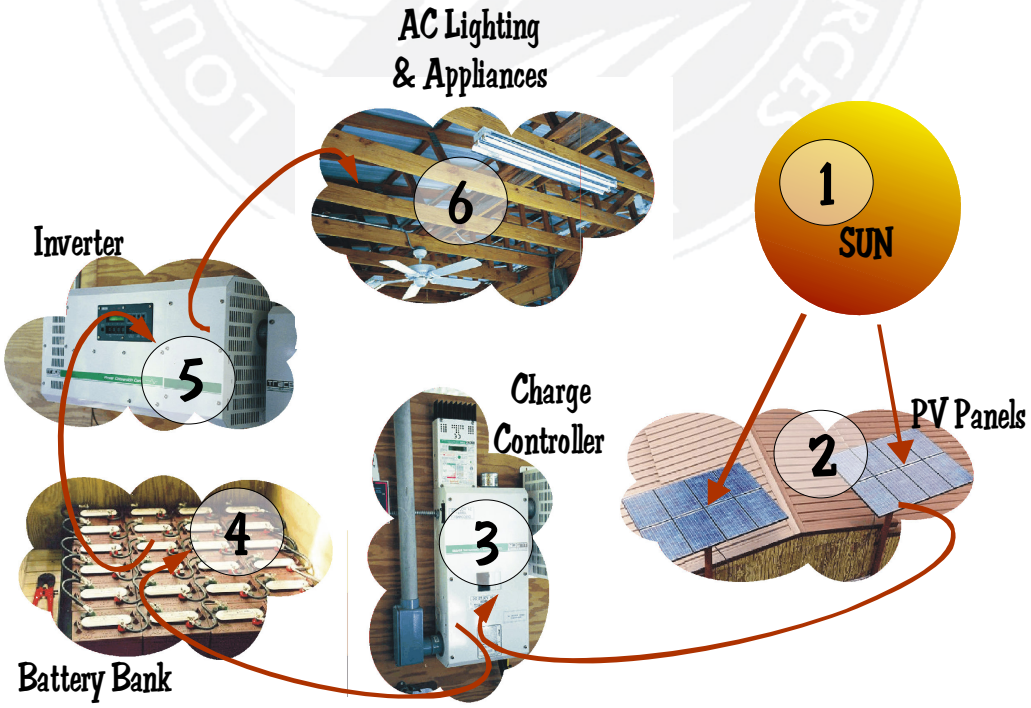
Guide #Five
Solar Electric
(Photovoltaics)

Solar Electric (Photovoltaics)

There are tax credits available from both the federal government, and the state of Louisiana that can be applied towards the purchase of photovoltaic equipment. Visit http://dnr.louisiana.gov/sec/execdiv/techasmt/energy_sources/index.htm for details

- Photovoltaic systems use semiconductor technology to convert sunlight directly into electricity. The systems are simple and quiet and require no moving parts. Batteries can store energy for use when the sun is not shining. Photovoltaic systems come in a near infinite number of sizes, ranging from a single cell to power a calculator or a single module (containing multiple cells) to power a light; to multiple modules to power a water pump or a home; to large arrays of modules to provide industrial-scale power. Photovoltaic technology is well established and field proven, and many sizes and types of modules are commercially available from a number of different companies.

- Photovoltaic (PV) Cell is the industry term for a more commonly used term from decades past - Solar Cell. The type of electricity that PV cells generate is direct current electricity. Some household devices operate on direct current electricity and can be powered directly from PV, but typically, most household lighting and appliances operate on alternating current electricity. In order to turn the DC electricity generated by the PV panels into AC electricity, you must incorporate a device called an inverter. An inverter changes direct current electricity into alternating current electricity, which can then be used by the lighting and appliance devices in the home.



PV - Flow Diagram

The PV – Flow Diagram above shows the major components that make up a photovoltaic system and how they work together. The numbers below correspond with the numbers in the PV – Flow Diagram above.

1. The sun must be shining in order for a PV system to generate electricity.

2. The PV panels convert sunlight into DC electricity.

3. DC electricity, from the PV panels, is directed through the charge controller. The charge controller monitors the charge state of the battery bank, while it monitors the amount of power the PV panels are producing. The charge controller continues to charge the battery bank until it is fully charged and then disconnects the PV panels from the batteries. Without the charge controller, the battery bank could overcharge to a point where it could explode.

4. The battery bank is used as the reservoir of power for the system. During the times when the sky is overcast, or at night, the system pulls power from the battery bank. The battery bank is sized to accommodate the anticipated load to be drawn by the building. When PV systems are being used in critical applications, such as emergency backup power for life supporting equipment, the battery bank sizing must also take into account and accommodate for the capacity needed to provide power during times when there may be extended periods of no sun.

5. As DC electricity is drawn through the inverter, it is changed into AC electricity.

6. AC electricity powers the AC devices in the building.

- Before deciding to install a PV system on your home, it is extremely important to make the home as energy efficient as is economically possible ***(see Sections One - Four of this guide)***. Every bit of power shaved from the home's utility usage will reduce the amount of PV required to power the home. It will always be much less expensive to make the home more energy efficient than it would be to over-size the PV system in order to accommodate a poor performing home.

- It is also important to realize that operating a home powered by PV is different from operating a home that is powered by a utility company ***(grid tied)***. A homeowner that owns a home that gets all of its power from the grid may not like it when the grid goes down, but he/she doesn't have to do anything other than call their utility provider and complain until the power comes back on. That may not necessarily be the case on a home that is powered by PV. All PV systems will require some type of maintenance. The larger the system and more removed it is from the grid the more maintenance that will be required to maintain that system.

- When you are billed by your utility company, you are billed according to the amount of positive change indicated on your utility meter from month to month ***(utility meter spins positively in one direction)***. The positive change from month to month determines what you pay for electricity. Net metering refers to a metering system that literally allows the utility meter to spin in both directions. When installed on a home that

incorporates energy producing equipment, such as a PV system, the utility meter monitors the net electrical energy used on that home. In a billing cycle, if the home uses more electricity than is produced by the PV system, the home pulls whatever it needs to make up the difference from the grid through the utility meter. The utility meter records the usage as a positive change in the meter reading and the home is billed for only that difference. If the PV system produces more electricity than the home uses in a billing cycle, it sends the surplus through the utility meter onto the grid. In this case, the utility meter spins backwards, subtracting the meter reading as it passes through the meter. At the end of this billing cycle, the meter would have a lower reading then it had at the end of the previous billing cycle. This would indicate a surplus in utility for the billing cycle. The homeowner will not receive any payment for any surplus power that the PV system sends to the grid ***(this is common in all states that have adopted net metering legislation)***. The surplus of power sent to the grid simply remains there as a surplus waiting to be pulled off by that home during a time when the home is using more power than it is producing ***(just like storing it in a battery)***.

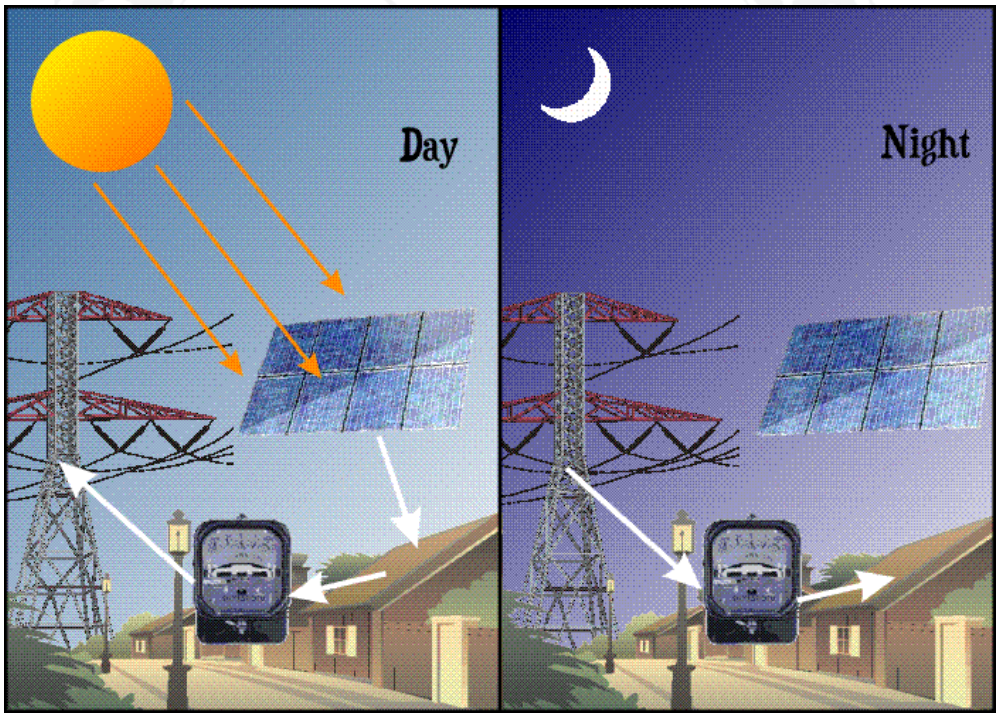


Figure 5 – Net Metering Diagram – During the day if the pv panels produce more electricity than is used by the home the utility meter spins in reverse as the electricity is stored on the grid.. During the night the home draws any electricity it stored during the day before it draws additional electricity off the grid..

Current Louisiana Net Metering legislation is some of the best legislation in the nation in that any surplus power sent to the grid remains there indefinitely – commonly this surplus is zeroed out at the end of each billing cycle. Even states with huge incentives for pv, such as California, zero out their surplus at the end of each billing cycle.

Although you do not receive a check from the utility company for any extra power that you produce and send to the grid, you do save the cost of what the PV produces and is used by the home. It's okay if the system surpluses a small amount of power each month to the grid in order to cover the home's usage during lean sun times, but if the system surpluses more power than can be used by the home, you are just wasting money; therefore, properly sizing your PV system is very important.

- Once you have decided that you want PV on your home, before sizing your PV system, and in addition to making the home as energy efficient as possible, you must also address one major consideration: will the system be a **Complete Stand Alone System** ***(PV with a battery bank large enough to power the entire home, as well as reserve power),*** a **Complete Grid Tied System** ***(only tied into the grid – no battery backup)***, or a **Combination System** ***(grid tied with limited battery back-up).***

Complete Stand Alone System ***(PV generates all of the power used by the building and stores a reserve in a battery bank)***

- Advantages
  1. No utility bill
  2. Full power when grid is down
- Disadvantages
  1. Highest costs of the three type systems
  2. Highest maintenance of the three type systems

Complete Grid Tied System ***(PV generates either part or all of the power used by the building with no battery backup)***

- Advantages
  1. Lowest costs of the three type systems
  2. Lowest maintenance of the three type systems
  3. Partial to full reduction in utility bills
- Disadvantages
  1. No power when grid is down

Combination System ***(PV generates either part or all of the power used by the building with a limited battery back up)***

- Advantages
  1. Partial to full reduction in utility bills
  2. Lower maintenance than complete stand alone systems
  3. Provides base-line power when grid is down
- Disadvantages
  1. Moderate costs as compared to the other two type systems
  2. Moderate maintenance as compared to the other two type systems

- Systems that contain batteries will cost more than systems that do not contain batteries due to the added costs of the batteries themselves as well as the extra control equipment needed in connection with the batteries. Battery systems also require more maintenance than do systems without batteries. If you are planning on a complete stand alone system - your system will have to contain a battery bank large enough to fully power the home. However, if you are planning to have a system that will simply provide limited backup power during the times when the grid is down, it is highly recommended that you restrict the amount of required battery capacity to accommodate the smallest load possible. Doing so will reduce the costs and maintenance associated with large battery banks. Even with above average battery maintenance you will only get about 7 years of life out of a set of batteries, so the smaller you can keep the battery bank the lower the replacement costs will be.

  EXAMPLE: ***(just to get you through a blackout)***

  Enough battery power for:

  1 refrigerator to keep food from spoiling
  1 fan to keep you cool
  1 additional 500 to 600 watt capacity circuit to trade off among lights, a microwave, and a tv ***(Green Acres style)***

- Properly sizing your PV system is the most important consideration to take into account before purchasing any PV equipment. If your system is undersized, it will not deliver the expected power and you will be disappointed with the system's performance. If your system is oversized it will produce more power than is needed and will not allow you to benefit from the overproduction. There are many free PV sizing calculators available. Sizing calculators are only as good as the information that you put into them. The more detailed the information that goes in, the more accurate and detailed the information that comes out. Sizing calculators that require only two to four entries with no reference to the actual building performance or operating conditions will yield poor results. Because PV equipment is such a large investment, be certain to spend the extra needed time to come up with a true and accurate system sizing calculation before you make any purchases. Once you have accurately determined the amount of PV needed, it will be much easier to shop for the best available price.

- Once you have accurate sizing information, it is also very important to determine the amount of space that will be required to accommodate the panel installation and where the installation will be placed. Knowing the system square footage requirements ahead of time may lead you to discover that you do not have enough roof area to install all of the panels facing south. If you do not take this important step, you may be forced to install the system in a place that you really did not want to install it.

- Finally, be sure to conduct a detailed site analysis using a "Solar Path Finder", or similar type instrument to determine the best placement of the panels. Where you want to install the panels is not necessarily the best location to take advantage of the best sun. A 10 minute site analysis with a "Solar Path Finder" will show exactly how much sun will strike a specific site over a full year. Conducting a site analysis for several locations will also insure that there will be no surprises.

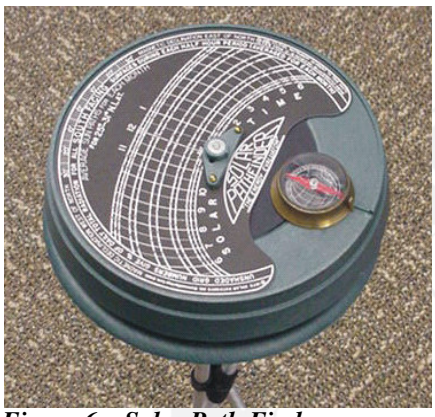


Figure 6 – Solar Path Finder

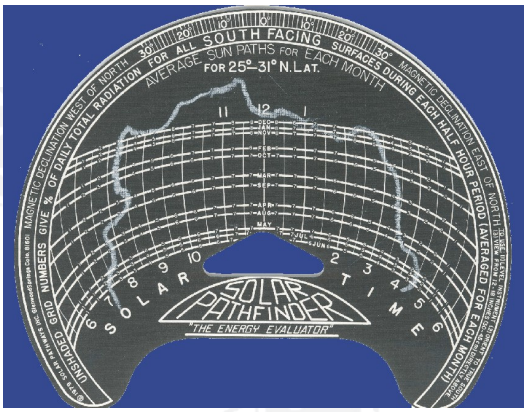


Figure7 – Solar Path Finder Template

- *Figure 6* above shows a Solar Path Finder instrument. When positioned level and facing due south, it allows you to manually plot the amount of sun that will strike the spot where the instrument is placed. *Figure 7* above shows a completed site analysis with detailed sun coverage data for every month in the year.

Solar Water Heaters (Solar Collectors)

(see Section Three pages 27- 30 of this guide).

For more information on Photovoltaics visit:
www.dnr.louisiana.gov/sec/execdiv/techasmt/energy_sources/index.htm
www.solardirect.com/swh/swh.htm
www.lses.org

To find a vendor for Photovoltaics visit:
www.findsolar.com

To find a Louisiana contractor to install or service Photovoltaics visit:
www.findsolar.com/index.php?page=findacontractor

PV Sizing calculators: (remember – these are just rough calculators)
www.rredc.nrel.gov/solar/codes_algs/PVWATTS/
www.xantrex.com/support/gtsizing/disclaimer.asp?lang=eng
www.infinitepower.org/pdf/FactSheet-24.pdf
www.pvresources.com/en/software.php
www.dnr.louisiana.gov/sec/execdiv/techasmt/energy_sources/index.htm

Notes:

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