Chapter 9

Energy-Efficient Comfort Conditioning Equipment

Recommendations	First Cost	% Potential Savings	
		Cooling	Heating
1. Choose air conditioners with SEERs of 12 or higher with sensible heat fractions (SHF) less than 0.8; consider multispeed compressors.	M	20-40	—
2. Properly size the air conditioner.	R	0-10	—
3. Shade the compressor/condensing unit.	N	0-5	—
4. Choose the best heating system for your location.	S/M		0-60
5. Use a multispeed blower to maintain comfort.	S	—	—
6. Locate air handler and duct system in conditioned space.	S/M	10-15	10-15
7. Install and seal the air handler and duct system properly.	S	10-25	10-25
8. Create zoned HVAC system.	M	0-15	0-15
9. Choose an appropriate thermostat and thermostat location.	S	0-5	0-5
10. Install timers on kitchen and bath exhaust fans.	S	5	—
11. Install ceiling fans.	M	5-30	—
12. Install whole house fans.	S/M	5-15	—
13. Seal fan penetrations.	N	0-5	0-5
Maximum Combined Total	H	65	60

Cost Codes: R = reduced
N = negligible
S = small (<$0.25/ft² of floor area)
M = medium (>$0.25 and <$1.00/ft² of floor area)
H = high (>$1.00/ft² of floor area)

Marketing Comfort Conditioning Equipment

"Come on in – it's 20 degrees cooler inside!"

Not too many years ago, banners worded like this were commonly used outside movie theaters to entice people to come in. Many people chose to spend summer afternoons in theaters for the air-conditioned comfort as much as for the featured movies.

Times have changed greatly, and air conditioning is now a part of just about every Floridian's lifestyle. And because energy use for home cooling ranges from 25% of the annual energy bill in North Florida to nearly 50% in the southern part of the state, an efficient system can significantly lower a home owner's utility bills. An efficient air conditioning system is a major selling point in marketing Florida homes.

To promote energy-efficient equipment selected for your homes, you need to explain to your clients how much they will save on their power bills. Prepare a sheet with a definition of SEER (see p. 9-3), and list the values for the units you have chosen.

Next, show your clients how much money an efficient unit will save them. The following chart shows dollar savings associated with installing efficient units (assuming a 3 ton air conditioner, 2100 annual cooling hours, and an energy cost of $0.09 per kwh).

		Existing SEER										
		10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
	15.0	227	194	165	138	113	91	70	50	32	16	0
N	14.5	211	179	149	122	98	75	54	35	17	0	
e	14.0	194	162	133	106	81	58	37	18	0		
w	13.5	176	144	115	88	63	40	19	0			
	13.0	157	125	95	68	44	21	0				
S	12.5	136	104	74	47	23	0					
E	12.0	113	81	52	25	0						
E	11.5	89	56	27	0							
R	11.0	62	29	0								
	10.5	32	0									
	10.0	0										

Compare SEER values along top of chart with SEER values at left to find annual energy savings in dollars by using units with higher SEERS. For example, choosing a unit with SEER = 13 instead of 10 would save $157/year (savings are for a 3 ton A/C, 2100 annual cooling hours at $0.09 per kwh).

An important part of marketing efficient cooling and heating equipment is assuring the home buyer that the equipment has been sized properly. Too large a system will do a poor job of dehumidifying the home and will cost more to purchase and operate. Too small a system will not do an adequate cooling job. Show the home buyers the actual calculations or other guidelines you have used to determine the best system size.

Explain to your clients that because you will be properly locating and sealing the air handler and ductwork, they will save up to 25% on their cooling and heating bills over typical new construction.

The best way to market fans is to use the most effective and attractive products in your office, model homes, or other areas where you meet with clients. Give clients who may be unfamiliar with whole house, exhaust, and ceiling fans the opportunity to appreciate how effective they are by demonstrating their use.

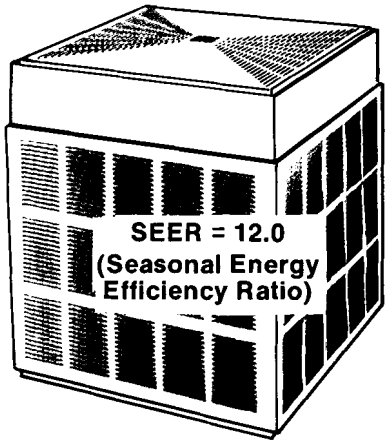
Ceiling fans increase comfort by making people feel cooler. They can be effective when ventilating or air conditioning. If you do not install ceiling fans in all the major rooms, at least consider pre-wiring rooms for them. Making it easier for home owners to add fans at a later time is a strong selling point in marketing your houses. Point out to prospective buyers that they should be able to install their own ceiling fans fairly easily, but that putting in the wiring after the house is built can be tricky and, if done by an electrician, expensive.

Selecting and Installing Comfort Conditioning Equipment

1. Select efficient air conditioners

While all the energy-conserving strategies discussed in this book affect both comfort and electricity consumption, selection of an efficient air conditioner with the right characteristics is the number one factor in reducing cooling bills.

Air conditioners are rated by their Seasonal Energy Efficiency Ratio (SEER). The higher the SEER rating of the unit, the greater the efficiency. A minimum SEER of 10.0 for central air conditioners is required by the National Appliance Efficiency Standard which went into effect in January of 1992. A unit rated at SEER 12, for example (the minimum we recommend for today's Florida homes), will be 20% more efficient than one rated at SEER 10.



Choose efficient air conditioners that have SEERs of 12 or greater.

You can obtain a copy of the latest ratings of energy-efficient cooling and heating equipment from the Air-Conditioning Refrigeration Institute (see "For further information" at the end of this chapter).

Keep in mind that the SEER rating tells you nothing about the unit's dehumidification ability. This is expressed by its sensible heat fraction (SHF); **the lower the SHF, the better the dehumidification ability**. The suggested maximum SHF is 0.80. Units with a higher rating may not adequately dehumidify some Florida homes, allowing mildew to grow and causing physical discomfort. Some air conditioners with high SEERs have high SHFs, so there is a trade-off between cooling efficiency and dehumidification. Compare manufacturers' engineering data to determine the SHF. Make sure to check the data for the combination of compressor *and evaporator* unit you will be using. The air flow rate is also important. Faster flow rates reduce air conditioner run times but also increase the SHF. Multispeed blowers are a good solution (see Section 5 of this chapter). **In general, search for units with an SEER of 12 or greater and SHF less than 0.80.**

Key Concepts for Heating/Cooling Systems

SEER - Seasonal Energy Efficiency Ratio - The seasonal weighted performance of an air conditioner based on the cooling accomplished (in Btu's of energy) divided by the electricity consumed (in kW).

$$SEER = \frac{Btu\ cooling\ provided}{kW\ consumed}$$

SHF - Sensible Heat Fraction is the fraction of a given cooling system's total capacity that is being used to remove sensible heat. One minus the SHF is the fraction that is used to remove moisture (latent heat).

CFM - Cubic Feet per Minute - This abbreviation is used to describe the rate of air flow for a given system.

COP - The Coefficient of Performance gives the energy output/energy input ratio for a given system at a given operating point.

HSPF - Heating Season Performance Factor - Rating used to describe the seasonal performance of heat pump heating systems.

AFUE - Annual Fuel Utilization Efficiency - Rating used to describe the efficiencies of gas units.

There are computer programs and calculations that can help you decide on the best combination of SEER and SHF for the home you are building. Check with your local utility company or air-conditioning suppliers for assistance in selecting programs and sizing guidelines.

Multispeed compressors. Some manufacturers have released air-conditioning units with two-speed or multispeed compressors. Depending on the operating conditions, a two-speed unit will run in either an efficient low-speed mode or a more powerful high-speed mode. A multispeed or variable-speed unit will change to any one of a number of speeds based on the operating conditions. These units can be sized to meet a peak party load without sacrificing energy savings and moisture removal during most of the cooling season. The overall efficiency of these units can be compared by their SEER rating. Using multispeed blowers with multispeed compressors will provide significant flexibility.

Sensible Heat Fraction (SHF) — To determine an air conditioner's dehumidification ability you have to find the sensible heat fraction for the compressor, evaporator and air flow rate you expect to use. Ask your dealer for the *manufacturer's engineering data.* Some manufacturers give the SHF value (which is always between 0 and 1) as shown below (0.71). Others give the sensible capacity as shown at right. Divide the sensible capacity at standard conditions (95 outdoor dry bulb, 67 indoor wet bulb, 80 indoor dry bulb) by the total capacity. For the example at right the SHF is 17.3/22.8 = 0.76. The lower the SHF, the more moisture the air conditioner will remove.

Compressor unit, evaporator unit, CFM rating					
O.D. D.B.	I.D. W.B.	TOTAL CAP.	SENS. CAP. AT ENTERING D.B. TEMP. 72	76	80
85	59	20.9	18.1	21.1	22.1
	63	22.5	14.9	18.1	21.3
	67	24.1	11.4	14.6	17.8
	71	25.8	7.8	11.1	14.3
95	59	19.7	17.6	20.1	21.1
	63	21.2	14.4	17.6	20.8
	67	22.8	10.9	14.1	17.3
	71	24.4	7.4	10.6	13.8
105	59	18.4	17.0	19.0	19.9
	63	19.8	13.8	17.0	19.9
	67	21.3	10.3	13.6	16.8
	71	22.8	6.8	10.0	13.2

Compressor unit, evaporator unit

Enter. Wet Bulb (°F)	Total Air Vol. (cfm)	Outdoor Air Temperature Entering Condenser Coil (°F) 85 Total Cool Cap. (Btuh)	85 Comp. Motor Watts Input	85 Sensible To Total Ratio (S/T) Dry Bulb (°F) 76	80	84	95 Total Cool Cap. (Btuh)	95 Comp. Motor Watts Input	95 Sensible To Total Ratio (S/T) Dry Bulb (°F) 76	80	84	105 Total Cool Cap. (Btuh)	105 Comp. Motor Watts Input	105 Sensible To Total Ratio (S/T) Dry Bulb (°F) 76	80	84
63	1000	36,300	2850	.70	.80	.90	34,000	3000	.72	.83	.93	31,800	3160	.74	.85	.96
	1250	37,900	2890	.75	.86	.97	35,400	3050	.77	.89	1.00	33,200	3210	.80	.93	1.00
	1500	39,100	2920	.79	.92	1.00	36,400	3080	.82	.95	1.00	34,400	3260	.85	.99	1.00
67	1000	39,300	2930	.55	.65	.74	36,800	3090	.56	.66	.76	34,400	3260	.58	.68	.79
	1250	40,600	2970	.58	.69	.80	38,000	3140	.60	.71	.83	35,500	3300	.61	.74	.86
	1500	41,600	3000	.61	.73	.85	38,900	3160	.63	.76	.89	36,300	3330	.64	.79	.92
71	1000	42,200	3010	.42	.51	.60	39,700	3190	.43	.52	.61	37,200	3360	.43	.53	.63
	1250	43,700	3050	.43	.54	.64	40,900	3230	.44	.55	.66	30,300	3400	.45	.56	.68
	1500	44,600	3080	.45	.56	.68	41,800	3250	.45	.58	.70	39,000	3430	.46	.60	.73

Basic Air Conditioning System Components and Terms

ADS - Air Distribution System- All indoor components of a heating/cooling system including the air handler, plenums, and supply and return ducts.

AIR HANDLER - Indoor component of a heating/cooling system comprised of a rectangular metal enclosure which houses the blower, evaporator, and in many cases a heater.

BLOWER - Fan mounted within the air handler used to drive air across the evaporator and through the air distribution system.

COMPRESSOR - Central outdoor component of a cooling system used to compress and drive refrigerant through the system.

CONDENSER - Heat exchanger which condenses hot, gaseous refrigerant, typically transferring the heat to the surrounding air.

DUCT - A passageway through which air moves, typically made of metal, fiberglass board with sheathing, or flexible tubing.

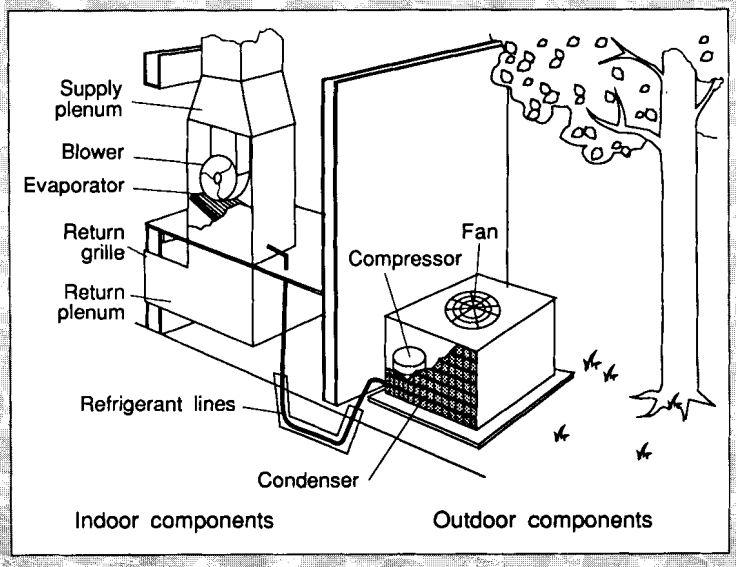
EVAPORATOR - Heat exchanger which vaporizes cold liquid refrigerant, typically absorbing heat from the surrounding air.

PLENUM - Enclosure on either side of the air handler through which air moves. Supply plenums are areas in which air is deposited before entering the supply ducts; return plenums are areas in which air is collected before entering the air handler.

RETURN AIR - House air drawn back to the air handler to be conditioned. The air is drawn either through open areas of the house (i.e. hallways) or through separate return ducts.

SUPPLY AIR - Conditioned air distributed throughout the house through supply ducts.

TONNAGE - Measure of the amount of cooling an air conditioner or heat pump is capable of; 1 ton = 12,000 Btu per hour.

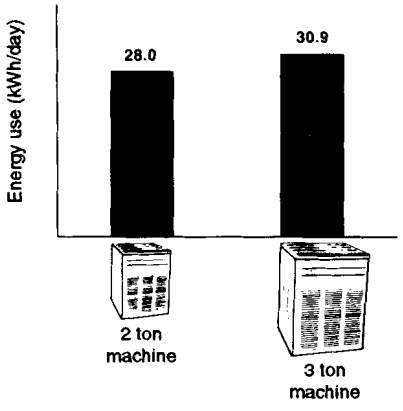


Air conditioning system components (heat pump in cooling mode).

2. Properly size the air conditioner

Accurate sizing is an important part of obtaining the most energy-efficient air conditioner. Systems should be sized to meet peak heating and cooling requirements. Peak heating generally is needed during early morning hours in winter; peak cooling is needed during the afternoon in summer.

Air conditioners are sized by the "ton." One ton is equal to 12,000 Btu of cooling per hour. When choosing the systems for your houses, keep in mind that bigger is not necessarily better. In fact, oversizing a residential air conditioner by 50% has been estimated to cause a 10% increase in energy use.



Source: FSEC analysis, unpublished, 1990

50% oversizing of a residential air conditioning system causes 10% increase in energy consumption

In the past, many builders have relied on general rules-of-thumb in sizing systems. Some builders have roughly estimated the needed size, then installed a slightly larger unit to make sure it was adequate. But as houses become more energy-efficient, with less air infiltration and more energy-conserving features, these old guidelines grow obsolete.

Air conditioning sizing should never be based merely on an estimate. Sizing methods are available from professional organizations such as ASHRAE and the Air Conditioning Contractors of American (ACCA). The most popular method is the ACCA's "Manual J" load calculation (required by FHA and VA). All these methods find home cooling and heating loads based on the area, orientation, and insulation of walls, windows, and doors and the area and type of ceiling and floor. They also account for load due to infiltration, people, and appliances. Many utilities will assist you in making the calculations.

System Charging

Air conditioner efficiencies are greatly affected by the state of refrigerant charge. A system that is undercharged by 10% may have a drop in efficiency of 20%. Over-charging can lead to refrigerant and oil flooding – causing over-heating of bearings and motor, and slugging or a reduced system life.

Unfortunately, system charging is not always done correctly, mainly because it can be time-consuming, taking a trained technician close to an hour. A device has recently been introduced that should lead to more accurate charging. The device, called an accumulator charger, is installed in the suction line external to the condensing unit and provides a visual means of charging systems. Results from field tests in Texas indicated the device does keep the system properly charged, and reduces maintenance calls.

The few minutes spent calculating the numbers and sizing the air conditioner to match may result in:

- Saving hundreds of dollars on initial cost of the system and ducting.
- Better air conditioner run time resulting in better humidity control, making it unnecessary for home owners to set thermostats lower to remove moisture.

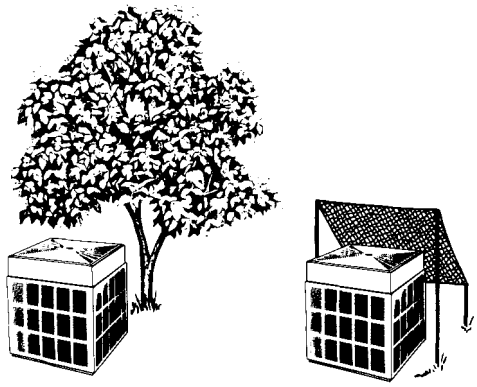
The disadvantages of not over-sizing are:

- The house will not cool down as fast when the system is first turned on.
- The unit may have trouble meeting the load for a large party held during a summer afternoon, requiring home owners to precool before the party begins.

The best compromise would be to use a multispeed blower, a multispeed compressor, or preferably both (see sections 1 and 5).

3. Shade the compressor/ condensing unit

Shading the compressor unit helps keep the condensing coil inside cooler and running more efficiently. One way to shade the unit is to install it on the north side of the house, in an area where it will receive little direct solar radiation in the summer. Avoid unshaded locations on the west side of the house because the sun will strike the unit when it needs to work the most in the late afternoon and evening. The condensor can also be effectively shaded with a shade tree, but be sure not to block airflow to and from the unit. Another shading method is to use a screen similar to the sun screens used for windows. Support the screen as shown below.



A tree or screen can be used to shade the compressor.

4. Choose the best heating system

Even though cooling is a greater concern of Florida home owners, annual heating costs still account for 18% of the total energy used to condition homes. The most common heating systems in Florida are electric strip, natural gas, oil and heat pumps.

Electric resistance or strip heat. First used in the state because of its low initial cost, electric resistance heating is more expensive to operate than alternative systems. It has a Coefficient of Performance (COP) of 1.0. The more efficient heat pumps, by comparison, typically have a COP of 2.0 to 3.5. Although most new homes with this type of heating use an air handler equipped with an electric resistance heater, baseboard heaters located in each room of the house are preferred. They offer the benefits of zoning and no duct losses.

Natural gas furnaces. Generally costing only one-third as much to operate as electric resistance heating, these systems offer benefits to home owners throughout the state. Gas units will cost about as much to operate as heat pumps, but offer two distinct advantages over heat pumps:

- Their efficiency does not decrease with colder weather.
- They have reduced maintenance costs (heat pumps require proper charging).

Look for sealed combustion systems which draw combustion air directly from and exhaust flue gases directly to the outdoors. These units are generally more efficient than non-sealed units and greatly reduce the possibility of dangerous combustion gases getting into the house through back-drafting or leaks.

Recent technological developments have resulted in substantial increases in furnace efficiency. The AFUE (Annual Fuel Utilization Efficiency) rating can be used to compare the efficiency of different models. Typical AFUE ratings for presently available furnaces and boilers are 0.78 to 0.85, meaning that 78 to 85% of the combustion heat is used effectively. The most efficient units achieve ratings of 0.90 or higher. Condensing furnaces that have an AFUE rating of 0.90 or greater need no chimney. Plastic pipe is adequate, thereby reducing the net cost of a high-efficiency unit. Typical annual heating bills for gas furnaces are shown below.

Annual Cost of Gas Heating*

AREA	AFUE 0.80	AFUE 0.93
North Florida	$117	$102
Central Florida	83	72
South Florida	25	22

* Gas priced at $0.60/therm.
Table source: City of Tallahassee Energy Services.