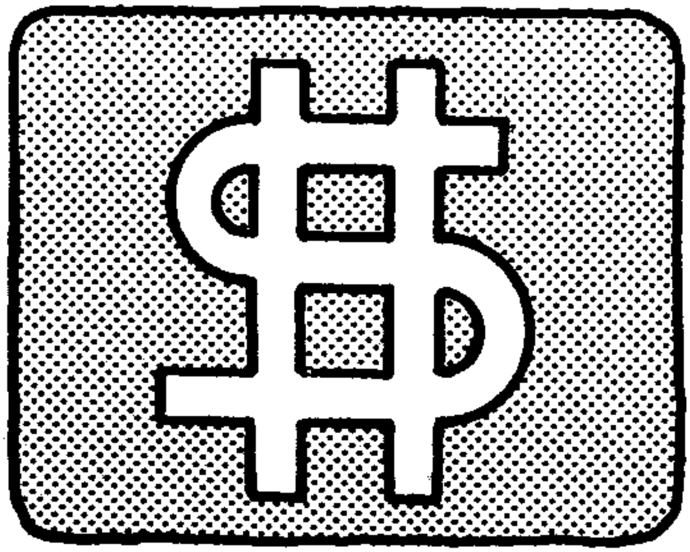
CHAPTER 6
ECONOMICS



This chapter is an introduction to the economic considerations involved in the decision to build a passive solar home. The discussion includes construction costs, energy savings, investment analyses, and applicable tax benefits.

While there are numerous benefits associated with the inclusion of passive solar strategies in new home or retrofit construction, there are costs associated with the solar option as well, and any analysis of solar feasibility is incomplete without the weighing of these benefits and costs (FIG 6-1).

To keep the analysis as objective as possible, only monetary benefits and costs are considered. Non-monetary benefits and costs, i.e., those benefits or costs to which it is difficult to assign a dollar value, are not considered. Examples of non-monetary benefits include the security of relative energy self-sufficiency and the ambiance of a sunspace. While non-monetary benefits and costs will not be included in this strictly economic discussion, that is not to say that they are inconsequential. Certainly these non-monetary benefits and costs will be important considerations in any decision regarding the solar option.

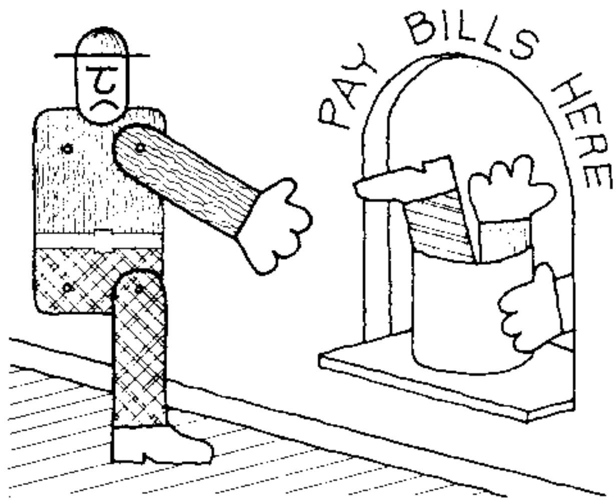
The investment in a solar home can be measured and evaluated by various economic performance indicators including the payback period, life-cycle costing, net benefits or savings, savings-to-investment ratio, and internal rate of return.

The simplest of these performance measures to understand is the payback period, and the payback period is discussed in detail and is the working example used in this chapter. The payback period is a function of 1) the additional construction cost of the solar work, and 2) the energy savings generated thereby. Once the additional costs of construction are known, and the annual heating requirements have been converted to a dollar figure, the payback period can be calculated.

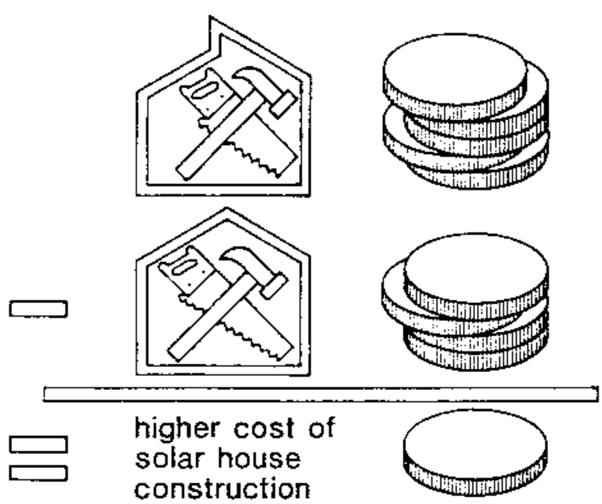
CONSTRUCTION COSTS

Passive solar heated or cooled buildings may have construction costs greater than conventional construction. These additional construction costs are due to items that would not be present in an otherwise conventionally built home. These items include thermal windows, overhangs, night shutters, thicker walls, thermal mass, extra insulation, etc. (FIG 6-2).

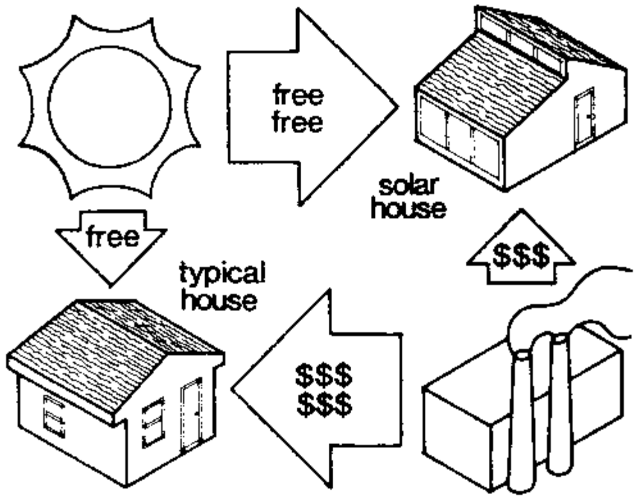
While passive solar construction will include additional cost items, reductions in cost may also occur, most likely as a result of downsizing or eliminating heating and air conditioning equipment.



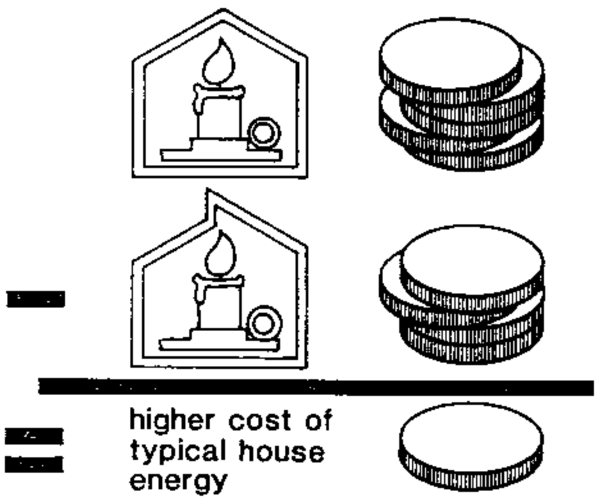
6-1 WILL GOING PASSIVE COST AN ARM AND A LEG



6-2 ADDITIONAL CONSTRUCTION COST



6-3 ENERGY COST BENEFIT



6-4 REDUCED ENERGY COST

TABLE 6-1 FUEL ENERGY EQUIVALENCY

COAL	
anthracite	6,800-10,150 btu/lb
bituminous	4,400-10,045 btu/lb
FUEL OIL #2	97,300 btu/gal
NATURAL GAS	780 btu/ft^3
COMMERCIAL PROPANE	1870 btu/ft^3
ELECTRICITY	3413 btu/kwh

The difference between these higher and lower costs can be considered the effective cost of the passive solar dwelling over a comparable, conventional non-solar house (FIG 6-3). For example, the additional insulation, night shutters, and extra south glass for Herbie's house in Chapter 5 result in an effective cost of $2500. For most passive solar homes, this effective cost of construction is usually between 5-10% more than the cost of a comparable, conventional non-solar house.

ENERGY COST SAVINGS

The energy cost savings (FIG 6-4) of a particular passive solar home will be influenced by a number of factors. These factors include the climate where the house is being built, the heating requirements of the house, the proportion of the heating and cooling requirements that will be satisfied by the passive solar system, and how these energy needs compare with the requirements of a comparable, conventional non-solar home.

The annual energy cost savings are determined by the amount of energy used, the type of fuel used, and the cost of that fuel. The amount of energy used is the product of the thermal integrity factor (TIF), the heating degree-days (DDy), and the floor area of the home:

Annual heating requirements = TIF x DDy x Floor area

For example, Herbie's house in Chapter 5 has net annual heating requirements of 20.35 Mbtus, which are calculated as follows:

Annual Heating Requirements = TIF x DDy x Floor Area
= 2.89 x 7031 x 1000
= 20,350,000
= 20.35 Mbtus

The annual heating requirements must next be converted to fuel energy equivalencies (TABLE 6-1). To determine the amount of fuel consumed, divide the annual heating requirements by the fuel energy equivalency from TABLE 6-1. Because Herbie's house uses electricity, the annual heating requirement of 20.35 Mbtus is converted to electrical consumption by dividing by 3413 to obtain kilowatt hours (kwh). The electrical usage for heating the home is calculated as follows:

Electricity Required = Annual Heating Requirements / 3413
= $(20.35 \times 10^6)/3413$
= 20350000/3413
= 5963 kilowatt hours

For any fuel, the annual cost is the product of the fuel consumed and the cost of that fuel:

Annual Cost = Fuel Consumed x Fuel Cost

For Herbie's house, electricity at a cost of 5 cents per kwh results in a projected heating bill as follows:

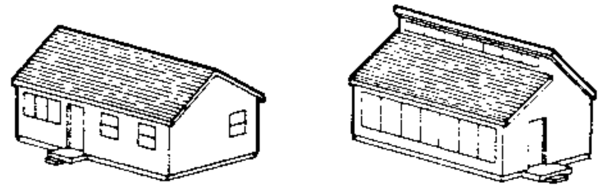
Annual Cost = Electricity Used x Cost
= 5963 kwh x 0.05 $/kwh
= $298.15

To compare Herbie's solar home with a conventional home of similar size in Chadron (FIG 6-5), the cost of heating the conventional home must be determined. For example, a 1000 sq ft tract home in Chadron with a TIF of 10 would have the following annual heating requirements:

Annual Heating Requirements = TIF x Ddy x Floor Area
= 10 x 7031 x 1000
= 70,310,000
= 70.31 Mbtus per year

The electricity required would be:

Electricity Required = Annual Heating Requirements / 3413
= $70.31 \times 10^6/3413$
= 20600 kwh



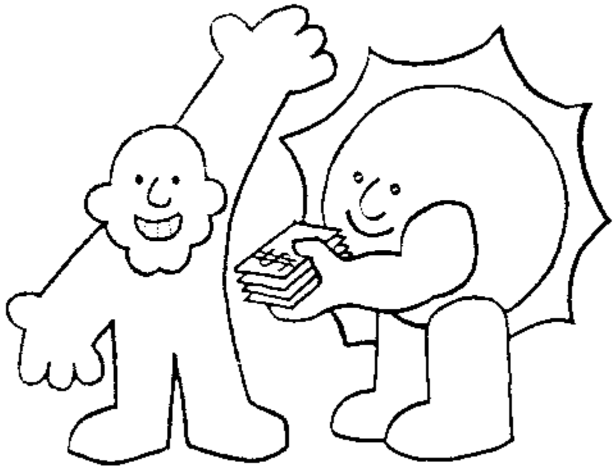
typical tract house TIF = 10.0 | passive solar house TIF = 1.5

6-5 THERMAL INTEGRITY FACTOR (TIF)

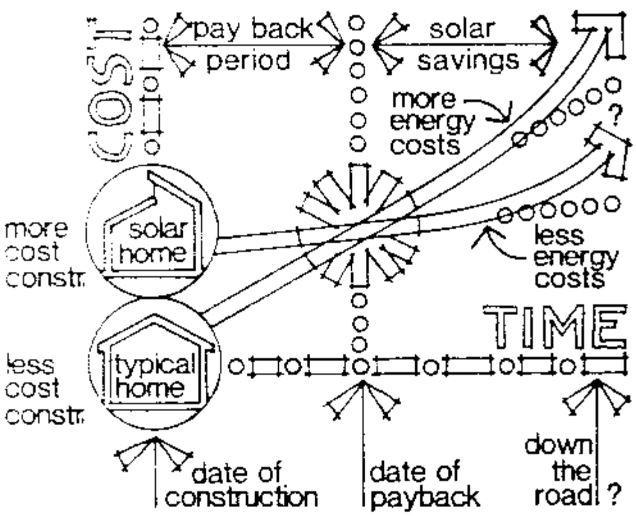
The annual heating cost for the conventional house would be:

Annual Cost = Electricity Used x Cost
= 20600 kwh x .05 $/kwh
= $1030.00

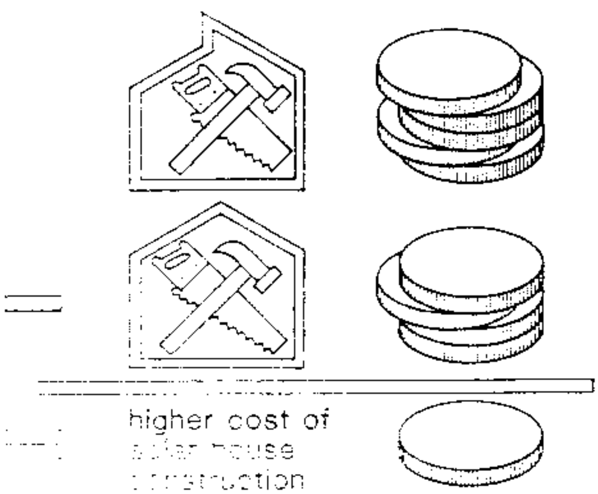
The energy costs of Herbie's home subtracted from the energy costs of the comparable conventional home give the initial annual energy cost savings, which, in this case, are approximately $731 per year. At 10 cents per kwh (which is a likely scenario by the year 1990) the savings would be nearly $1462 per year. As energy costs escalate, the impact of savings from a solar home becomes more apparent.



6-6 SOLAR PAYBACK



6-7 SOLAR ECONOMICS



6-8 ADDITIONAL CONSTRUCTION COST

THE SOLAR INVESTMENT

PAYBACK PERIOD

Having identified the effective cost of a passive solar system (house construction, heating and cooling systems) and the monetary benefits of such a system (annual energy cost savings), it is now possible to address the question: Is it worth it?

One of the most easily understood methods of calculating the monetary benefits of an investment in a passive solar home is the payback period (FIG 6-6). The payback period is defined as the number of years required to generate enough money (in energy cost savings) to pay for the initial investment (the effective cost of a passive solar rather than a conventional home) (FIG 6-7).

The simplest way to determine payback is to divide the additional cost of construction by the annual energy cost savings:

$$\text{Payback Period} = \frac{\text{Additional Cost of Construction}}{\text{Annual Energy Cost Savings}}$$

For Herbie's house, the $2500 additional cost of construction divided by the $731 annual energy savings results in a payback period of 3.42 years (FIG 6-8), calculated as follows:

$$\text{Payback Period} = \frac{\text{Additional Cost of Construction}}{\text{Annual Energy Cost Savings}}$$

$$= \$2500/\$731 \text{ per year}$$
$$= 3.42 \text{ years}$$

This payback period suggests that, in a period of less than four years, the passive solar home will have saved enough money in energy costs to pay for the initial extra cost of the structure.

This simplified payback analysis, however, gives only a very rough estimate of the monetary benefit of passive solar for two reasons. First, this method ignores the time value of money. The money invested in the solar house is not available to earn interest until it is recovered through energy cost savings. Calculating a simple payback period ignores this foregone interest. Second, the payback period approach ignores the fact that the benefits, in terms of energy savings, will continue long after the initial investment has been recovered. In fact, if energy prices increase according to some current forecasts, potential energy cost savings in future years will be greater than they are in the current year; the investment in passive solar would be "paid back" over and over again.

LIFE-CYCLE COSTING

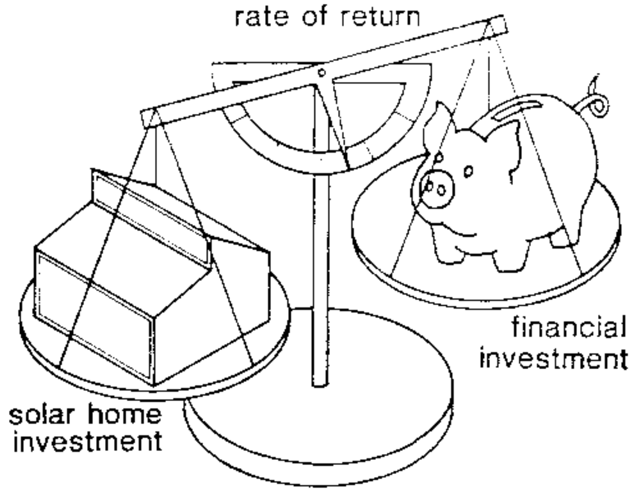
A life-cycle cost analysis takes into account all costs associated with a structure over its useful life -- purchase price (less any salvage value), energy costs, maintenance, repair, replacement, etc. -- and includes the cost of money over the life of the structure. The best investment is that which has the lowest overall life-cycle costs.

NET BENEFITS OR SAVINGS

The net benefits or savings analysis is very similar to the life-cycle cost analysis. It is determined by the difference between the life-time dollar energy savings and life-time dollar costs of the investment. Net benefits or savings may be expressed in either present value or annual value dollars.

SAVINGS-TO-INVESTMENT RATIO

In this analysis, savings and investment costs are expressed as a ratio rather than a dollar amount. A savings-to-investment ratio of greater than 1.0 indicates that the present value of the energy cost savings outweighs the cost and that the investment in the solar house is "profitable." The higher the ratio, the more dollar savings realized per dollar of investment.



6-9 RATE OF RETURN

INTERNAL RATE OF RETURN

When the construction of a passive solar dwelling is viewed as an investment, the question facing the buyer is: "Is this investment better than others I might make?" One way to answer this question is to compute the rate of return on the investment in a passive solar dwelling (FIG 6-9). The rate of return is the interest rate, stated in a percent, for which life-time dollar savings are equal to life-time dollar costs. If, for example, the rate of return on the solar investment is 25%, and interest rates on long-term financial investments (stocks, bonds, Certificates of Deposit, etc.) are 15%, the passive solar home is a better financial investment. A study performed at the University of Nebraska at Omaha computed the rate of return of a passive solar home to be 27%. This home, the "Islander", is featured in Chapter 9.

There are many unknowns in any economic calculation. Especially important is the future price of electricity, natural gas, and other fuels. Also unknown is the course of technological development in home heating and cooling designs. And, finally, one must consider the non-monetary elements involved in building a passive solar home, in particular the conservation of energy on a regional, national, and world level.

Any economic analysis of a solar investment must also include an analysis of applicable tax benefits available in conjunction with the use of solar and energy conservation techniques.

TAX BENEFITS

FEDERAL RESIDENTIAL ENERGY CREDITS

Persons -- including homeowners, renters, condominium owners, etc. -- who install certain energy conserving devices and/or renewable energy devices in their homes are eligible for a significant income tax credit. To fully appreciate this tax benefit, it is important to first understand the difference between a tax deduction and a tax credit. A tax deduction is subtracted from the taxpayer's adjusted gross income, and then the amount of tax is determined. A tax credit, however, is applied directly against the amount of tax owed. Thus, a tax credit reduces the amount of tax owed dollar for dollar and is usually a much more significant benefit than a tax deduction.

The Federal Residential Energy Tax Credit consists of two separate types of credits:

(1) CREDIT FOR ENERGY CONSERVATION COSTS.

This includes such items as insulation, storm or thermal windows or doors, weatherstripping or caulking, clock thermostats, etc. The credit is 15% of the first $2000 spent on items to save energy, or a maximum credit of $300. The cost of the items includes the cost of installation.

(2) CREDIT FOR RENEWABLE ENERGY SOURCE COSTS.

This allows credit for the installation of solar energy equipment for heating or cooling the home or for providing hot water or (after 1979) electricity for use within the home; wind energy equipment for generating electricity or other forms of energy for home use; or geothermal energy equipment. For years beginning after 1979, the credit for renewable energy source costs is 40% of the first $10,000 spent, or a maximum credit of $4,000.

PASSIVE SOLAR SYSTEMS. Under IRS regulations, "solar energy property" includes both active and passive solar energy systems. However, the current IRS position is that solar energy property does not include "materials and components that serve a significant structural function or are structural components of a home, and labor costs of installing such materials and components." The practical effect of this position is that, in most cases, significant portions of the passive system will not qualify for the income tax credit since most of the system also serves as structural components of the home. For example, windows (including clerestories and skylights) and greenhouses are not included as solar energy property and are not eligible for the tax credit. For a trombe wall, the mass wall and labor costs associated with installing it do not qualify. However, the outer (non-window) glazing and any shading, venting and heat distribution mechanisms do qualify. Hopefully, this position will be altered in the near future.

BUSINESS ENERGY INVESTMENT CREDIT

Businesses investing in certain energy property are eligible for tax credits of 10%, 11%, or 15%, depending on the type of energy property.

10% ENERGY INVESTMENT CREDIT PROPERTY

--Alternative energy property including biomass property;

--Specific equipment for which the principal purpose is to reduce the amount of energy consumed in any existing industrial, agricultural, or commercial process and that is installed in connection with an existing industrial, agricultural, or commercial facility, e.g., heat exchanger, recuperator, heat wheel, waste heat boiler, etc;

--Recycling equipment;

--Shale oil equipment;

--Equipment for producing natural gas from geopressured brine;

--Cogeneration equipment; and

--Qualified intercity buses.

11% ENERGY INVESTMENT CREDIT PROPERTY

--Qualified hydroelectric generating equipment.

15% ENERGY INVESTMENT PROPERTY

--Solar or wind energy property;

--Ocean thermal equipment;

--Geothermal equipment.

The same restrictions on passive solar energy systems that apply to the residential energy credits, also apply to the energy investment credit.

Regulations to be promulgated under the new Economic Recovery Tax Act of 1981 may affect the investment tax credit. Also, additional legislation to broaden tax credits to builders and developers and to include credits for passive solar systems is currently under consideration in Congress.

NEBRASKA SALES TAX REFUND

Under current Nebraska law, any sales or use tax paid by an owner on any alternative energy source facility approved by the Nebraska Energy Office, will be refunded to the owner. The refund applies to sales and use taxes paid on or after January 1, 1980. The refund will terminate on December 31, 1983. The refund applies to both active and passive solar energy systems. Aplication forms are available through the Nebraska Department of Revenue.

NEBRASKA PROPERTY TAX EXEMPTION

Under legislation passed during the 1981 Session of the Nebraska Unicameral, the value of major solar and energy conservation additions to a home will not be included in the valuation of the home for property tax purposes. In order to be eligible for this tax benefit, the owner of the real estate must receive approval of the improvement by the Nebraska Energy Office and must apply for the exemption to the County Assessor within 90 days after installation of the improvement or by January 1 of the year following installation. The exemption applies to both active and passive solar energy systems. The exemption applies to improvements installed after November 11, 1980, and on or before December 31, 1985. The improvement remains exempt from taxation for 5 years. The property tax exemption regulations are administered through the Nebraska Energy Office, Nebraska Solar Office, and the Nebraska Department of Revenue.