Energy Projects: Energy Audit of Your Home

"Education is a liberating force, and in our age it is also a democratizing force, cutting across the barriers of caste and class, smoothing out inequalities imposed by birth and other circumstances."

-Indira Gandhi

Guidance

Prof. V.N. Rajasekharan Pillai, Vice Chancellor, IGNOU

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BLOCK PREPARATION TEAM

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ENERGY PROJECTS

You are aware that energy is required for doing any kind of work. You can't imagine present day life without energy. Energy is used for various activities like industrial activities, cooking, lighting, heating, air-conditioning etc and is derived from various sources. Energy conservation and energy substitution is the need of the hour. This can help to fill the gap between demand and supply. In this course, you will learn about some of the energy technologies, their functional aspects with emphasis on energy audit of home etc.

GUIDELINES

The Project "Energy Audit of Your Home" consists of several components. You should try to attempt as much as you can. For the students admitted in January session, the project is to be submitted by May and for January session, it has to be submitted by May 10 to the Programme Coordinator(s) at the following address:

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IGNOU Regional Centre, Delhi-I
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From July 2011 session onwards, the project reports are to be submitted to the concerned coordinator.

Evaluation of Project Report

The project activities will be evaluated based on the activities attempted. The project is of 100 marks. You have to score minimum 40 marks to pass the course.

Energy Projects

Name:……

Enrolment No……

Signature of the student…….....

Name and Address of the Student

…….

…….

…….

…….

Tel. No……..

Mobile……

Email…….

You should tick the activities attempted and not attempted by you. There are 12 activities listed. The marks assigned to each activity are also given.

Activity No	Name of the Activity	Attempted (please tick)	Not Attempted (please tick)	Maximum Marks allotted	Marks Obtained
1	Analyze electricity consumption in your home			8	
2	Determine energy consumption in your home			14	
3	Electricity consumption data for various activities			10	
4	Identification of good housekeeping measures			5	
5	Energy conservation measures in lighting			9	
6	Energy conservation measures in air conditioning unit			10	
7	Energy conservation measures in desert coolers			5	
8	Energy conservation measures in refrigerators			5	
9	Energy conservation measures in bathrooms			5	
10	Solar water heaters			14	
11	Solae Photovoltaic systems			5	
12	Solar cookers			10	
Total				100	

Name of the Evaluator:----------

Signature of the evaluator:----------

Date of the evaluation:

OBJECTIVES

After studying this course, you will be able to

- understand the concept of energy audit
- understand how to conduct energy audit of your home
- understand how to carry our energy balance of energy use in your home
- understand how to identify energy conservation measures in your home
- understand how to implement the identified energy conservation measures in your home
- understand how to make use of renewable energy technologies like solar water heaters, solar cookers and solar PV technologies

Energy Audit of your home

Energy audit of your home is a methodology devised to account for:

- energy input in your home
- energy utilization by various activities in your home
- identify energy conservation measures in your home

How to Start Home Energy Audit?

Step 1: Collect electricity bills of last one year, the consumption data of LPG, kerosene, and other fuels used in your home.

Step 2: Calculate average energy consumption and try to understand your energy use pattern during the year.

Step 3: Analyze the past electricity consumption. This will give you an idea of monthly average, peak and lean consumption.

Step 4: Start recording your energy consumption.

Step 5: Make a note of the electricity and gas meter reading and then record the weekly meter reading on the same day for at least a month. Make a note of 'idle burning' of gas stove, time for which lights and fans are on without any use etc.

Step 6: Calculate energy consumed and cost for each specific category and energy appliance. The energy consumed should tally with the total units that the meter reads for that period. If not, check your calculations and meter again.

You may now attempt various activities that follow.

Activity 1: Analyze Electricity Consumption in your Home: 8 Marks

(1) Collect Annual Consumption Data

Total Number of Units (KWh) Consumed in the past one year period.	
Total Number of Units consumed in the past three year period (if available)	

Monthly Average	
Total Units Consumed / 12	
Monthly Average / 36	

(2) Collect Peak Consumption Data

Months	**No. of Units**
May	……
June	……
July	…….
Total Units Consumed	……

Average Peak Consumption	
Total Units Consumed / Number of Months	……..

(3) Collect Lean Consumption Data

Months	**No. of Units**
October	……
November	……
December	…….
Total Units Consumed	……..

Average Peak Consumption	
Total Units Consumed / Number of Months	……..…

(4) Examine the reasons for variation in electricity consumption.

……

……

……

……

……

Activity 2 Determine Energy Consumption in your home: 14 Marks

Determine energy consumption by various energy using devices in various sectors for a month, if possible for two-three months

A: Energy Used for Cooking Purpose

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
1. Oven								
2. Grill								
3. Hotplate								
4. Toaster								
5. Electric Kettle								
6. Others								

B: Energy Used in Lighting

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
Bulb: 5W								
15W								
25W								
40W								
60W								
100/200W								
Tubes: 40w								
36w								
20w								
11w								
Any Other								

C: Energy Used for Cooling Purpose

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
Fans: 40W								
75/120W								
Air Coolers: 60W								
115W								
186.5W								
373/746W								
Air Conditioner: 1000W								
1500W								
2000W								

D: Energy Used for Heating Purpose

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
Room Heater/500W								
Convector:1000W								
1500 W								
2000/3000W								
Any Other								

E: Energy Used in Helpmates and Other Devices

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
Refrigerator								
Blender/Juicer								
Geyser								
Electric Iron								
Water Pump								
Vacuum Cleaner								
Battery Inverter								
Others								

F: Energy Used for Entertainment Purpose

Devices Used	Wattage Rating	No. of Appliances Used	Total Wattage	Estimated Daily Hours of Use	Estimated Daily Consumption (KWh)	Estimated Days in a Month	Estimated Monthly Consumption (KWh/month)	Monthly Energy Cost (Rs.)
	(1)	(2)	(3)=(2)x(1)	(4)	(5)=(3)x(4)	(6)	(7)=(5)x(6)	(8)=(7)x Unit Price (Rs/KWh)
Dish Antenna with Receiver								
TV:								
DVD								
Radio/Transistor								
Others								

G: Summary of the Energy Consumption Data (A to F)

Energy Use Area	Units Consumed (1)	% Consumption (1) x 100/Total	Arrange in Maximum to Minimum	Look for Energy Conservation Opportunities in the same order
A: Cooking				
B: Lighting				
C: Cooling				
D: Heating				
E: Helpmates and other Devices				
F: Entertainment				
	Total :			

Activity 3 Electricity Consumption Data for Various Activities: 10 Marks

After completing the activity 2, you need to calculate energy consumption data room wise and then group them into activity wise (like cooking, lighting etc). An example how to compile data for a room is given in Table 3.1.

Table 3.1. Example of Collecting Daily Energy Audit Data

S.No.	Name of the Place		Nature of Load	Wattage (W)	Daily Hrs of use	KWh consumed
1	Room 1	1	Bulb	100	5	0.5
		2	48" Fan	60	12	0.72
		3	Electric Iron	500	1	0.5
		4	Air Cooler	1275	10	12.75
		5	Battery Inverter	400	8	3.2
		6	TV	100	4	0.4
		7	Room Heater	500	12	6.0
Total Energy Consumed						**24.07**

Another example for determining the running time and power consumption of some commonly used electrical equipments given is in the Table 3.2.

Table 3.2 The Energy Consumption by Appliances

Equipment	Power (W)	Running Time Daily (hr)	Annual Energy Consumption (KWh)
Microwave Oven	1300	0.5	237
Refrigerator	100	10	365
Hand Mixer	200	0.5	37
Electric Shaver	20	0.15	1
TV	100	5	183
Toaster	800	0.15	44
Coffee Machine	800	0.25	73
Lamp	100	6	219
CFL	18	6	39
Iron(weekly)	1000	0.5	26
Vacuum Cleaner(weekly)	600	2	62
Hair Dryer(weekly)	600	1	31
Total			1317

Following the examples of Table 3.1 and 3.2, calculate energy consumption in your home in Table 3.3 for as many months as possible.

Table 3.3: Energy Audit Data: Month……						
Sr.No.	Name of the Place		Nature of Load	Wattage (W)	Daily Hrs of use	KWh consumed
1	Room 1	1	Bulb			
		2	48" Fan			
		3	Electric Iron			
		4	Air Cooler			
		5	Battery Inverter			
		6	TV			
		7	Room Heater			
		8	Any Other			
			Sub Total			
2	Room 2	1.	Tube			
		2	Bulb			
		3	TV			
		4	Refrigerator			
		5	Air Conditioner			
		6	Room Cooler			
		7	Music System			
		8	Room Heater			
		9	Fan			
			Any Other			
			Sub Total			
3	Drawing Room	1	Bulb			
		2	Tube			
		3	56" Fan			
		4	Air Cooler			
		5	Room Heater			
		6	Water Pump			
		7	Refrigerator			
		8	Any Other			
			Sub Total			
3	Kitchen	1	Bulb			
		2	Tube			
		3	Heater/Cooker			
		4	Mixer			
4	Veranda	1	Bulb			
		2	Tube			
5	Bathroom	1	Bulb			
		2	Geyser			
Total Energy Consumed						

Activity 4: Identification of Good Housekeeping Measures: 5 Marks

Identify good housekeeping measures in order of preference

(1)----------

(2)----------

(3)----------

(4)----------

(5)----------

(6)----------

(7)----------

(8)----------

(9)----------

(10)----------

Activity 5 Energy Conservation Measures in Lighting: 9 Marks

5.1 Turn off unnecessary lights wherever possible

If you have to go out from the room even for 4-5 minutes, turn off the light. If you know that everyone forgets to turn off light, make a sticker or a sign to hang next to the switch that says "Lights Out!" or "Don't Forget!"

Activity: (a) Estimate the hours of light use when there is no one in the rooms as shown in Table 5.1.

Table 5.1 : Monthly Energy Consumption by Appliances Running Idle

	Nature of Load	Wattage (W) (1)	Daily Hrs of idle use (2)	Monthly Consumption of idle running, KWh (1) * (2) * 30/1000
1	Bulb	100		
2	Bulb	60		
3	Bulb	40		
4	Tube	36		
5	Any Other			
Total energy consumed while idle running				x KWh
Total costs of energy				x KWh x Rs/KWh

Activity: (b) Use bulbs with lower wattage in halls, stair ways, and other areas of general illumination. Estimate the energy saved as shown in Table 5.2.

Table 5.2 : Energy Saved by Replacing Bulbs of Lower Wattage

	Existing Wattage (W) (1)	Wattage Replaced (W) (2)	Wattage Saved (W) (3) = (1)− (2)	Daily Hours of Use (4)	Monthly Energy Saved, KWh (5) = (3) * (4)* 30/1000
1					
2					
3					
4					
5					
Total costs of energy = Monthly energy used (KWh) * Rs/KWh					

5.2 Use of Energy Efficient Lighting Fixtures

LEDs use up to 1/10 the electricity of an incandescent and last 10 times as long. If you compare LED with an incandescent bulb, an LED will last up to 100 times as long - up to 100,000 hours of use. If you compare the electricity used, you'll be saving a lot over a twenty year period. If you are using a bulb for Eight hours a day, you will have the savings as shown in Table 5.3.

Table 5.3 Comparing Costs of Incandescent Bulb, CFL and LED

Sr. No.	Fixture Type	Life (Hrs)	Usage (hrs/day)	Bulbs replacement in 20 Years	Cost of Replacement	Electricity Consumed (KWh)	Cost of Electricity @ Rs. 3/KWh	Total Costs (Rs.)
1	Incandescent Bulbs (40W)	1000	8	8*20*365/1000 = 59	59 * Rs. 10 = Rs. 590	40W*8 hrs*20Yrs*365 Days/1000 = 2336 KWh	Rs. 7008	7598
2	CFL (18W)	10000	8	8*20*365/10000 = 6	6 * Rs. 240 =Rs. 1440	18W*8 hrs*20Yrs*365 Days/1000 = 1051 KWh	Rs. 3153	4593
3	LED (4W)	20 Years	8	0	0	4W*8 hrs*20Yrs*365 Days/1000 = 233 KWh	Rs. 699	699

You can see that shifting from incandescent bulb to CFL, you can save over the life of the LED an amount of Rs. 7598−4593 = Rs. 3005. The corresponding saving when shifted to LED is Rs. 7598 – 699 = Rs.6899.

Activity (c) Estimate the annual electricity consumption in lighting of a incandescent bulb of 100 W and CFL of 18 W for burning 6 hrs/day.

Sr. No.	Fixture Type	Usage (hrs/day)	Electricity Consumed (KWh)	Cost of Electricity @ Rs. 3/KWh (Rs.)
1	Incandescent Bulbs (100W)	6		
2	CFL (18W)	6		
3	Additional Electricity Consumption by Incandescent and its cost			

Activity 6: Energy Conservation Measures in Air-conditioning Unit: 10 Marks

Air conditioning has become an essential component in hot and humid climates to improve thermal comfort and hence working conditions. Depending on the size of the room and total area needing air conditioning, you may take some decisions for the air conditioner to be installed. The usual choice for a home may be window or split air conditioning. Central air conditioning may be the choice for very large homes.

The cost can be one big factor you need to consider when making a choice. The other factors you should consider are tonnage of the air conditioning, power consumption and other mechanical features. Let's examine some of the technical data you ought to acquire to get your money's worth, when buying an air conditioner.

(1) First you need to know your budget.
(2) Secondly you should know the size of the room or area of the house you wish to cool.
(3) This helps to ascertain the tonnage of the air conditioner you require.
(4) The price of the air conditioner increases with the increase in tonnage.
(5) Normally for window or split tonnage of air conditioners available are from 0.60, 0.75, 1, 1.5 and 2 tons.
(6) Depending on the brand, the price will vary. Sometimes there are assembled air conditioners available, which may turn out to be cheaper though not entirely reliable.
(7) The cooling capacity varies in direct proportion to the air conditioner tonnage. The cooling capacity is measured in K Cal/hour or BTU/hour and the greater the number, the more powerful is the unit.
(8) The cooling capacity of an air conditioner of one ton is 3000 K Cal/hour or 12000 BTU/hour.
(9) A 0.75-ton machine is suitable for 35 sq. ft. area, one-ton machine for 90 to 110 sq. ft. area, 1.25-ton machine for 115 to 140 sq. ft. area, 1.50-ton machine for 150 to 170 sq. ft. area, 1.75-ton machine for 180 to 220 sq. ft. and so on.

Other than room size, you should know the number and size of windows, the direction the room faces, how much shade your room gets, the thickness of walls and type of roof, type of insulation the room has and the number of appliances in the room like computers, TV Sofa etc. Such details will enable you to decide about the best type, tonnage and number of air conditioners to be installed.

A Point to Remember:

(1) You should not select a lower tonnage simply to save on initial cost. Lower tonnage can reflect in higher bills, which will eventually hurt your pocket in the long term.

(2) It is important to ensure that the power supply in your home is sufficient to run the machine. Your authorised electrician can advise you on the power supply angle. You should also get him to check the wiring. If required, separate wiring and heavy-duty electric plug connection should be provided to install the air conditioner.

(3) You should also know about the efficiency of the air conditioner. This is a function of Energy Efficiency Ratio (EER) which helps you to determine how much it costs of run each unit. Units with higher EER are more expensive, but consume less power and turn out cheaper in the long run.

The cost for an AC depends primarily on the room size. As a broad thumb rule, if the budget is small, one will be required to go for window AC. A split AC is suitable for a higher budget and a larger area. Having discussed above features, always remember the following:

- Install air conditioner only if its use is warranted. In many cases desert cooler, planting trees/creepers can reduce cooling problems to quite an extent.
- Install the most energy efficient unit even if it is little more expensive.
- Estimate the required capacity of the air conditioner unit to a realistic value. Too low or too high a capacity are both energy wasting. It is wise to buy a slightly undersized unit, rather than oversized one.
- Avoid direct sunshine on the outdoor heat exchanger of an air conditioner and improve its work efficiency by 10%.
- Remove regularly, obstructions from front of air conditioners or their grills and registers, and effect energy savings of the order of 5-15%.
- Clear air filter on room units and grills and registers of central unit, every 2-3 weeks. It can save energy up to 5-10%.
- Check for air leaks, this can lead to energy savings of the order of 5-20%.
- Clean and calibrate thermostats, this save energy savings of the order of 5-20%.
- Set air-conditioning unit to re-circulate cool air instead of pulling in warm outside air.
- An increase in temperature setting for summer air-conditioning reduces energy consumption.
- Follow manufactures suggested maintenance. Properly maintained air conditioning unit consume 5-10% less energy.
- Replace old unit with more efficient unit. This will help you to save energy in long run.

Electrical input wattage or Hp, and refrigeration wattage are two different things.

A unit drawing 746W (1Hp) of electricity may move 2 to 3.5 times that in cooling or heating wattage. Only the latter refrigeration kilowatt (KW) rating will give an accurate representation of unit size.

Input power conversions

To convert from Hp to KW multiply by 0.746
To convert from KW to Hp multiply by 1.34

Systems are judged on their efficiency by their Coefficient of Performance (COP) in the case of heating, or the Energy Efficiency Ratio (EER) for cooling. The EER and COP are calculated by dividing the capacity output by the electrical input.

You can work out how much your unit will cost to run by multiplying the KW input data (electrical) by how much you pay per KWh for your electricity. For example, if the cost of

electricity is Rs. 3/KWh and your AC is of 1.25 KW, then your AC will be consuming Rs. 3/KWh x 1.25 KW = Rs. 3.75 per hour to run.

Point to Remember:

You should always do your own calculations before making a purchase. It is quite possible that some of the star ratings on the energy rating site may have been derived from incorrect manufacturers EER/COP figures, giving a false efficiency rating.

Activity (a) Collect from the market the specifications of 1.5 Ton Window Air Conditioners and work out the cost of energy consumed for running 1000 Hrs. You should work the cost as shown in Table 6.1.

Table 6.1 Cost Calculations for ACs: Window AC

Parameter	**Brand A**	**Brand B**	**Brand C**	**Brand D**
Star Rating				
Energy Efficiency Ratio				
Cooling Capacity				
Rate of Energy Consumption (KWh/hr)				
Total Energy Consumption for 1000 Hrs (KWh)				

Activity (b) You should always keep in mind that human body is thermally fit at temperatures between 25–27°C. Therefore, the thermostats should be set between 25–27°C. You should also remember that for every 1°C lower can increase running costs by up to 15%. Your air conditioner will work at its optimum during the night if you allow the inside warm air to go out by opening windows and doors before switching on the AC.

Your AC consumes 100 units in a month when set at temperature 25 °C. What will be the energy consumption if the temperature is set at 24 °C.

Solution:

Activity 7: Energy Conservation Measures in Desert Coolers: 5 Marks

The desert coolers are of two types (a) for inside room and (b) for installation in the window. Preferably the desert coolers should be installed in the windows. The following points should be carefully looked into from the energy conservation point of view:

- Desert coolers should be as per BIS specifications. If not, try to obtain details of the energy consumption and power factor of the unit.
- The power factor for the desert coolers lies in the range 0.85 to 0.90. This can be improved to 0.95 by application of shunt capacitors. This will result in substantial savings of electrical energy.
- Wherever feasible prefer desert cooler to air-conditioner because for the same capacity of air-conditioner, the average power consumption-in these coolers savings is found to be 4 to 5 times lower.
- Avoid over sizing of coolers. Select correct tonnage (size of desert cooler) from the table below:

Cooling Capacity (tons)	Volume of the room cooled (m^3)
1.0	30 to 50
1.2	40 to 60
2.0	80 to 120
2.2	80 to 140
3.0	100 to 180
3.2	120 to 200
3.6	150 to 250

Activity (a) Collect the following data for five desert coolers and calculate the energy consumption for running 500 hrs in Table 7.1.

Table 7.1 Cost Calculations for Desert Coolers of similar size (48")

Parameter	**Cooler A**	**Cooler B**	**Cooler C**	**Cooler D**
Rating of Motor (W)				
Power Factor				
Rating of Pump (W)				
Energy Consumption*				

***Energy Consumption = Motor Rating (W) * 500 hrs * cost of electricity/1000**

Activity 8: Energy Conservation Measures in Refrigerators: 5 Marks

Whenever you're planning to buy a color television, a refrigerator, a water heater or a ceiling fan, be sure to check out its electricity consumption. VOICE (Voluntary Organization in Interest of Consumer Education), has conducted a study of energy consumption by electrical devices. As per the findings of the report, "There is a wide variation of energy consumption among brands tested, and some of the popular brands had surprisingly poor performance in terms of energy consumption."

Eight brands catering to the segment of 165-175 liter direct cool refrigerators were tested. The VOICE study revealed that the energy consumption of each brand per day varied from 0.60 KWh (Videocon) to 1.44 KWh (Kelvinator). In terms of actual running cost for an entire year at the rate of Rs 4 per unit (KWh), the refrigerator that consumes 0.60 KWh of power (Videocon) will cost Rs 876, while that consuming 1.44 KWh (Kelvinator) will cost Rs 2,102.

Things you should remember while deciding with refrigerators.

- Install refrigerators in areas having proper ventilation.
- Switch off the refrigerator whenever you go on long holidays.
- The freezer should be cleaned periodically.
- The refrigerator should be of right size meeting your requirements.
- Choose the right temperature
- Do not make door open for long time
- The cooked meal should be covered before putting in to the refrigerator.

Activity (a) Determine the cost of the energy consumed in your refrigerator by noting the following parameters:

1. Type of refrigerator (single door/double door):----------
2. Rating of refrigerator (Liters): ----------
3. Rating of refrigerator (W): ----------
4. Average Loading of refrigerator (partly, half, full): ----------
5. KW or Tonnage of the refrigerator: ----------
6. Distance from the wall:----------
7. Energy consumed per month----------

Activity 9: Energy Conservation Measures in Bathrooms: 5 Marks

Things you should remember while making use of water in bathrooms are the following:

(1) The wasting of water needs to be stopped immediately. You should avoid wasting water as it amounts to wasting energy required for pumping and supplying.

(2) Usually 60-70% of water we use in our home is used in bathrooms. The high flush toilets use 15 to 25 liters of water per flush. A leaky toilet can waste more than 35000 liters of water in a year.

(3) A shorter shower saves both water as well as electricity. This will also saves hot water requirements.

Activity (a): Measure the water used in your house for:

(1) Bathing:----------Liters (Buckets of 15 liters) or the one is available in your home
(2) Washing clothes---------Liters (as above)
(3) Estimate the amount of water used in one month and then in one year(Liters)----------
(4) No of leaky tapes----------
(5) Measure the amount of water in 30 minutes: ----------(in liters, glass or by any measureable method).
(6) Estimate the amount of water leaked in one year.
(7) Estimate the % of leaked water: (6)*100/(3).----------

Activity 10: Solar Water Heaters: 14 Marks

We are blessed with Solar Energy in abundance at no cost. The solar radiation incident on the surface of the earth can be conveniently utilized for various applications. One of the popular devices that harness the solar energy is solar hot water (SHW) system.

A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. The solar energy incident on the absorber panel coated with selected coating transfers the heat to the riser pipes underneath the absorber panel. The water passing through the risers get heated up and are delivered to the storage tank. The re-circulation of the same water through absorber panel in the collector raises the temperature to about 80 ºC in a good sunny day.

Broadly, the solar water heating systems are of two categories. They are:

(1) Closed loop system
(2) Open loop system.

In the first one, heat exchangers are installed to protect the system from hard water obtained from bore wells or from freezing temperatures in the cold regions. In the other type, either thermosyphon or forced circulation system, the water in the system is open to the atmosphere at one point or other. The thermosyphon systems are simple and relatively inexpensive. They are Suitable for domestic and small institutional systems, provided the water is treated and potable in quality. The forced circulation systems employ electrical pumps to circulate the water through collectors and storage tanks.

The choice of system depends on heat requirement, weather conditions, heat transfer fluid quality, space availability, annual solar radiation, etc. The SHW systems are economical, pollution free and easy for operation in warm countries like ours. Based on the collector system, solar water heaters can be of two types.

Flat Plate Collectors (FPC) based Solar Water Heaters

The solar radiation is absorbed by Flat Plate Collectors which consist of an insulated outer metallic box covered on the top with glass sheet. Inside there are blackened metallic absorber (selectively coated) sheets with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water. There are about 60 BIS approved manufacturers of Solar Flat Plate Collectors in the country.

Evacuated Tube Collectors (ETC) based Solar Water Heaters

Evacuated Tube Collector is made of double layer borosilicate glass tubes evacuated for providing insulation. The outer wall of the inner tube is coated with selective absorbing material. This helps absorption of solar radiation and transfers the heat to the water which flows through the inner tube. There are 44 MNRE, Govt. of India approved ETC based solar water heating suppliers. Solar water heating is now a mature technology. Wide spread utilization of solar water heaters can reduce a significant portion of the conventional energy being used for heating water in homes, factories and other commercial and institutional establishments.

Salient Features of Solar Water Heating System

Solar Hot Water System turns cold water into hot water with the help of sun’s rays.

- Around 60 – 80 ºC temperature can be attained depending on solar radiation, weather conditions and solar collector system efficiency
- Hot water for homes, hostels, hotels, hospitals, restaurants, dairies, industries etc.
- Can be installed on roof-tops, building terrace and open ground where there is no shading, south orientation of collectors and over-head tank above SWH system
- SWH system generates hot water on clear sunny days (maximum), partially clouded (moderate) but not in rainy or heavy overcast day
- Only soft and potable water can be used
- Stainless Steel is used for small tanks whereas Mild Steel tanks with anticorrosion coating inside are used for large tanks
- SWHs of 100-300 litres capacity are suited for domestic application.
- Larger systems can be used in restaurants, guest houses, hotels, hospitals, industries etc.

Fuel Savings:

A 100 litres capacity SWH can replace an electric geyser for residential use and saves 1500 units of electricity annually.

Avoided utility cost on generation

The use of 1000 SWHs of 100 litres capacity each can contribute to a peak load shaving of 1 MW.

Environmental benefits

A SWH of 100 litres capacity can prevent emission of about 1.5 tones of carbon dioxide per year.

Life: 15-20 years

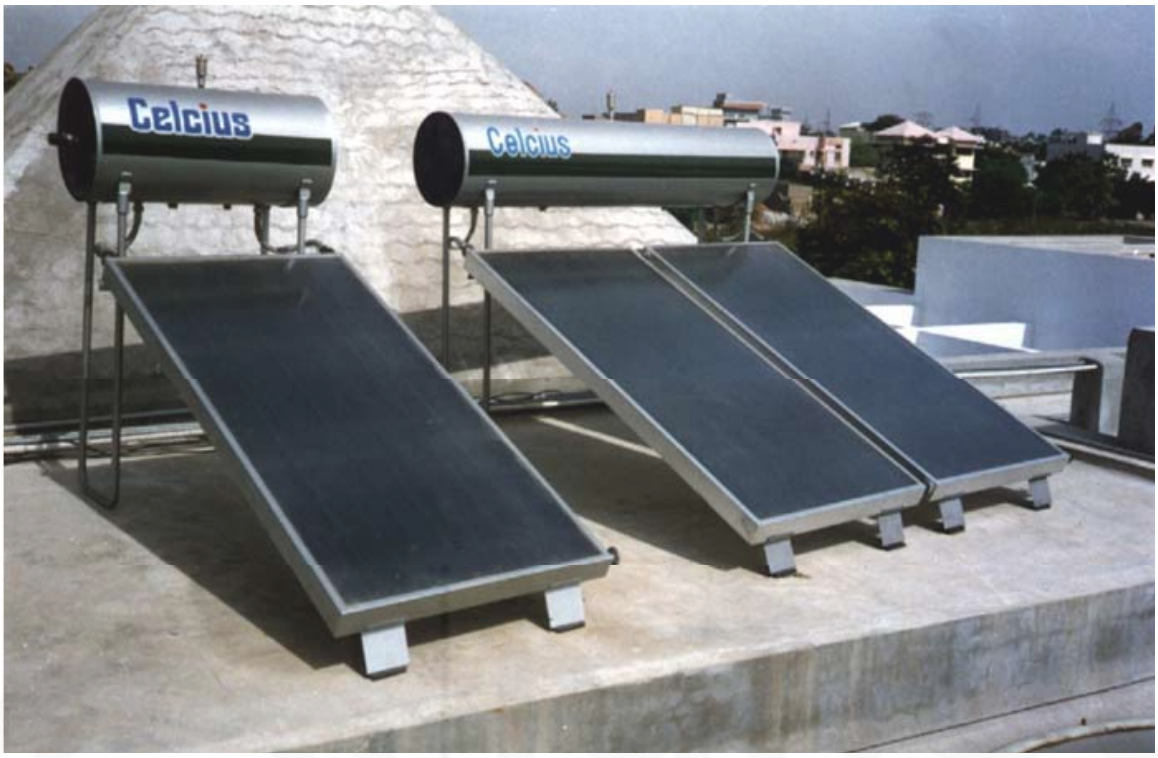
Approximate cost: Rs.15000- 20,000 for a 100 litres capacity system and Rs.110-150 per installed litre for higher capacity systems

Payback period:

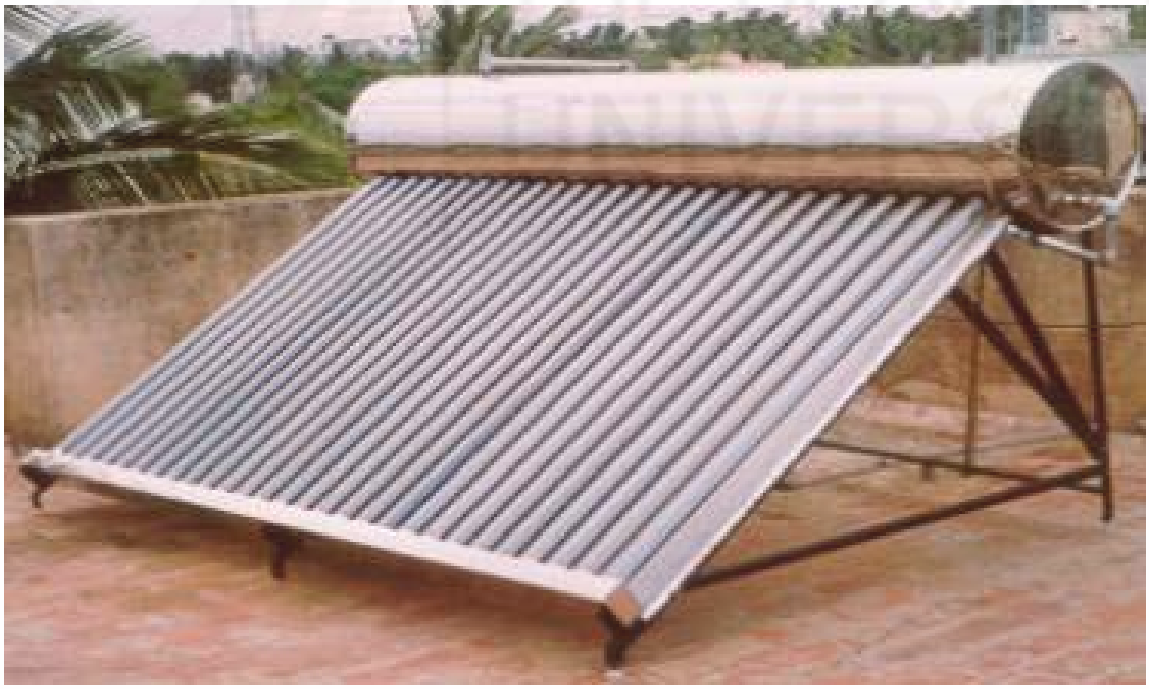
- 3-4 years when electricity is replaced
- 4-5 years when furnace oil is replaced
- 5-6 years when coal is replaced

Though the initial investment for a solar water heater is high compared to available conventional alternatives, the return on investment has become increasingly attractive with the increase in prices of conventional energy. The payback period depends on the site of installation, utilization pattern and fuel replaced.

Flat plate collector (FPC) based solar water heater



Evacuated tube solar water heater



Activity (a):

Write down how the water is being heated in your home.

1. ……..

2 ……

3 …….

Activity (b):

Make a visit of any solar water heater and identify the type of solar water heater (please tick).

(a) Collector-cum-storage solar water heater
(b) Natural circulation type solar water heater
(c) Forced circulation type solar water heater

Activity (c):

After seeing the solar water heater, record the following parameters: (you will need an inch tape and a glass thermometer for this)

(1) Length of the collector (m) ……..
(2) Breadth of the collector (m) ……..
(3) Calculate Area of the collector (m^2) ……..
(4) Temperature of the inlet water (ºC) …….
(5) Temperature of the outlet water (ºC) …….
(6) Calculate difference of temperature (ºC) ……
(7) Type of insulation used ……
(8) No. of glass covers used ……...
(9) Rating of water pump (Hp) …….

Activity (d):

Give three important reasons of using glass covers in solar water heaters

(1) …….
…….
(2) …….
…….
(3) …….
…….

Activity (e)

The thermal efficiency, η, of solar water heater is given by the following relation:

$$\eta = \frac{Useful\ Heat\ Gain(useful\ output\ of\ the\ collector)}{Input\ Energy}$$

$$\eta = F_R[(\tau\alpha) - U_L(\frac{T_i - T_a}{I})]$$

where

m = flow rate of water, Kg./s
C_p = Specific heat of water, J/Kg. ºC
T_o = Outlet water temperature, ºC
T_i = Inlet water temperature, ºC
A_c = Collector area, m^2
I = Solar radiation received on the collector surface, W/ m^2
τ = Transmissivity of the glazing
α = Absorptivity of the absorber
U_L = Collector overall heat loss coefficient, W/ m^2 ºC

Assume the following parameters for the solar water heater which you have visited:

I = 900 W/ m^2
$\tau \alpha = 0.8$
U_L = 5 W/ m^2 ºC
$F_R = 0.9$

Now do the following activities:

(1) measure the inlet temperature, T_i and outlet temperature, T_o, and ambient temperature, T_a
(2) Calculate the thermal efficiency of solar water heater

Report the results in the following way:

T_i = …… ºC
To = …… ºC
T_a = …….ºC

η = ……

Activity (f):

Give five major advantages of solar water heater vis a vis an Electric Heater

(1) ……
……

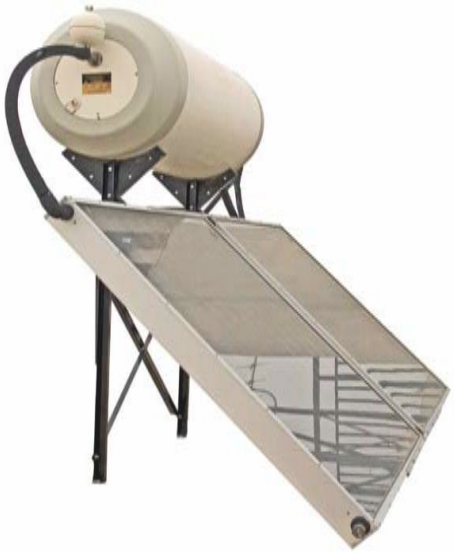
(2) ……
……

(3) ……
……

(4) ……
……

(5) ……
……

Activity 7



A solar water heater is given in the figure. Name the category of solar water heater.

(a) Built-in-Type solar water heater

(b) Natural Circulation Type solar water heater

(c) Forced Circulation Type solar water heater

Activity 11: Solar Photovoltaic Systems: 3+ 2 = 5 Marks

Activity (a):

Write down the specifications of solar PV lantern seen by you.

Answer.

Wattage of Solar PV: ……

Wattage of CFL used: ……

Battery Specifications: ……

Activity (b):

Describe the working of Solar PV Lantern

Answer:

……

……

……

……

……

Activity 12: Solar Cookers: 3 + 3 + 4 = 10 Marks

Activity (a):

Describe the type of solar cooker visited by you.

Answer:

……

……

……

……

Activity (b):

Describe the advantages and Disadvantages of solar cookers.

Answer:

Advantages:

……

……

……

……

……

Disadvantages:

……

……

……

Activity (c):

A box type of solar cooker is shown in Fig. 12.1 (source: indiamart.com). The important parts of a box solar cooker include the outer box, inner cooking box or tray, the double glass lid, thermal insulator, mirror and cooking containers.

Answer the following questions:

(1) What is the function of glass cover
(2) What is the function of the mirror
(3) State the reasons why the cooking pots are blackened

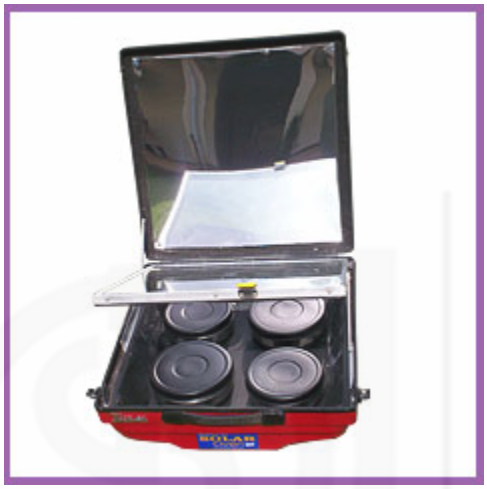


Fig. 12.1 Box Type Solar Cooker

Answer:

(1) ……

(2) ……

(3) ……

CERTIFICATE IN ENERGY TECHNOLOGY AND MANAGEMENT (OEYP)

COURSE STRUCTURE SUMMARY

Course Code	Course Title	Credits
OEYP 001	Energy Resources and Conversion Processes	4
OEYP 002	Renewable Energy Technologies and Their Uses	6
OEYP 003	Energy Management: Audit and Conservation	6
OEYP 004	Energy Projects	4

OEYP 004	**Energy Projects**

STATE-WISE LIST OF DISTRICTS HAVING ADITYA SOLAR SHOPS

1. Andhra Pradesh: Rangareddy, Adilabad, Nellore, West Godawari, Prakasam, Guntur, Visakhapatnam, Cuddapah, Medak, Mehbubnagar, Chittor, Warangal, Khammam, Vizianagaram, East Godavari, Krishna, Nizamabad, Ananthapur
2. Arunachal Pradesh: West Siang, Upper Dibang Valley, Lower Dibang Valley, Lohit, Upper Subansiri, East Kamong
3. Assam: Guwahati
4. Bihar: Patna
5. Chattisgarh: Raipur
6. Delhi: New Delhi
7. Gujarat: Rajkot, Ahmedabad, Panchmahal, Narmada, Bhavnagar, Jamnagar, Surendranagar
8. Haryana 10 Gurgaon, Faridabad, Hissar, Panchkula, Jind, Rewari, Kaithal, Karnal, Narnaul, Sirsa
9. Himachal Pradesh: Shimla
10. J&K: Ladhakh
11. Jharkhand: Ranchi, Ranchi
12. Karnataka: Bangalore
13. Kerala: Thiruvanthapuram, Ernakulam, Cannore
14. M.P.: Bhopal
15. Maharashtra: Aurangabad, Jalgaon, Latur, Yawatmal, Sangli, Kolhapur, Osmanabad
16. Manipur: Imphal
17. Mizoram: Aizwal, Lunglei, Champhai
18. Nagaland: Kohima, Dimapur
19. Orissa: Bhubaneshwar, Behrampur
20. Pondicherry: Pondicherry
21. Punjab: Jalandhar, Kapurthala
22. Rajasthan: Jaipur, Mount Abu
23. Sikkim: East Sikkim
24. Tamil Nadu: Chennai, Madurai, Dindigul
25. Tripura: West Tripura, South Tripura
26. U.P.: Lucknow, Kanpur, Allahabad, Agra, Varanasi, Ballia, Meerut, Gorakhpur, Deoria, Siddharthnagar, Ghaziabad
27. Uttaranchal: Dehradun, Pithoragarh, Chamoli, Pauri garhwal, Haridwar
28. West Bengal: Kolkata, 24 Paraganas South, Siliguri, Bardhaman, North 24 Parganas, Hoogly, Bankura, Birbhum

The addresses of the shops and other details may be obtained from the concerned State Nodal Agencies.

STATE-WISE LIST OF DISTRICTS HAVING AKSHAY URJA SHOPS

1. Bihar: Munger, Supaul, Nalanda, Gopalganj, Bhojpur, Nawada, Khagaria, Begusarai
2. Chattisgarh: Korba, Raigarh, Dhamtari, Kawrdha, Rajnandgaon, Durg, Mahasmund, Bilaspur, Ambikapur, Kanker, Dantewada, Jagdalpur, Janjgir Chamba
3. Chandigarh: Chandigarh
4. Gujarat: Sabarkantha
5. Haryana: Rohtak, Fatehabad, Sonepat, Kurukshetra, Bhiwani, Ambala, Panipat, Yamuna Nagar, Jhajjar
6. Himachal Pradesh: Solan,
7. Jharkhand: Dhanbad,, Deogarh, Pakur, Godda, W.Singhbhum
8. Karnataka 22 Gulbarga, Belgaum, Bijapur, Bagalkot, Bidar, Bellary, Raichur, Shimoga, Mysore, Davanagere, Uttara Kannada, Udupi, Koppal, Chitradurga, Chikkamagalore, Gadag, Haveri, Kodagu, Hassan, Dakshina Kannada, Dharwad/Hubli, Mandya
9. Kerala: Malapuram, Kollam, Kottyam, Thrissur, Kozhikode, Idukki, Palakkad
10. Madhya Pradesh: Indore, Sagar, Dhar, Barwani, Rewa, Jabalpur, Balaghat, Seoni, Chatarpur, Chindwara, Sidhi
11. Maharashtra: Nanded, Gondia, Bhandara, Washim, Navi Mumbai, Pune, Parbhani, Amravati
12. Punjab: Ropar, Faridkot, Ferozpur, Fatehgarh Sahib, Amritsar, Gurdaspur, Patiala, Mansa, Bhatinda, Sangrur, Mukatsar, Mohali
13. Tamil Nadu: Kancheepuram, Kanyakumari, Karur, Thoothukudi
14. Uttar Pradesh: Kanpur(Dehat), Firozabad, Moradabad, Badaun, Mainpuri, Pilibhit, Saharanpur, Unnao, Sitapur, Gonda, Bagpat, Ghosi(Mau), Mathura, Ambedkar Nagar, Sonebhadra, Banda, Hamirpur, Ghazipur, Chandauli, Bhadohi, Raebareli, Bahraich, Sarawasti,Pratapgarh, Kaushambi, Shahjahanpur, Bijnor, Farrukhbad, Etah, Rampur,Aligarh, Chitrakoot, Padrauna/Kushinagar, Hardoi, Azamgarh, Basti, Faizabad, Etawah,Gautam Budh Nagar, Sant Kabir Nagar, Sultanpur, Mirzapur, Bulandshahar,Lakhimpur Khiri,Jhansi,Fatehpur, Jalaun, Hathras(Mahamaya Nagar), Kannoj, Bareilly, Maharajganj, Jaunpur, Auriya, J.P.Nagar, Barabanki, Balrampur, Lalitpur, Mahoba
15. Uttaranchal: Nainital, Almora, Rudraprayag, Tehri

The addresses of the shops and other details may be obtained from the concerned State Nodal Agencies.

State Nodal Agencies across the Country

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