Greening my home: How do I reduce my energy footprint?

Why we must think of energy efficient life style?

Construction industry in India is growing at a rate of 9.2 per cent per annum as against the world average of 5.5 per cent per annum. The construction industry is also nearly 10 percent of the GDP. It is one of the largest in terms of economic expenditure, use of raw materials and environmental impacts. Buildings are the nucleus of urban consumption – water, energy and material, and, are also responsible for enormous wastes. Demand for housing and commercial space will escalate in India, and lock up enormous carbon and energy. Already the residential and commercial sector consumes more than a quarter of the total electrical supply usage of the country and major portion of this is utilized in the buildings. Malls, multiplexes, housing conglomerates are springing in cities. An effective environmental management of building provides the opportunity for intensive demand management to reduce overall footprint of urban consumption of water and energy and minimise waste.

Change begins in our own home – with little steps. What can each one of us do to green our homes? How can we reduce the energy imprint of our buildings, our living? How do we know what works and how? There are a range of products that we can select and use starting from efficient lighting products such as compact fluorescent lamp, light emitting diode bulbs, solar products such as water heaters, cookers, lantern, home lighting system, rooftop system, energy efficient appliances such as refrigerators, TFLs, air conditioners etc. But we know so little about them. Why don't we start to look at them one by one and understand why will this help to reduce our energy budget and make our home and our city sustainable.

How do I light my home?

Do you know lighting accounts for almost 20 per cent of the monthly electricity bill in many households? Energy saving can make a considerable difference to our household budget. Do you know the yellow incandescent bulbs that we have got so used to is extremely energy inefficient? Only 5 per cent of the electricity is converted into light in these bulbs, the rest is lost as heat. How can we adopt efficient lighting that can help to reduce energy consumption, thereby save energy and money, without compromising on the quality of light?

Use of new lighting technologies can reduce energy use in the house by 50 to 75 per cent – that's enormous in terms of monetary savings. In addition, lighting controls offer further energy savings by reducing the amount of time that lights are on without being used. Following are some of the energy efficient devices for lighting that we can consider:

Compact fluorescent lamp (CFL)?

- **What is it and why it helps?** A Compact fluorescent lamp (CFL) is an energy efficient alternative and are much more efficient than incandescent bulbs. A CFL uses only one-fifth as much electricity as an incandescent lamp to provide the same level of illumination. A 15 W and 20 W CFL can replace a 60 W and 100 W incandescent bulbs respectively.

- The lighting efficiency in case of CFL, ranges from 45 lumen per watt to 60 lumen per watt. Since an incandescent bulb converts about 95 per cent of electricity into heat and only five per cent is converted into light, it generates only 14 to 16 lumen per watt. In case of Delhi, where the domestic consumers pay Rs. 4.5 per unit of electricity (kilo watt hour -- kWh), a 60 W incandescent bulb burning for 4 hours a day will consume 87.6 kWh in a year, whereas a 15 W CFL in a similar condition will use 21.9 kWh, saving Rs. 296 to

a consumer. Similarly, comparison of 20 W CFL and a 100 W incandescent bulb shows that the CFL will consume 116.8 kWh less saving Rs. 526. Not only savings, CFLs also save heat trapping carbon dioxide emissions. While a 60 W incandescent bulb emits 65 g/hr of CO2, a 15 W CFL emits only 16 g/hr.[1]

- **What is the life span and cost?** CFLs last up to six times longer than incandescent bulbs. The average cost of a CFL is in the range of Rs. 80 to 100 compared to Rs. 10 to 15 for an incandescent bulb. Although these cost a bit more than incandescent bulbs, the excess investment is easily paid back in a year's time.

- **Where can you get it?** A consumer can buy a CFL from any electrical shop. One can get CFLs manufactured by companies such as Osram and Phillips. There are other manufacturers as well. In addition, low cost Chinese CFLs are also found. You need to check out on the lamp life.

- **Any concern?** Mercury, which is a proven neurotoxin, is a small but essential component of CFLs. It allows the bulb to be an efficient light source. It has no substitute but its quantity can be reduced. In developed countries like the US and Europe, CFLs with 1 mg of mercury are available but CFLs sold in India however have 3 milligrammes (mg) to 13 mg mercury. There is however no system of collection and proper disposal of used CFLs to be able to avert the risks of mercury contamination. Now collection system is evolving.

- **Any official policy?** The 'Bachat Lamp Yojana' aims at large scale replacement of incandescent bulbs in households by CFLs. It seeks to provide CFLs to households at the price similar to that of incandescent bulbs and plans to utilize the Clean Development Mechanism (CDM) of the Kyoto Protocol to recover the cost differential between the market price of the CFLs and the price at which they are sold to households.[2] Under this scheme, the Bureau of Energy Efficiency (BEE) is coordinating voluntary efforts to provide high quality CFLs to domestic consumers for about Rs. 15 per lamp, at a rate comparable to that of incandescent bulbs. This would remove the barrier of high CFL price (which is currently Rs. 80 to 100 per lamp) which is constraining its penetration into households. The BEE targets replacement of about 400 million incandescent bulbs in use in the country, leading to a possible reduction of about 6,000 MW of electricity demand, and a reduction of about 24 million tones of CO2 emissions every year.[3]

Light Emitting Diode (LED) bulbs?

- **What is LED?** LEDs have been around for over 50 years in colours red, orange, yellow, blue, green and then sheer white. These have come a long way from being tiny indicator lights that tell one when an electronic appliance is switched on. They are beginning to get noticed in India as an energy saving option for lighting buildings and streets though still a speck on the horizon. Delhi has replaced 150 Watt solar vapour lamps in streetlights with 50 Watt LEDs in a residential locality early this year.

- **What is the benefit?** Unlike incandescent bulbs, LEDs do not have filament that is heated to create light. These are illuminated by the movement of electrons in a semi conductor material (diode). Since electricity is directly turned into light, LEDs waste less energy as heat. Energy consumption is lower than CFLs that use mercury vapour to produce light. LEDs have taken over CFLs promoted as the most advanced lighting

[1] G Pandian undated, National Educational/Awareness Programme On Standards & Labeling, BEE.
[2] http://www.bee-india.nic.in/content.php?id=2
[3] Anon undated, *The Action Plan for energy Efficiency*, Bureau of Energy Efficiency, Ministry of Power, Government of India.

device, in energy efficiency. A 5 Watt LED can replace a 15 Watt CFL, saving Rs. 77 on the electricity bill a year.

- **What is the life span and cost?** LEDs score over incandescent bulbs and CFLs in life span as well. A LED lasts three to five years; an average CFL lasts about 250 days and an incandescent bulb, 41 days. Long life makes it a fit-and-forget fixture, saving cost of maintenance and replacement.

- The biggest challenge LED faces is high cost. It is 80 times as expensive as an incandescent bulb and 10 times a CFL. Manufacturers claim high prices are offset by savings but recovering the cost takes 5 to 10 years. A Rs.10, 40 Watt incandescent bulb is replaceable by a CFL that costs Rs. 100. But an LED for the same light output will cost Rs. 800 last year the cost was Rs. 1,200.

- **Any concern?** These are safer as LED beams do not emit radiation and unlike CFLs, they do not contain mercury.

- **Any official policy?** At present, there is no subsidy for LEDs. The LED industry pays 28 per cent import duty and 12 per cent VAT. The manufacturers are looking to the government for subsidies to promote LEDs. The technical challenge in popularizing LEDs is to manage the heat generated. If the heat is not dissipated properly the light will begin to dim and the life of the bulb will be reduced. Although LEDs have much higher lighting efficiency than CFLs and incandescent bulbs, the efficiency decreases with use. Unless high standards are maintained in mass production, the output of light and lifespan will be affected.

Catching the sun?

We have all heard about the potential of solar power. But it is not as esoteric as you think. You can bring sun power to your home. There are a range of solar lighting products. But what are the various solar thermal systems/devices?

Solar water heaters

- **What is it?** A solar water heater is a device that uses solar energy to heat water for domestic, commercial and industrial needs. Solar water heater can be used to generate hot water for homes, hostels, hotels, hospitals, restaurants, dairies, industries etc. It can be installed on rooftops, building terrace and open ground where there is no shading, south orientation of collectors and over-head tank above solar water heater system. Solar water heaters of 100 to 300 litres capacity are suited for domestic application. Larger systems can be used in restaurants, guest houses, hotels, hospitals, industries etc.

- **How does it work?** 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 hat to the riser pipes underneath the absorber panel. The water passing through the risers, get heated up and is delivered to the storage tank. The re-circulation of the same water through absorber panel in the collector raises the temperature to 80 degrees celsius in a good sunny day. The total system with solar collector, storage tank and pipelines is called solar hot water system.

- **What are the different categories of solar water heater?** Broadly, the solar water heating systems are of two categories. They are: closed loop system and open loop system. In the first one, heat exchangers are installed to protect the system from hard water obtained from borewells 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 solar water heater systems are economical, pollution free and easy for operation in warm countries like ours.

- **There are many types of solar water heater:** There are two types of solar water heater based on the collector system. These are flat plate collectors and evacuated tube collectors.

  - **Flat plate collectors based SWH (FPC):** 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.

  - **Evacuated tube collectors based SWH (ETC):** 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.

Most of the domestic solar water heaters are provided with electrical back up. Electrical heating elements are usually placed in the storage tank and can be switched on during cloudy days. In some cases, the solar heated water is led into an existing electric geyser, the geyser needs to be switched on only in cloudy conditions. Most domestic systems are in the capacity range of 100 to 500 litres of hot water per day.

- **What is the benefit of solar water heater?**It has many advantages such as availability of hot water round the clock depending on the use and system capacity, electricity saving,

reduction in CO2 emissions. A residence can save 70 to 80 per cent on electricity or fuel bills by replacing its conventional water heater with a solar water heating system. A 100 litres capacity of solar water heater can replace an electric geyser of 2kW capacity for residential use. It can save around 1,200 units of electricity in homes every year. Use of 1,000 solar water heaters of 100 litres capacity each can contribute to a peak load saving of approximately 1 MW.

- A solar water heater of 100 litres capacity can prevent emission of 1.5 tonnes of carbon dioxide per year. To generate that much of electricity from a coal based power plant, 1.5 tonne of CO2 per year is released in atmosphere. One million solar water heating systems installed in homes will, therefore, also result in reduction of 1.5 million tone of CO2 emission in atmosphere.

- **What is the life span and cost?** Solar water heaters made using materials as per BIS specifications can last for 15 to 20 years. But it depends on the general upkeep of the solar water heater.[4] The smallest solar water heater available has a capacity of 100 litres per day which is sufficient for a family of four or five members. It costs Rs. 15,000 to Rs. 20,000 for a 100 litres capacity system and Rs. 110 to Rs. 150 per installed litre for higher capacity systems.

- **How much will it cost?** The total cost of a solar water heating system is dependent upon many things. These include, the capacity, the kind of back-up used, the materials used for the inner and outer tanks, the length of distribution piping required to take hot water to the bathrooms, and not insignificantly, the brand value. Typically, for an Indian make system with a single BIS approved flat plate collector of 2 sq. m area, the current market costs are reported to be in the range of Rs. 15,000-20,000, excluding the distribution piping. However this range is indicative, and could vary from manufacturer to manufacturer.

- The pay back period varies depending on the fuel that is replaced. It is 3 to 4 years when electricity is replaced, 4 to 5 years when furnace oil is replaced, and 5-6 years when coal is replaced. Though the initial investment is high compared to available conventional alternatives, the return on investment has become increasingly attractive with increase in prices of conventional energy. The pay back period depends on the site of installation, utilization pattern and fuel replaced.

- **Government subsidy?** The Ministry of Renewal Energy provides subsidized loan at the rate of 2 per cent to domestic users, 3 per cent to institutions and 5 per cent to community users plus Rs. 100 per square meter of collector area as incentive to motivator.[5] Interest free loans are provided to the domestic users of northeast and hilly states, islands and Chattisgarh, Jharkhand and Uttarakhand. Thirty banks are operating the scheme which will continue till 2009-10.[6] Builders and developers/housing boards/development authorities of institutional/commercial establishments/ group housing societies will get similar subsidy. For housing complexes, the subsidy is at the rate of Rs. 1,900 per sq m of collector area.[7]

- Other financial provisions include Rs. 10 lakh to municipal corporations for making amendment in building bye-laws, similar support also for announcing rebate in property tax and to utilities for announcing rebate in electricity tariff, Rs. 10 lakh for publicity campaign to banks/FIs/intermediaries/SNAs/MCs/utilities. Rs. 5 lakh per year for publicity to BIS/MNRE approved manufacturers on cost sharing basis through Indian Renewable Energy Development Agency (IREDA), Rs. 2 lakh per activity for

[4] http://mnes.nic.in/faq.htm
[5] http://mnes.nic.in/cfa-schemes-programmes.htm
[6] Arun K Tripathi 2009, Solar city programme: The path towards low carbon Indian cities, MNRE.
[7] Arun K Tripathi 2009, Solar city programme: The path towards low carbon Indian cities, MNRE.

seminars/training/workshops/publicity etc to banks/MCs/SNAs, support for study tours/exposure visits abroad by industry delegation and survey, evaluation study etc and loans at 5 per cent to approved manufacturers for technology improvements and expansion of production facilities from IREDA as well as from PSU banks. The public sector banks include Canara bank, Bank of Maharashtra, Union Bank of India, Syndicate Bank, Punjab and Sind Bank, Punjab National Bank, Andhra Bank, Vijaya Bank, Dena Bank, Bank of India, J&K Bank, Oriental Bank of Commerce. The NBFCs include IREDA, Nagarjuna Credits & Capital Ltd, SREI Infrastructure Finance Ltd, Bhonsale Leasing Finance Co. and Madhya Pradesh Financial Corporation. The private banks include the Ratnagar bank Ltd. The United Western Bank Ltd and rest are cooperative banks. [8]

- **Where can you get it?** These can be obtained and installed through various manufacturers who have received BIS certification, their dealers and 'Aditya' solar shops.[9] There are 63 BIS approved manufacturers of FPC based solar water heating systems.[10] In addition, there are MNRE approved suppliers of ETC based systems. These include one indigenous manufacturer of ETCs and ETC based solar water heating systems and 60 manufacturers/suppliers of solar water heating systems based on imported ETCs.[11] These can also be repaired at these places along with the servicing facilities. Information regarding solar water heating systems can also be obtained from the renewable energy agencies established by state governments.[12]

Solar cookers

- **What is it?** A solar cooker is a device that uses heat energy from the sun to cook food. Solar cooking involves no recurring expenses on fuel. Solar cookers if used properly can save three or four LPG cylinders per year. Since solar cooking is a slow process, it ensures better and more nutritious food. These are durable and simple to use. These work well only on clear sunny days. However, if an electrical heater is built in, these can be used on cloudy days too.

- **Types of solar cookers:** Two types of solar cookers are available in the market, box type and dish type.

- **A box solar cooker**: It is suitable for a family of four or five can cook most of the dishes except frying or for making chapattis. It is an ideal device for domestic cooking during most of the year except on cloudy days. Some models are available with electrical backup, so it can be used even in non-sunshine hours. These can be procured from manufacturers, suppliers, district and head offices of state agencies as well as from 'Aditya' solar shops.

[8] Arun K Tripathi 2009, Solar city programme: The path towards low carbon Indian cities, MNRE.
[9] Anon undated, Solar Heat, Ministry of Non-Conventional Energy Sources, New Delhi, p 11.
[10] http://mnes.nic.in/list/list-fpc-m.htm
[11] http://mnes.nic.in/list/list-etc-m.htm
[12] Anon undated, Solar Heat, Ministry of Non-Conventional Energy Sources, New Delhi, p 11.

A dish solar cooker:

- It uses a parabolic dish to concentrate incident solar radiation. This solar cooker commonly known as an 'SK-14' solar cooker is useful for homes and small establishments. This can meet the needs of about 15 people and can be used for eight to nine hours during the day. Upon full use at small establishments, these can save upto 10 LPG cylinders per year.

- **How do these work?** A box type solar cooker consists of an outer box made of either fibre glass or aluminium sheet, a blackened aluminium tray, a double glass lid, a reflector, insulation and cooking pots. The blackened aluminium tray is fixed inside the box with insulating material in between to prevent heat loss from all sides. A double glass lid with toughened glass acts as the cover of the cooking tray. A reflecting mirror, fitted on the inside of the outer box cover, reflects the solar radiation and helps in increasing the solar energy input. The cooking pots are made of steel or aluminium and painted black on the outer side. The food to be cooked is placed in the cooking pots which are then placed in the aluminium tray and covered by the double glass lid. The cooker is kept facing the sun appropriately to cook the food.

- A dish solar cooker uses a parabolic dish to concentrate the incident solar radiation. It has a aperture diameter of 1.4 m and a focal length of 0.28 m. The reflecting material used for fabrication of this cooker is anodised aluminium sheet which has a reflectivity of over 80 per cent. The cooker has to track the sun and has to be adjusted manually after every 15 -20 minutes. The cooker can deliver power of about 0.6 kW which can boil two or three litres of water in half an hour. The temperature achieved at the bottom of the vessel could reach 350 to 400 degrees celsius which is sufficient for roasting, frying, and boiling.

- **What are the benefits?** A box type solar cooker can be used to prepare all kinds of dishes, except frying or making chapattis. A normal size of this cooker is sufficient for a family of four to five members. A dish solar cooker however can meet the needs of about 15 people and can be used for eight to nine hours during the day. It can save up to 10 LPG cylinders per year upon full use at small establishments.

- **What is the life span and cost?** The box type solar cooker has a life of 10 to 12 years. The cost varies from Rs 1,200 to Rs. 2,500 depending on its size and features. The payback period is 2 to 3 years depending upon the extent of use and place of use. The cost of a dish solar cooker may vary from Rs. 4,300 to Rs. 5,000 depending on the type of reflector and supporting structure. Its payback period ranges from 2 to 3 years depending on the extent of its place of use. The life of this cooker is estimated at about 20 years for the metallic structure. However, the reflecting sheets may have to be replaced once in five years due to degradation in their reflectivity.

- **Government subsidy?** In case of box type solar cookers, the MNRE provide incentives to state nodal agency (SNA) which is Rs. 200 per cooker of ISI brand and Rs. 100 per cooker of non-ISI brand. In addition, Rs. 1.50 lakh is given to SNA for publicity or conducting

workshops etc. The manufacturers also get 50 per cent fee reimbursement for obtaining BIS approval. Inorder to encourage the use of dish type solar cookers, an incentive of 50 per cent of the cost of the dish solar cooker is provided, which is limited to Rs. 2,500 per cooker.[13]

- **Where can we get them?** The MNRE website has a list of manufacturers and suppliers of concentrating solar cookers (dish and scheffler cookers).[14]

Community solar cooker

- **What is it?** A community solar cooker is a parabolic reflector cooker like a dish solar cooker. It is commonly known as a Scheffler cooker and is larger than the dish solar cooker (SK-14 type).

- **How does it work?** It can cook food using solar energy inside the kitchen itself. The cooker has a large reflector ranging from 7 to 12 sq m aperture area. This reflector is placed outside the kitchen so that it reflects solar rays into the kitchen through an opening in its north wall. A secondary reflector further concentrates the rays on to the bottom of the pot/frying plan which is painted black to absorb maximum heat. The temperature attained is so high up to 400 degrees celsius that the food can be cooked quickly.

- The cooker is provided with a mechanical clockwork arrangement that rotates the primary reflector outside to automatically track the sun. The cook has to set this reflector in focus only once a day in the morning. By shifting two arms provided in the reflector frame, it is possible to change the curvature of the parabolic reflector for seasonal adjustment thus keeping fully tracked on to the sun during all seasons.

i. Outside view (solar dishes), ii. Inside view of kitchen

- **What is the benefit?** It is possible to cook food for about 40 to 50 persons with this cooker. One dish may take about 60 to 90 minutes to cook depending on the type of dish and solar insulation available. The cooker works nicely in areas where solar insulation is good during most part of the year and it is possible to cook two meals a day with this cooker. Due to the high temperature attained with this cooker, it is suitable for making almost all traditional

[13] http://mnes.nic.in/cfa-schemes-programmes.htm
[14] http://mnes.nic.in/list/list-conc-solar-cookerm.pdf

dishes. When not in use for cooking, the cookers can be used to hear or boil water. These can be used in schools, institutional kitchens, canteens, religious ashrams, hotels, hospitals, police and armed forces' kitchens etc.

- **What is the lifespan and cost?** The cost of this cooker is about Rs. 50,000. The payback period is 4 to 5 years.

- **Government subsidy?** In case of Scheffler or community type cooker, the MNRE provides Rs. 25,000.[15]

Solar photovoltaic (SPV) systems

- Outdoor lights can be powered by small photovoltaic (PV) modules that convert sunlight directly into electricity. Solar outdoor lights also come as stand alone fixtures. An 11 W CFL, with a 74 W photovoltaic module and a 12 V/75 AH battery, costs Rs. 22, 000 to 24 000. When fully charged, the battery can power the light from dusk to dawn.

SPV lantern

- **What is it?** Solar lantern is a portable device for lighting. Due to its light weight, it can be carried around and is therefore ideal for both indoor and outdoor usage.

- **How does it work?** A solar lantern consists of three main components -- PV module of 8 W to 10 W capacity, a sealed maintenance free battery of 12 V, 7 ampere hours (AH) capacity and a CFL of 5W or 7W rating. It does not require installation. The PV module is placed in the sun during the day and is connected through a cable to the lantern unit. The incident solar radiation is converted into electricity which in turn charges the battery. A green LED light indicates the charging of the battery.

- **What is the benefit?** A solar lantern, which is commonly used for lighting purposes, can save about 50 liters of kerosene in a year by replacing a kerosene lantern.[16] It is meant to provide light for three to four years daily and can function like this for three days without sunlight. During night, the lantern is simply detached, the battery provides power to the lamp and is used wherever required.

- **What is the life span and cost?** The average cost of a solar lantern is around Rs. 3,500.[17] Low cost models with smaller PV modules and battery capacity are also available.

- **Government subsidy?** The MNRE provides a subsidy of Rs. 2,400 on purchase of solar lantern in northeast and special areas.[18] This is mostly in unelectrified villages and hamlets of special category states and UTs/islands.[19] There is however no subsidy in other areas.[20] Under the solar lantern programme, the Ministry will also provide Rs.100 per lantern as service charges to the SNAs/departments and the Akshaya Urja shops. The SNAs/departments will also get Rs. 100 per lantern towards inspection charges of solar lanterns sold by the Akshaya Urja shops. Subsidy will be provided only on eligible models of solar lanterns, procured from the pre-qualified manufacturers, after competitive bidding.[21]

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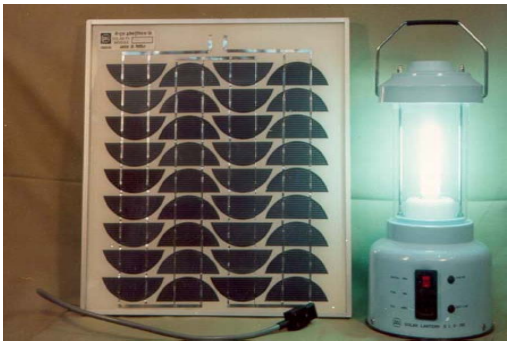
[15] http://mnes.nic.in/cfa-schemes-programmes.htm
[16] http://www.pib.nic.in/release/rel_print_page.asp?relid=40491
[17] http://www.pib.nic.in/release/rel_print_page1.asp?relid=43903
[18] http://mnes.nic.in/cfa-schemes-programmes.htm
[19] http://www.pib.nic.in/release/release.asp?relid=51333
[20] http://mnes.nic.in/cfa-schemes-programmes.htm
[21] Anon 2009, Implementation of the 'Solar Lantern Programme' during 2009-10, SPV Group, Ministry of New and Renewable Energy, New Delhi.

In addition, one girl child from a BPL family studying in class IX to XII and residing in the un-electrified villages and hamlets of the special category states and UT islands is eligible to get one solar lantern free of cost during her entire period of school study. This has been done to encourage a girl child belonging to the BPL family to continue her studies. The distribution of solar lanterns is organised by the concerned SNAs through the district administration.[22]

- **Where can you get it?** One can get the solar lanterns from Akshay Urja Shops established in various states and union territories.

- **Any concern?** At present, CFL is being used as the light source in solar lanterns. The Ministry of Renewal Energy is supporting development of white LED based solar lanterns, for replacing CFL, which is expected to further reduce the cost of the solar lanterns. The draft performance specifications of white LED based solar lanterns have been prepared for product development and performance evaluation.[23]



SPV home lighting system

- **What is it?** A solar home lighting system provides solar electricity for indoor lighting. It can operate lights in one or more rooms of a house along with power to run small DC fan or a 12 V DC television with the system. It consists of a PV module of 18, 37 or 74 W capacity, a sealed, maintenance free or flooded lead acid battery of 12 V and 20, 40 or 75 AH capacity and CFLs of 9W or 11 W rating. There are several models with one, two or four CFLs.

- **How does it work?** The PV module is usually mounted on the roof of the house so that it is exposed to direct solar radiation throughout the day. The module converts incident radiation into electricity which in turn charges the battery which is placed inside the house. The battery provides power to the CFLs and to the television and fan as required. A change controller prevents overcharging and deep discharge of the battery.

- **What is the benefit?** The system is designed to provide service for 3 to 4 hours daily and can function for three cloudy days. In addition to lighting, it is also possible to run a fan or a television with the system.

- **What is the lifespan and cost?** The cost of an SHS depends on the load to be supported, the capacity of the PV modules used to meet the load requirement and the capacity of the battery to meet the required autonomy. The indicative costs of the five different SHS models are model I (one 9W CFL) Rs. 6000; model II (two 9W CFLs) Rs. 10,000; model III (one 9W

[22] Anon 2009, Implementation of the 'Solar Lantern Programme' during 2009-10, SPV Group, Ministry of New and Renewable Energy, New Delhi.
[23] http://www.pib.nic.in/release/rel_print_page1.asp?relid=43903

CFL and one fan) Rs. 11,000; model IV (two 9W CFLs and a fan/television) Rs. 18,500; and model V (four 9W CFLs) Rs. 17,500. The indicative costs do not include the cost of the fan/ television as there could be variations due to local taxes, additional transportation costs etc.

- However, the lifespan of the components varies. A typical SPV panel has a reported lifespan of 20 to 25 years, a CFL around battery 2 to 5 years.

- **Government incentives?** The MNRE provides subsidy of Rs. 4,500 to 8,600 for northeast and special areas and Rs. 2,500 to 4,800 for general areas depending on the model.[24] The eligible category of beneficiaries includes all individuals and non-profit institutions or organizations. (Except for beneficiaries from remote un-electrified census villages) No individual would be given more than one system.

Rooftop SPV systems

- **What is rooftop solar photovoltaic (SPV) system?** Rooftop SPV systems can reduce dependency on diesel gensets during load shedding and to utilize the existing roof space of building.

- **How does it work?** A roof top SPV system could be with or without grid interaction. In grid interaction system, the DC power generated from SPV panels is converted to AC power using power conditioning unit and is fed to the grid either of 11 KV three phase line or of 220 V single phase line depending on the system installed at institution/commercial establishment or residential complex. They generate power during the daytime which is utilized fully by powering the captive loads and feeding excess power to the grid as long as grid is available. In cases, where solar power is not sufficient due to cloud cover etc. the captive loads are

[24] http://mnre.gov.in/cfa-schemes-programmes.htm

served by drawing power from the grid. The grid interactive rooftop SPV systems thus work on net metering basis wherein the beneficiary pays to the utility on net meter reading basis only. Ideally, grid interactive systems do not require battery back up as the grid acts as the backup for feeding excess solar power and viceversa. However, to enhance the performance reliability of the overall systems, a minimum battery back of one hour of load capacity is strongly recommended. In grid interactive systems, it has , however to be ensured that in case the grid fails, the solar power has to be fully utilized or stopped immediately feeding to the grid (if any in excess) so as to safeguard any grid person/technician from getting shock (electrocuted) while working on the grid for maintenance etc.

- Non-grid interactive systems ideally require a full load capacity battery power back up system. However, with the introduction of advanced load management and power conditioning systems, and safety mechanisms, it is possible to segregate the day-time loads to be served directly by solar power without necessarily going through the battery back-up. As in the previous case of grid-interactive systems, minimum one hour of battery back-up is, however, strongly recommended for these systems also to enhance the performance reliability of the systems. The non-grid interactive system with minimum battery back are viable only at places where normal power is not available during daytime. In case the SPV power is to be used after sunshine hours, it would require full load capacity battery back up which will increase the cost of system which may not be economically viable even with support from Government.

- **Government scheme and subsidy?** In February 2009, the MNRE has announced a revised scheme on 'Demonstration and Promotion of Solar Photovoltaic Devices/Systems in Urban Areas and Industry' which has major focus on rooftop SPV systems. This scheme pertains to diesel abatement in institutions, government buildings, commercial establishments example malls, hotels, hospitals, nursing homes, industry excluding manufacturers of SPV cells/modules and housing complexes facing huge power shortage during daytime. The scheme has a target of 4.25 MW during rest of the Eleventh Plan.

- The MNRE provides central financial assistance (CFA) for rooftop SPV systems at the rate of Rs. 75 per watt of SPV panels to a maximum of 30 per cent of the cost of the systems to profit making bodies availing depreciation benefits and at the rate of Rs. 100 per watt to a maximum of 40 per cent of the cost of systems to non-profit making bodies (with or without grid interaction) limited to 100 kW capacity mainly for daytime use. Minimum capacity of installation is 25 kW. Smaller systems (not less than 10 kW) may be considered as special case. No targets are set for these systems to state or urban local bodies. Proposals will be considered on first come first served basis through SNAs. Sanction of CFA will be based on the existing diesel consumption level of the establishment.

- **Benefits of the scheme?** The pay pack period is 5 to 6 years. The life is 25 to 30 years. No air and noise pollution. No moving parts and zero maintenance except cleaning of SPV panel once in a while. The beneficiary has to decide supplier on cost and quality competitive basis. List of suppliers is available on the MNRE's website. A 100 kW capacity rooftop system could save around 50,000 litres of diesel per year.

Solar generator

- **What is it?** It is a small capacity, stand alone SPV power system based on a PV array connected to a battery bank of appropriate size and an inverter of 12, 24 or 48 V.

- **What is the benefit?** It is designed to supply power to limited loads such as lights, fans, credit card operating machines and personal computers for a period of two to three hours.

- **What is the life span and cost?** The MNRE promotes four models of solar generators with capacities of 150, 350, 450 and 600 W. These are meant to replace the conventional small capacity petrol based generators that are used during routine load shedding periods in urban areas by shops, clinics and other small establishments. The cost varies from Rs. 3,500 to Rs. 1.45 lakh

Energy efficient appliances: Look for energy label

We use a variety of appliances for our daily needs, most of which consume large amounts of energy. This inflates our electricity bills. It is therefore important for a consumer to look for such appliances which are energy efficient.

In May 2006, the Ministry of Power launched the standards and labelling programme with an objective to provide the consumer an informed choice about energy saving and thereby the cost saving potential of the marketed household and other equipments.[25] There was a need for standards and labelling programme because of wide variation in energy consumption of products, information on energy consumption being often not easily available or easy to understand from the nameplate and leading to continued manufacture and purchase of inefficient equipments and appliances.

Under this programme, the Bureau of Energy Efficiency (BEE) has established comparative star labelling system for indoor appliances like tubular fluorescent lamps, refrigerators (frost free and direct cool), and air conditioners. Other appliances include distribution transformer, induction motors, pump sets, ceiling fans, LPG, electric geysers and colour TV.[26]

More the number of stars, more is the energy efficiency of the appliance. There are six significant benefits from this programme which include providing information on energy use to consumers, enabling consumers to reduce energy bills, reducing capital investment in energy supply infrastructure, strengthening competitive markets, mitigating climate change goals and reducing urban/regional pollution

Refrigerators

- **What is it?** These are one of the highest consumers of electricity. However, they have become significantly efficient in the past few years, and are still improving.

- **What is the life span and cost?** A typical refrigerator has a lifespan of 15 to 20 years. The cost of running it over that time period is several times the initial purchase price. Therefore it is important to buy the most efficient model available. A BEE 5-star rated refrigerator that costs more initially will have lower operation costs because of better construction and insulation, and will pay for itself in less than four years compared to a 2-star refrigerator. Models with top or bottom mounted freezers use 12 per cent less energy than side-by-side designs.

- **Star label**: The BEE has rated 422 models of refrigerators from 13 companies based on their gross volume, storage volume in litres and electricity consumption in units per year. According to the BEE rating, the best refrigerators get a 5 star energy label whereas the ones with lowest performance have got a 2 star label.[27]

[25] http://97.74.87.53:8090/beeLabel/index.jsp
[26] http://97.74.87.53:8090/beeLabel/index.jsp
[27] http://www.bee.gov.in/search_result.php

- The available stars are between a minimum of one and a maximum of five shown in one star interval. The star rating is calculated from the Star Rating Band which is the range of energy efficiency (kWh/year). This is used for determining the number of stars displayed on the energy label.

Air conditioners

- **What is the energy issue?** Air conditioners usually consume the highest energy among all home appliances. Window and split air conditioners (AC) are most commonly used. These are available in different sizes --- 0.75 tonne, 1 tonne, 1.5 tonne, and 2 tonne.

- **What is the benefit of a BEE star label AC?** The energy consumption of an AC depends on its size. Therefore, it is important to select an AC with requirements one have. A 1-tonne AC is appropriate for a 150 sq ft room, while a 2-tonne AC is sufficient for a room, which is 300 sq ft in area.

- The efficiency of an AC affects energy consumption as much as the size of the AC does. The number of stars on the BEE label indicates the efficiency of an AC; the higher the number of stars the more efficient the appliance.

- The BEE has rated 254 models of window and split ACs with high performers getting a 5 star label and 1 star for a worst performer.[28] The labeling is based on the cooling capacity, power consumption and energy efficiency ratio.

- **What is the lifespan and cost?** For instance, a BEE 4-star rated 1.5-tonne AC would consume 194 units of electricity in a month compared to an inefficient AC of the same size that would consume 278 units during the same period. An efficient 1.5-tonne AC would cost about Rs. 16, 500, whereas an ordinary AC would cost about Rs 15, 000. The additional Rs. 1,500 invested on the efficient AC will be recovered in less than six months due to savings in the electricity bill.

Tubular Fluorescent Lamps (TFLs) :

- The BEE has given star labels to 49 TFLs manufactured by various companies. The highest performer has got the 5 star rating and the lowest 2 star.[29]

Ceiling fans

- It is said that fans consume the maximum energy among our electric home appliances. The BEE has specified the labelling requirements for ceiling fans covering 1200 mm sweep. So far various models of 9 brands have been rated. All these have got five star labels.[30]

LPG gas stoves

- The BEE has specified the energy labeling requirements for domestic LPG gas stoves that are being manufactured, imported or sold in India. The energy labeling requirements is based on the thermal efficiency of gas stoves which should not be lesser than 64 per cent. In the star rating index, the minimum thermal efficiency of a burner of a stove (having any number of burners) is taken to decide the thermal efficiency of the stove.

[28] http://www.bee.gov.in/search_result.php
[29] http://www.bee.gov.in/search_result.php
[30] http://97.74.87.53:8090/beeLabel/SearchFANS.page?etype=ET0019&ename=Ceiling%20Fans

Stationary storage type water heaters (electric geysers)

- The BEE has specified the energy labeling requirements for stationary storage type electric water heaters up to a rated capacity of 200 liters being manufactured, imported, or sold in India. The ratings are based on the standing losses per 24 hours. The Standing loss (kwh/24hour/45 degrees centigrade difference) which is the energy consumption of a filled water heater after steady state conditions have been reached when connected to electrical supply when no water is drawn for 24 hours. Starting with 6 litres rated capacity of a water heater followed by 10, 15, 25, 35, 50, 70, 100, 140 and 200 litres, depending on the standing loss per 24 hours, star ratings are given to each category.

Colour Televisions

- A colour television is a commercially available electronic product designed primarily for the display and reception of audiovisual signals from terrestrial, cable, satellite, Internet Protocol TV (IPTV), or other transmission of analog and/or digital signals, consisting of a tuner/receiver and a display encased in a single housing. This product relies upon a cathode ray tube (CRT), liquid crystal display (LCD), plasma display, or other display device. The BEE has rated various models of Videocon and Samsung CRT TVs and Onida LCD.