# Solar Roofs: A huge stride towards sustainable development

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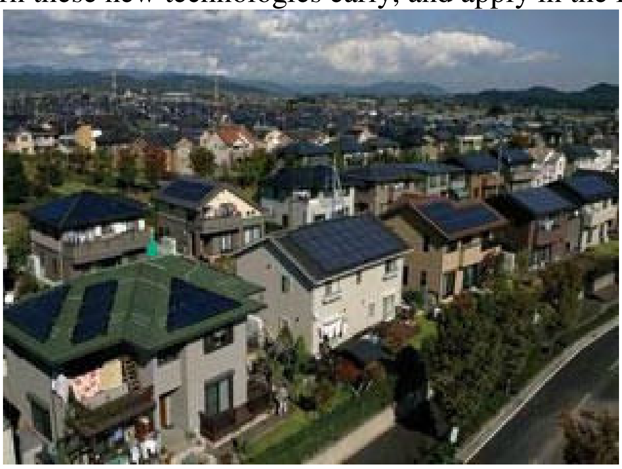
## *Introduction*

Building integrated photo-voltaics (BIPV) have a huge contribution to make towards sustainable development in the future. The advantage for PV solar is the freely available space on roof tops and walls of existing and new buildings, without taking any additional land space. PV panels do not have moving parts, produce any noise and pollute the environment. These small power stations can be connected to the national grid, and feed the energy when all the industries are busy working during the day time. The inverters have been designed and manufactured for this purpose. This accessory has been designed to convert DC power into AC, step up the voltage and feed into the grid. Also the electronic circuitry has been intelligently designed with safety in mind to stop feeding the grid, when the grid power is switched off for maintenance purposes. In addition, two-way electric meters have enable a house-hold to import energy from the grid during night time and feed energy into the grid during the day time, using the roof as a small and clean power station. Millions of such solar roofs are now emerging in Japan, US, Italy and Germany, reaching grid parity in some countries (California & Italy). All sun-rich countries should learn these new technologies early, and apply in the future.



*Solar roofs already well established and grid connected for clean energy generation*

In 2004, the cost of a 3 kW solar roof in Germany was about £18,000. However, after 5 years, this cost has dropped down to about £12,000. This trend will continue in the future due to improvement of solar panel efficiency, mass production and the competitiveness of the market place. Regardless, £12,000 for the roof of an average house in Europe costing about £250,000, is not an unreasonable amount right now. It has a double purpose; roof for the building and an income source producing clean energy for the future. Since this solar roof cost is still very high for the average household in developing countries, rapid take up is not possible until costs are reduced further.

Imagine a sunny country like Sri Lanka with around two million developed homes having 3 kW solar roofs. During the day time, the power production is equivalent to 6 GW (Sri Lanka's total power production today is in the range of 2-4 GW). This should be the long-term strategy of any country in the sun-belt. Also power generation is not concentrated in one place, reducing the risk from any terrorist attacks in the future; hence "PV for Peace".

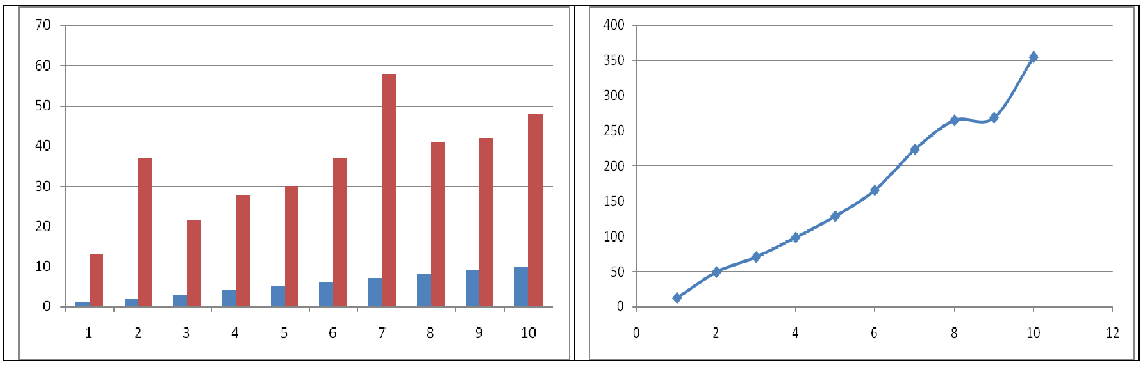
## *Case Study - I: In the United Kingdom*

What about the solar roofs in countries like UK with low level of sunshine? We monitor and regularly report on a solar roof installed in January 2010, in Derbyshire, to learn more about the performance of these systems under real climatic conditions.

*Place:* *Chime Cottage, Heath, Chesterfield, UK*
*Owner:* *Mr Frank Gilliver*
*Total cost:* *£ 15,000*
*Specifications:* *16 poly-silicon solar panels*
*Total maximum power = 2.8 kW*
*Installed and grid connected on 26$^{th}$ January 2010.*

*Proud owner of the solar roof, Frank Gilliver facing the camera with Professor Dharmadasa.*

The amount of weekly electricity units produced in kWh, and the cumulative energy units produced by this system are shown in the following charts as a function of time in weeks. The aim is to monitor this real situation and see how it performs in the north of England.



*Weekly electricity units (in kWh) and cumulative units produced as a function of week number, from the day of installation (26th January 2010)*

No doubt in the UK, the pay-back period will be long, but there are many people who care about the environment and clean energy production, more than just economics. UK Government has introduced £2,500 grant for such systems and 41.3p tariff for solar electricity unit from 1st April 2010 to encourage and accelerate clean energy production process. These positive steps will encourage the rapid market penetration of these most needed new technologies.

## *Case Study - II: In Sri Lanka*

There are over 150,000 solar home systems operating today in Sri Lanka to provide lighting and power for TV, in rural homes where there is no access to the National grid. While these systems are powered by ~50 W solar panels, three larger solar roofs (25 kW each) have also installed in Sri Lanka's capitol city of Colombo. The oldest system was installed on Worldview building and two more systems were installed on Nikini and Hydramani buildings. The total installation was handled by local engineers using reputed brands used in the renewable energy industry. Following are some information about one of these systems installed about 2 years ago.


*The array of solar panels on the Nikini building rooftop*

*Place: Colombo - Sri Lanka*
*Owner: Nikini Automation Systems Ltd*
*Total cost: Rs 28,000,000 (~ £150,000)*
*Specifications:*
*Solar panels: 140 poly-silicon solar panels (Total area of 220 square meters)*
*Power: Maximum power output, 25 kW*
*Energy delivery: 125 kWh per day (105 kWh per day on average)*
*Grid tie inverters: SMA 3 Phase inverters with battery charging capability*
*Battery bank: To provide power of 25 kW for 2 Hours*
*Battery capacity: 490 Ah at 48 V*


*The Nikini building powered by a solar roof connected to the National Grid*

Its' energy production since August 2008 has been over 70,000 kWh. A realistic fact that does embed Nikini's achievement firmly in the real world is it's carbon saving. Since August 2008, their zero-energy building has prevented over 50,000 kg of $CO_2$ emissions by its reliance on solar power – to put it into perspective, that's enough to drive a car over a distance of 245,000 km.

This system is slightly different from a standard grid tied renewable energy systems we find in the UK. The solar panels are used to charge a deep cycle battery bank of 25 kW, which could power the whole building for two or more hours. The capacity of the battery bank is 490 Ah at 48 V. In case of a main grid failure, the intelligent control system will prevent any power going out of the building (anti-islanding), but instantly powers the equipment inside the building without any significant switch over time. Hence the building doesn't need a backup UPS (Uninterrupted Power Supply) system even for sophisticated servers and computers. The intelligent control system which controls all the electrical equipment will switch off the unnecessary loads in case of a grid failure, reducing the load on the backup battery bank. The system has been designed mainly to safeguard expensive equipments from frequent power disruptions experienced in the country.

The grid tie inverters are capable of maximum power tracking with varying panel temperatures and solar insolation levels. Also they are combined with Siemens based control systems connecting the whole installation to a central SCADA (Supervisory Control and Data Acquisition) system. Even the rain water which falls on to the solar panels are collected in an intelligent manner, so the initial rainfall which collects lot of dust will be diverted out of the collection tanks.

Also, another very important requirement for a solar roof in a tropical country such as Sri Lanka is an excellent lightning protection system (LPS). The LPS used in this installation is a special lightning arrestor known as an Early Streamer whose sensors identify if the cloud has negative ions for instance and then spray positive ions to neutralise it, thereby preventing a lightning strike. With all these sophisticated control systems in place, Nikini rooftop system continues to add renewable energy into the Sri Lankan grid, reducing the carbon footprint of this green & lush island. During the past 6 years, solar roofs with 25 kW capacities were installed in Colombo. With the experience gained by these comparatively small projects, larger solar farms in the range (500 - 1000 kW) have been planned for installation in Sri Lanka.

***Summary***

The PV technology situation is advancing very rapidly. The cost of solar panels with conventional silicon technology has gone down from ~20 $/W in 1970 to the present range of 2-4 $/W. This is a tremendous achievement with silicon technology, but further reduction is challenging due to cost of silicon material and saturation of the light to electricity conversion efficiency. However, thin film solar technology based on cadmium telluride has brought this figure down to ~1 $/W in 2009. This will drastically cut down the cost of solar panels, the most expensive part in these systems, accelerating the installation of solar roofs round the globe. At this early introduction stage, the rapid take up of BIPV, and solar farms will depend on Governments' right policies and the contributions from positive thinkers like Mr Frank Gilliver.

**Authors:**

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