

## An Innovative Solution for Roof Top Solar Systems Using DC Appliances & Smart Nano/Micro Grid

### **The Present Solution:**

- ★ Consists of Solar Panels, Battery with Charge Controller & Inverter for converting the DC from panels to 230V, 50 Hz AC for running the appliances.
- ★ Mostly addresses the lights and small fans.
- ★ Running bigger motorised appliances like Refrigerator, Air Conditioner, Mixer Blender, Wet Grinder and Pumps is very difficult because:
  - ★ The high starting inrush current of the motors.
  - ★ Comparatively poor efficiency of the present day appliances, which are mostly run by 1 Phase AC induction motors.
  - ★ Higher battery and inverter rating required to cater to the starting currents of the motor.
- ★ Consequent high cost of the system due to the combination of the above make the widespread deployment very unlikely.
- ★ Roof Top area for the panels as well as the floor area required for inverter and batteries is also very large.

### **The New Solution:**

- ★ Use of Permanent Magnet Brushless DC or Synchronous motors with increased efficiency due to:
  - ★ Complete elimination of a winding for production of magnetic field by the use of permanent magnets.
  - ★ Elimination of Carbon brushes and related parts resulting in complete elimination of friction losses, while improving reliability.
- ★ As the new motors are of variable speed type, the power/energy consumption is greatly reduced if the load demands are reduced.
- ★ The power/energy savings of different appliances are as under:
  - ★ Air Conditioner: at least 50%
  - ★ Refrigerator & Deep Freezer: at least 60%
  - ★ Pumps: at least 40%
  - ★ Ceiling Fan: at least 50%
  - ★ LED lights: at least 55%
- ★ All the new motors have soft starting, i.e., the inrush starting current is totally eliminated.
- ★ All the new appliances are DC type running directly from PV panels
  - ★ No inverter is required
  - ★ Battery is normally not needed, except for back up requirements - can be given as an optional extra.
- ★ The system uses the proposed 380 V DC. The rectified AC is also compatible.
- ★ The appliances can also run from AC grid power by using a AC-DC converter, which rectifies the AC to DC.
- ★ Due to the combined effect of the above the solar panel rating is reduced by a factor of at least 60%
- ★ The home/office will run on the following priorities:
  - ★ Use solar energy as far as possible.

- ★ In case the solar power is not sufficient due to bad light, it will use the available power and the balance is taken from the AC mains
- ★ In case of total absence of solar power, the appliances will run automatically from AC mains
- ★ In the absence of both solar and AC mains power, the system will run from battery if back up is available.
  
- ★ A smart grid controller takes care of the power and load monitoring and automatic enabling use of power from PV panels, battery or AC grid.
- ★ When the load demand is less than the power generated, the excess power can be fed back to the power grid through a grid tie inverter.
- ★ The AC and DC circuitry in both grid tie inverter and AC - DC converter are galvanically isolated.
- ★ MPPT (Maximum power point tracking) is incorporated in the AC-DC converter so that at any point of time, the power available in the PV panel is used.
- ★ Other sources of renewable energy can be used concurrently like roof top micro wind, PICO Hydel, Bio mass/gas driven generation, etc., Depending on the terrain and location.
- ★ Thus the building will not use grid power at all when sunshine or renewable power is available.
- ★ During night times grid power will be used with the following advantages:
  - ★ The power requirement & consequently the power bill will be halved
  - ★ The power factor will be near unity. This is a great boon for the electricity board and enables a possible increase of connected load by 25% from the same distribution transformers.
  - ★ The new appliances will work on a wide range of input supply voltage in both DC and AC.
  - ★ In case grid power is not available Battery storage is possible. The battery will be charged by solar panels. The battery capacity is reduced by about 60% due to the improved efficiency and absence of starting current.

### **Readiness of the Solution:**

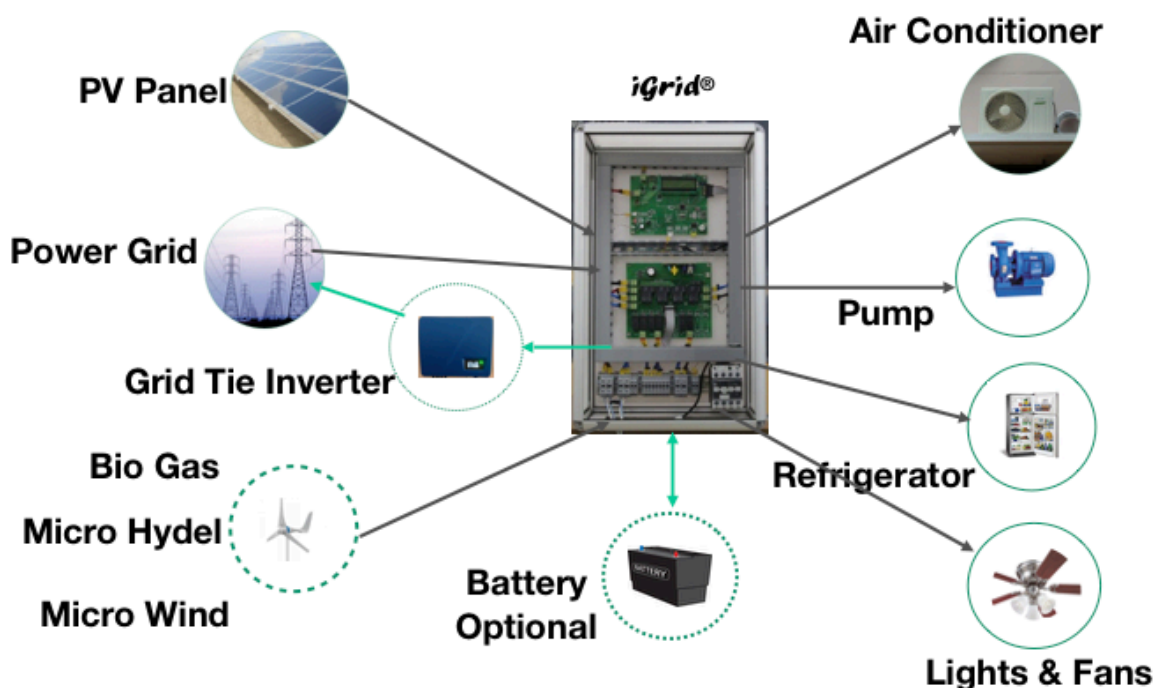
- ★ The solution is already deployed in a many homes & offices in Tamilnadu.
- ★ The following appliances are available:
  - ★ 1 & 1.5 Ton Air conditioners - cooling only and cooling & heating models.
  - ★ 50, 180 & 300 Litre Refrigerators
  - ★ 250 & 350 L Deep Freezer
  - ★ 1150 mm Sweep Ceiling Fan
  - ★ A range of LED lights including Bulbs, Tubes, Panel lights, street lights and spot/focus lights.
  - ★ RO water purification system with solar operated pumps for water extraction, pumping and RO filter
  - ★ Electric Cycle with Lithium battery
- ★ Existing wiring of the building has been used with minor changes.
- ★ The solution can be customised to individual needs of the home/office subject to a minimum size of 300 W.
- ★ Continuous power & energy monitoring of both DC and AC power is being done through smart meters.
- ★ The solution has been tested thoroughly in the laboratory and in the field.

## Smart Micro Grid for A Cluster of Houses - Electricity Access in Remote Areas:

The solution is also equally applicable to rural and remote areas, either as an off-grid or on-grid system. A cluster of low income group dwellings can be clubbed together to form a micro grid and very small loads like, say 1 Fan, 2 Lights and One plug point for TV/Mobile Charging can be given. If the grid is not available, it can be configured purely as an off-grid system with battery backup. Or else if the grid is available, it can also be used, with relatively lower backup time to provide for any power outages. Even in the case of a complete off-grid system, it can be connected to grid as and when the grid becomes available.

In addition to lighting and fan, the community can be provided with Air Con, Refrigerator, Deep Freezer, Lights & Fans for the primary health centre. Solar operated DC pumps are provided for water pumping and purification. This mostly operates in day time only. Pumps can also be used for agriculture. Cold storage solutions for value addition in agriculture can be provided.

Mobile Chargers, TVs & Set Top boxes can also be provided for education and entertainment. They operated directly from DC. Electric Cycles and Three wheeler rickshaws are also available for local transportation and connectivity to nearest towns. They are charged from solar panels. The schematic of the solution is given below:



Thus a holistic and comprehensive electricity access is enabled for rural and remote communities with limited or no access to electricity. The basic needs of Water, Sanitation, Basic Electricity needs, cold storage, education & entertainment, Healthcare and Green transportation is possible with a DC system. This can also interface with the AC power grid as and when it is made available at the site.

### **Range of Appliances:**

#### **Air Conditioners:**

Split Type Room Air Conditioners (Cooling & Heating): 3500 W (1 TR), 5250 W (1.5 TR), 7000 W (2 TR)

Packaged Air Conditioners (Duct type): 10500 W (3 TR), 14000 W (4 TR), 17500 W (5TR), 26250 W (7.5 TR), 35000 W (10 TR) - These are under development and will be introduced soon

**Refrigerators:** 50, 180 & 300 Litre models (600 Litre can be done for quantities)

**Deep Freezers:** 180, 250, 350 & 550 Litre models ( up to - 24<sup>o</sup> C)

**Milk Chillers:** 350 & 550 Litre models (2 ~ 5<sup>o</sup> C)

**Ceiling Fan:** 1150 mm sweep

**LED Lights:** A range of LED lights like Bulbs, Tube Lights, Panel Lights, Spot Lights, Focus Lights, Garden Lights & Street Lights can be given.

**Water Pumps:** A range of pumps in the range 0.37 kW ~ 5.5 kW for the following uses:

1. Water lifting
2. High Pressure pumps for water purification
3. Booster pumps for buildings

These pumps are under development through a project funded by UNIDO & GEF under FLCTD (Facility for Low Carbon Technology Deployment) and will be introduced in the market soon.