TECHNOLOGY FACTSHEET

DC MOTOR/ ALTERNATOR BASED INVERTER FOR GRID CONNECTED SOLAR PV SYSTEMS[1]

1. **Sector:** Energy Supply

2. **Introduction**:

A serious obstacle encountered by the developers of grid-connected solar PV system is the high capital cost of such system. A grid connected solar PV system has the following two major components: (a) Solar PV Module; (b) Inverter and grid interconnector. This cost of the first component varies from about US$ 2 to US$ 4 per peak Watt output of the panel. The price of this first component has been gradually declining over the past many years. The cost of the second component also varies from about US$ 2 to US$ 4 per Watt. The price of this second component is remaining at around the above mentioned values in the recent past.

The traditional inverter / grid-interconnector deploy the solid state electronic technology. An alternative to this traditional technology is to make use of a D C (brushless) motor and a conventional rotating A C Alternator. The cost of this alternative technology is much lower than the solid state based inverter – grid interconnector.

3. **Technology Name**: DC Motor/ Alternator Based Inverter For Grid Connected Solar PV Systems

4. **Technology Characteristics: (Feasibility of technology and operational necessities)**

Feasibility of Technology

This technology deploys to integrate some of the well developed and commercialized components to resolve the high cost of conventional solid state inverter to link solar PV modules to national electricity grids.

The first component used in this technology is a Brushless D C Motor. This component is deployed in electric vehicles. This component operates at reasonable efficiency and little maintenance. This component is widely used in the electric vehicles and in industrial drives. This component could be easily procured in the open market.

The second component is a conventional AC Induction Generator and Grid Interconnector. This component is widely used in the renewable energy sector to interconnect renewable energy based electricity generation systems to national AC electricity grid. This is common in small

[1] **This fact sheet has been extracted from TNA Report – Mitigation for Sri Lanka. You can access the complete report from the TNA project website** http://tech-action.org/

hydropower, wind power and biomass based systems. This component too could be easily procured from reputed manufactures in the open market.

Operational Necessity

The high cost of solid state based inverter technology has impeded the application of Solar PV technology to generate electricity in a distributed manner and feeding the national electricity grid. An alternative system which is significantly lower in cost would enable many renewable energy developers.

5. Country Specific Applicability:

5.1 Electrical Energy Supply Sector

The data provided by the Sri Lanka Sustainable Energy Authority (SEA) in their web: www.energy.gov.lk show that the present the national peak electricity demand is 2033 MW (28th September 2011) and the corresponding daily electrical energy consumption is 33.35 GWh/ day. The same data published during this year (2011) also show that the annual electricity peak demand growth is growing at about 400 MW per year and the daily electrical energy demand is growing at around 8 GWh/day/year.

In order to meet the above mentioned growth, the Ceylon Electricity Board (CEB), the sole utility responsible for the generation and distributing most of the electricity generated to the final consumers have been annually preparing and releasing their Long Term Generation Plan (LTGP). According to the last published LTGP, most of the future generation of electricity would be generated from coal based power plants as shown in figure 2.

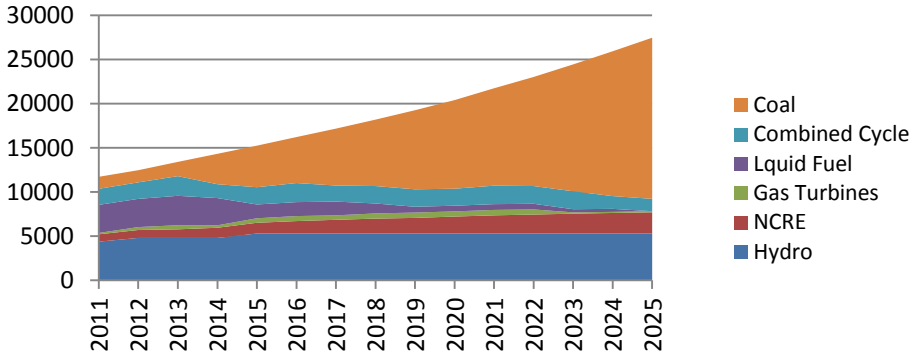

Figure 2: Annual Energy Generation (GWh/y)

In fact as per the above plan, EB has already commissioned and operating a 300 MW coal based power plant. The second phase of coal based power plant with a capacity of 2x300MW is under construction. Action has been initiated to construct another 2 x 500 MW coal based power plant in the country.

While the state owned utility CEB is planning to commission as many coal based power plants as necessary to meet the growing demand for electricity, the Ministry of Power and Energy, through the SEA is encouraging the private investors to develop renewable energy based power plants. In an attempt to generate at least 10% of the electrical energy requirements by the 2015, the SEA has offered an incentive scheme for the private sector to harness renewable energy resources and generate electrical energy and feed the national grid. A concessionary tariff based on the estimated cost of generation has been offered for each of the following technologies:

- Small Hydro: Rs. 13.04 / kWh
- Wind: Rs. 19.43 / kWh
- Biomass: Rs. 20.77 / kWh
- Agro/Industrial Waste: Rs. 14.60 / kWh
- Municipal Waste: Rs. 19.73 / kWh
- Other (Solar PV, Solar Thermal, Wave etc.): Rs. 20.77 / kWh

For a solar PV system with an annual load factor of 20% to generate and feed electricity to the grid within a tariff of Rs. 20.77 / kWh, the total capital cost of the system including the inverter/ grid interconnection equipment should not exceed Rs. 224 / kW (peak). The solar PV module price, excluding storage batteries and inverters, is reaching US$ 1 to 2/ kWp. There is very likely that this barrier of solar PV module price crossing the US$ 2 per peak Watt would be reached in the near future.

In order for solar PV systems to be commercially used for grid connected electricity generation, the total cost of such a system including the inverter and grid connection should not exceed US $ 2 per peak watt. Hence it is essential that the cost of inverter/ interconnection component should be as low as possible.

If the above target is reached, solar PV based systems would be able to enter the grid-connected renewable energy market in Sri Lanka.

6. Status of the technology in the country and its future market potential:

6.1 Status of Technology in Sri Lanka

The technologies to be used in this proposal are not available at present in Sri Lanka. Through the TNA Project it is proposed to obtain these technologies from appropriate countries.

6.2 Future Market Potential

The Long Term Generation Plan of the Ceylon Electricity Board depends heavily on fossil fuels to meet the future demand for electricity. According to this plan, by the year 2025, as much as 20,000 GWh of the 27,000 GWh per annum is expected to be produced from fossil fuels, mostly

from coal. Solar PV is planned to make any significant contribution. However, if solar PV technology is made available so as to make the cost of generation of such energy competitive, then it is likely that solar PV could make a significant impact. If the proposed technology is introduced at least 5% of the 2000 GWh per annum could be met through this technology.

7. Barriers: -

8. Benefits: (How the technology could contribute to socio-economic development and environmental protection)

8.1 Social Benefits

- Employment opportunities to skilled and semiskilled workforce in the country.

8.2 Economic Benefits

- Increase in the amount of electricity generated from renewable and indigenous energy resources based power plants.
- Decrease in the amount of electricity generated imported fossil fuel based power plants.

8.3 Environmental Benefits

To estimate the mitigation impact of this technology, it is assumed that without the introduction of this technology, the capital cost of conventional solid state driven inverter based grid connected solar PV systems would not be financially viable. It is assumed that with the introduction of this technology, the grid connected solar PV technology would be able to cross the threshold and the grid connected solar PV technology would become viable. The unit size of the technology is assumed to be a 100 kW system. The annual plant factor for a solar PV system in Sri Lanka has been found to be 20%. Hence the annual energy output of this unit would be: 100 x 8760 x .2 = 175.2 MWh/y. With the national Grid Emission Factor of 0.76 tCO2/ MWh, the emission reduction would be: 175.2 x .76 = 133 tCO2/y/100 kW module.

Assuming 100 MW of Solar PV based system would be commissioned in the short term, the annual national mitigation benefit would be: 133,000 tCO2/y.

The capital cost of implementing this project is taken as 0.5 $ per peak watt. A 1-watt system would deliver: 1 x 8760 x 0.2 /1000 kWh per year = 1.752 kWh = 1.752 /10^6 GWh = (1.752/10^6) x 240 toe. = 0.00042048 toe. Hence to generate 1toe the capacity required = 1/.00042048 = 2378 watts. Hence the cost of implementing the project = 2378 x 0.5 x 112 = Rs. 133168 .

- Less local pollution(NOX and SOX) resulting from the reduction of fossil fuel based electricity generation.

9. Operations: -

10. Costs

The estimated total cost of the proposed inverter/ grid-connection equipment is expected to cost 0.2 $ per peak Watt. To achieve a 5% target (of 20,000 GWh/y) by the year 2025, a total 600 MW of solar PV is needed. This would cost US $120 million for this component of the technology.

11. References

(1) Standardized Power Purchase Tariff, 2011. Sri Lanka sustainable Energy Authority.
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(9) Mr. N.K.Gunewardene, ElectroServ (Pvt) Ltd., Sri Lanka.