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# Modelling & simulation studies of harvesting solar energy system

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**Abstract**

The paper discusses results of modelling and simulation studies undertaken on harvesting solar energy. Affordable and sustainable energy may force any nation's ability to advance economically and socially. India as a developing nation foresees its bright prospects towards rapid industrialization and urbanization, which is further enhancing scope for application of new methods in search of continuously raising energy generating capacity. Due to industrialization and urbanization, India's need for more and more energy is continuously increasing. Renewable sources of cleaner energy seem to have a viable option in recent years in India.

**Keywords:** Renewable energy, sustainable energy, industrialization, micro-grid

## Introduction

Undoubtedly, India's fossil fuel-based power generation is a major source of electricity today. However, the enormous amounts of pollutants gases and heavy metals that are emitted from the stack of these conventional power generators add poisonous and toxic gases in a very significant manner causing number of human deaths every year. Hybrid alternative being thought of owing to mixing of different renewable energy sources with energy storage technology is fast emerging strategic solution addressing to useful choice for overcoming power uncertainties. And, this appears to be reliable and cost effective.

The micro-grid [1] approach enabling storage battery (energy store-house) technology helps lower the operational cost of the power distribution network. Thus, the combination of full-fledged solar energy unit and energy storage technologies improves rural energy access, which ultimately spurs economic growth globally. 24x7 power for all is a programme that the Indian government has already initiated. India's demographics position as a tropical nation with good radiation intensity and excellent solar energy potential. Renewable energy source will give a sustainable solution to meet India's energy needs. The best option for the development of India is a green energy source. Some of the critical features already studied by Kumar [2] are as follows:

1. Micro Grid has potential to supply electricity in sparse and remote locations utilizing nature's gift (so called solar energy).
2. This is affordable and sustainable with reliability of 99.70% or more.
3. If interconnected with national or regional grid it offers flexibility of import or export of power flow with reliability increased to 99.99%.

A micro-grid (MG) is generally considered as a small network of electricity users. It is advantageous because of its low cost and the conveniences it offers in terms of flexibility and ease of operation / control. The building block of simple MG consists of low voltage power generating units, storage devices and multiple loads. It may or may not be connected to the larger regional/national grid. A simplified model layout prescribed by Kumar [3] has been taken in this paper reliability analysis with economic aspects. The economic viability has been the focus of our study reported in the paper.

## Model layout for study

Figure 1 shows a schematic view of a local area micro-grid network depicting micro-grid operation with or without interfacing with the regional or national grid. It may be noted here that during sudden power outages conditions MG offers a viable solution to redistribute energy. The MG is

quite capable of isolating itself via a utility branch circuit, co-ordinating with the standby unit(s) available as storehouse in the system. The presence of standby unit(s) shall absorb the sudden changes in load (increment or decrement). To encourage the local area as well as sparse location industrial plants and/or manufacturing plants, this scheme is very reliable; and thus, recommended by the authors for its adaptability to improve productivity and profitability of farmers and entrepreneurs. Besides, the MG can sense the load perturbations owing to fault conditions prevalent on the grid system, and thus, is capable of automatically decouple the faulty zone out of the grid, and going into "island mode" of operation.

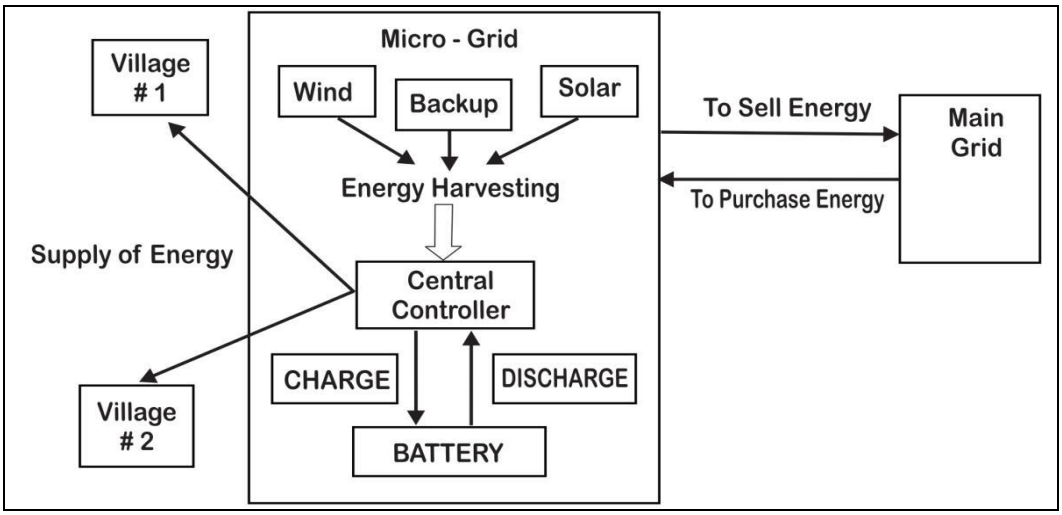


**Fig 1:** Local area micro-grid network for harvesting solar energy – a schematic view

**The reliability calculation:** The 4-unit reliability diagram shown in Figure 2 is considered to represent interface of micro-grid and main-grid, the overall reliability of system success is depicted in Table 1.

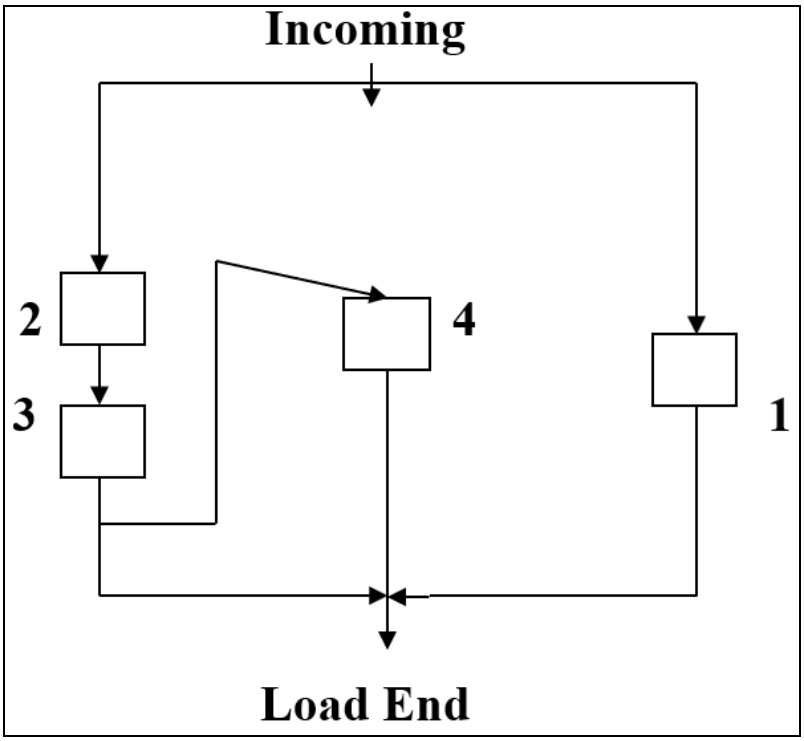


**Fig 2:** Reliability block digram of interface of micro-grid and main-grid

**Table 1:** Overall system reliability ($R_{SS}$)

| Component | Failure Rate, $\lambda$ | Reliability, $R_i$ | Overall $R_{SS}$ |
|---|---|---|---|
| 1: Main Grid | 0.20 f/yr | 0.99 | 1. When Battery is good, $R_{SS}$ = near 1.0.<br>2. When MG is functional with main Grid, $R_{SS}$ = 0.999 |
| 2: Solar Power | 0.10 f/yr | 0.999999 | |
| 3: Controller | 0.15 f/yr | 0.999 | |
| 4: Battery | 0.001 f/yr | 0.999999 | |

## Conclusion

The risk factor is assessed in the paper in terms of the study of reliability of system success ($R_{SS}$). When $R_{SS}$ is nearer to 1.0, the risk is almost negligible. Further the $R_{SS} \geq 0.99$ is very impressive. In both the conditions in column #4 of Table 1, the risk is quite under control. And, the system is quite successful based on studies reported in the paper.

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