Abstract Submitted for IERE 2003 Conference; SESSION 2: Centralized versus Dispersed Power Generation

Enhancing the Economics of Photovoltaic Power Generation with Innovative Direct Current Applications

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Abstract

Photovoltaic Direct Current (PV-dc) applications are those that use the dc energy directly from the solar cells to power loads; in other words, there is no intermediate step of converting the dc power to 60-Hz sine-wave alternating-current (ac) power. Since photovoltaic cells output dc energy, using it in that form, in principle, requires the least interface equipment and can obtain the highest efficiency. There are already a variety of PV-dc applications widely used today including sign lighting, telecommunications equipment, water pumping, instrumentation, off-grid residences, and other loads. Therefore, the idea of using the dc energy from the solar array without conversion to ac is not a truly new idea. The aspect of this paper that is innovative, however, is that the dc applications discussed in this paper are not typical remote loads where dc clearly could be suitable, but instead the loads are at sites that already have a connection to the ac power distribution system and are normally powered with ac. At sites that already have ac power, the traditional approach in deploying PV systems has been to use an inverter to convert the PV module power into ac power and interconnect with the ac power system.

A common assumption is that loads in typical buildings operate only with ac power since this is traditionally the type of power employed. However, many loads can operate with dc power and some are even better suited for dc than ac. In fact, many loads internally convert the ac power they receive into dc for utilization. Examples of loads that can be suitable for dc include adjustable speed motor drives, lighting technologies, resistive heating elements, and electronic switch-mode power supplies found in various office equipment.

In the case of a typical adjustable speed drive (ASD), the ASD unit takes standard utility-supplied 60 Hz power, converts it to dc, and then uses an inverter to convert the dc into variable-frequency ac to power a synchronous or induction motor. By varying the frequency of ac with the inverter, it is possible to adjust the speed of the motor. ASD units are in widespread operation today; they can be found in large industrial applications, some air-conditioning compressors, machine tools, pumps, fans and other mechanical devices.

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This paper investigates the technical and economic criteria for direct dc application of PV for adjustable speed drives (ASDs) for motors. ASD driven motors are increasingly being used in a lot of applications and then inherent AC-DC conversion within an ASD makes it an ideal choice for direct integration of PV. The paper will review basic design considerations and economics related to different design options including:

- Integration to ASD DC bus using a DC-DC converter.
- Direct integration to ASD DC Bus through modification of ASD rectifier circuit.

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