Nighttime Tare Loss Cost Analysis

Xantrex Technology Model PV45208, PV100208 and PV225208 Photovoltaic Inverter Systems

Prepared by BEW Engineering, Inc.
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Michael R. Behnke, P.E.
Dr. William L. Erdman
Charles M. Whitaker, P.E.

Purpose

The purpose of this document is to provide guidance in estimating energy costs associated with nighttime tare losses incurred by a subset of the Xantrex Technology PV Series inverter product line.

Scope

The scope of this document is limited to Xantrex's PV45208, PV100208 and PV225208 grid connect photovoltaic inverter systems, including the manufacturer-specified isolation transformers for application at 208 and 480VAC. Other inverter models and transformer configurations are not considered, however, a similar analysis would follow for the balance of inverter systems that comprise the PV Series.

Background

For applications of the Xantrex PV Series that do not utilize a nighttime disconnect means, tare losses are incurred that result in energy consumption from the utility. These tare losses are the result of two parasitic loads on the system: 1) the control electronics of the inverter, and 2) magnetization of the core of the inverter's isolation transformer. Though tare losses in the isolation transformer are, by far, the dominant parasitic load, both are accounted for in the following analysis.

The transformer magnetizing current consists of two components. The first component establishes magnetic flux in the core of the transformer, through which energy is coupled from the primary to the secondary winding. This flux producing component of current simply charges and discharges the magnetic field within the core every AC line cycle, with no net consumption or delivery of energy from the utility. While current must flow in the primary winding to establish this magnetic flux, it is purely reactive, and will not cause a kilowatt-hour meter to register energy consumption. The second component of the transformer magnetizing current arises from eddy currents that circulate in the core material, as well as hysteresis in the magnetization curve of this material. This component of current is active, and these eddy current and hysteresis losses do result in energy consumption that will register on a kilowatt-hour meter. These parasitic loads are present anytime the transformer is energized from an AC source, and are essentially independent of the load on the transformer.

Test Data

Tare loss tests were performed on 12/11/03 on the three subject inverter types with isolation transformers designed for 208 and 480 VAC interconnection voltages. Test equipment included a Yokagawa Model WT1600/760101 three-phase power analyzer and AEMC Model SR704 AC current probes. The power analyzer was connected on the utility side of the isolation transformer, and the inverter was maintained in an idle state with its control electronics energized and active. Total tare losses (transformer and inverter control) were as follows:

Inverter Model	Transformer Rating	Transformer Ratio	Xantrex Transformer Part #	Total Tare Losses (kW)
PV45208	45 kVA	480:208	1-151717-02	0.55
PV45208	45 kVA	208:208	1-151717-01	0.54
PV100208	100 kVA	480:208	1-151708-02	1.02
PV100208	100 kVA	208:208	1-151708-01	1.09
PV225208	225 kVA	480:208	1-151812-02	1.36
PV225208	225 kVA	208:208	1-151812-01	1.34

Table 1. Tare Losses for Inverter/Transformer Configurations Considered

Tare Loss Costs

Nighttime tare loss costs may be reasonably estimated by multiplying the total tare loss by the expected nightly idle duration and by the utility energy billing rate. Tare losses (in kW) will be a constant number as determined by the inverter and transformer configuration (refer to Table 1, above). The nightly idle duration will vary by season and by array orientation. Monthly nighttime tare loss costs for each of the inverter/transformer configurations of Table 1 are plotted as a function of utility billing rate (over a range of $0.05/kWh through $0.16/kWh) in Figures 1 through 6, below.

As an example, in Figure 1, consider a PV45208 inverter with a 480V interconnection voltage. The system will be net metered, and the utility billing rate is $0.12/kWh. During a month where 13 hours of nightly idle time is expected of the PV system, the tare loss energy cost will be approximately $25.50. For comparison purposes, the revenue produced a 45 kW system during an average month in inland southern California[1] would be $894.24 at this rate.

1 Based on 23% capacity factor, reference: CEC Handbook, "Buying a Solar Photovoltaic System, A Consumer Guide", 2003 Edition.

Finally, the time value of these tare losses is considered in Figure 7. For a given discount rate and amortization period, the present worth factor may be determined on the left axis of this figure. The monthly nighttime tare loss multiplied by this present worth factor provides the present worth of the nighttime tare losses over the amortization period.

For the previous example, if the system is amortized over ten years (120 months) at a 12% discount rate, the present worth factor is 68. The present value of these tare losses over a ten year period is 68 times $25.50, or $1,734.

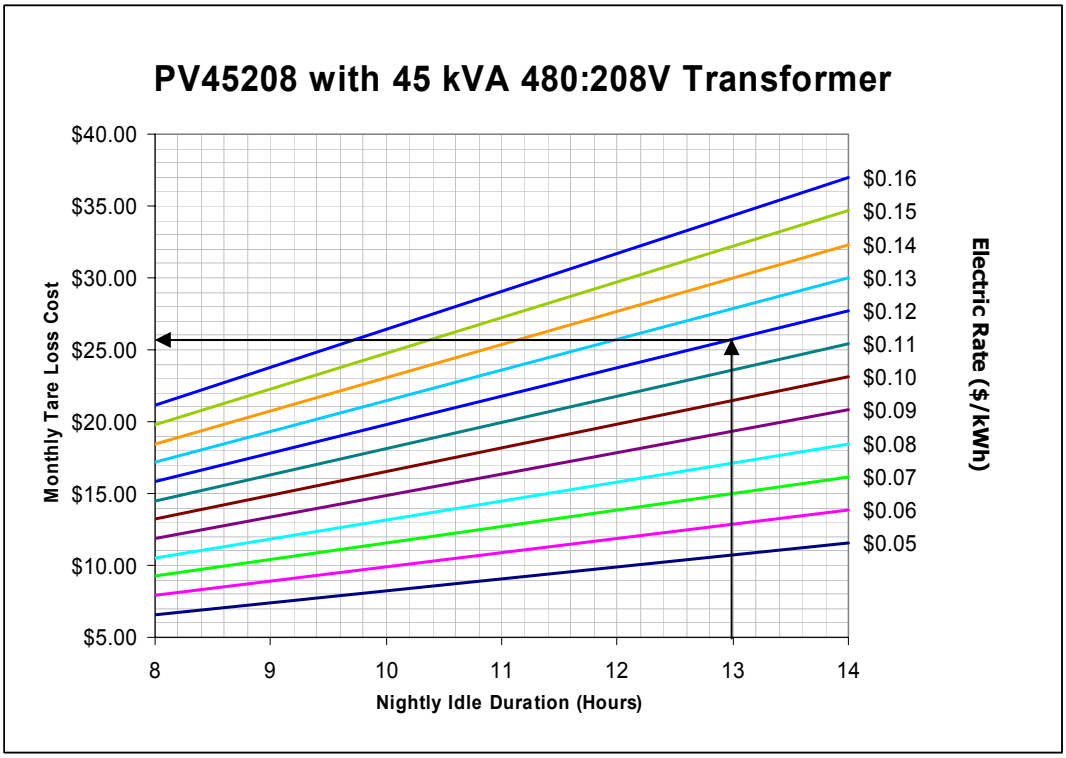

Figure 1. PV45208 Inverter System, 480VAC Interconnection Voltage

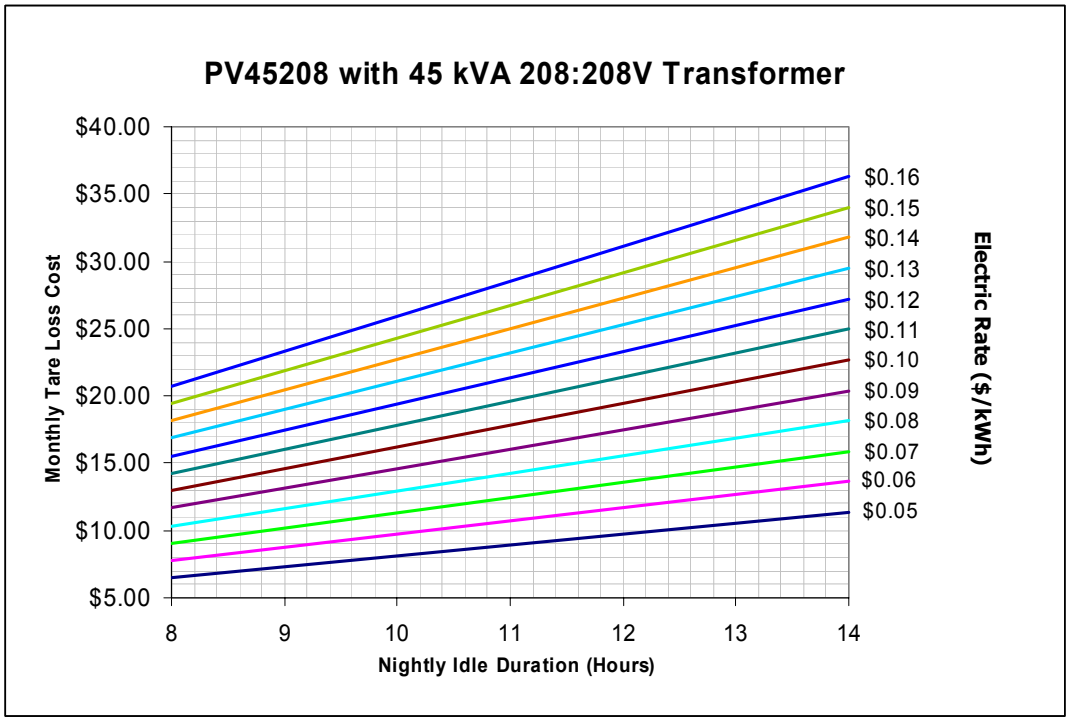

Figure 2. PV45208 Inverter System, 208VAC Interconnection Voltage

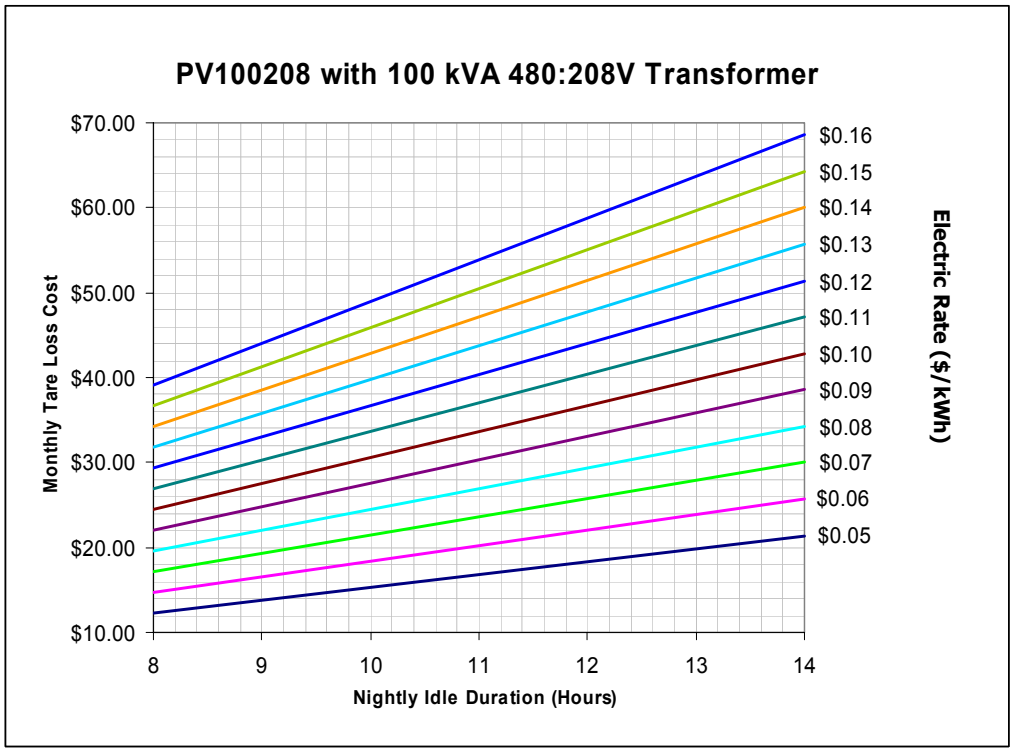

Figure 3. PV100208 Inverter System, 480VAC Interconnection Voltage

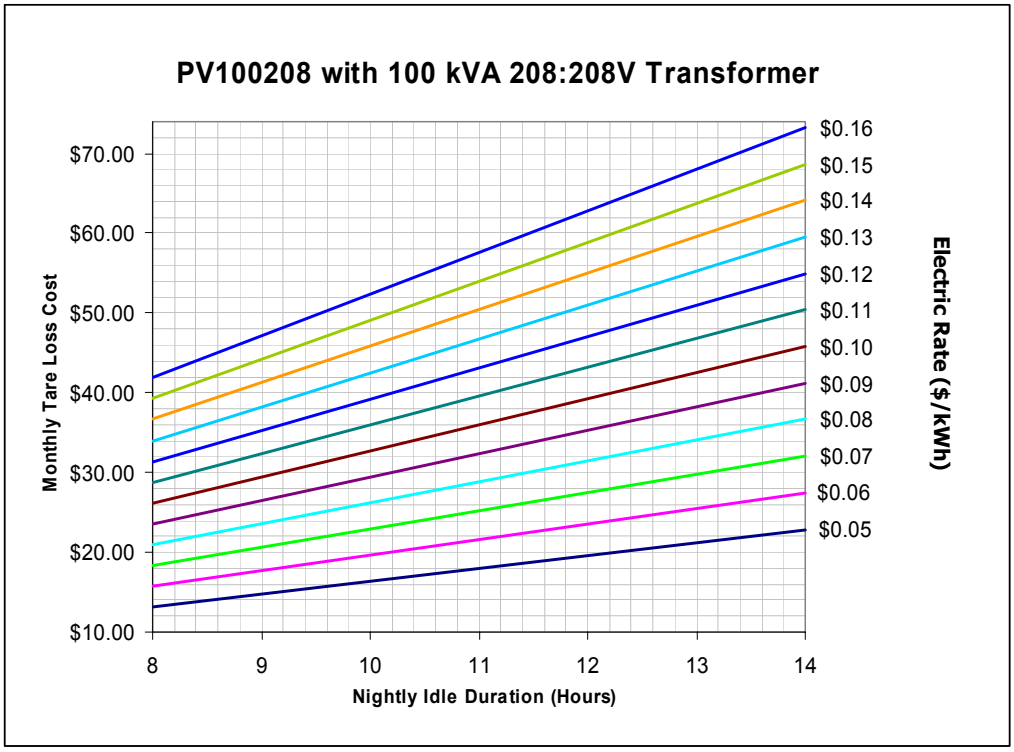

Figure 4. PV100208 Inverter System, 208VAC Interconnection Voltage

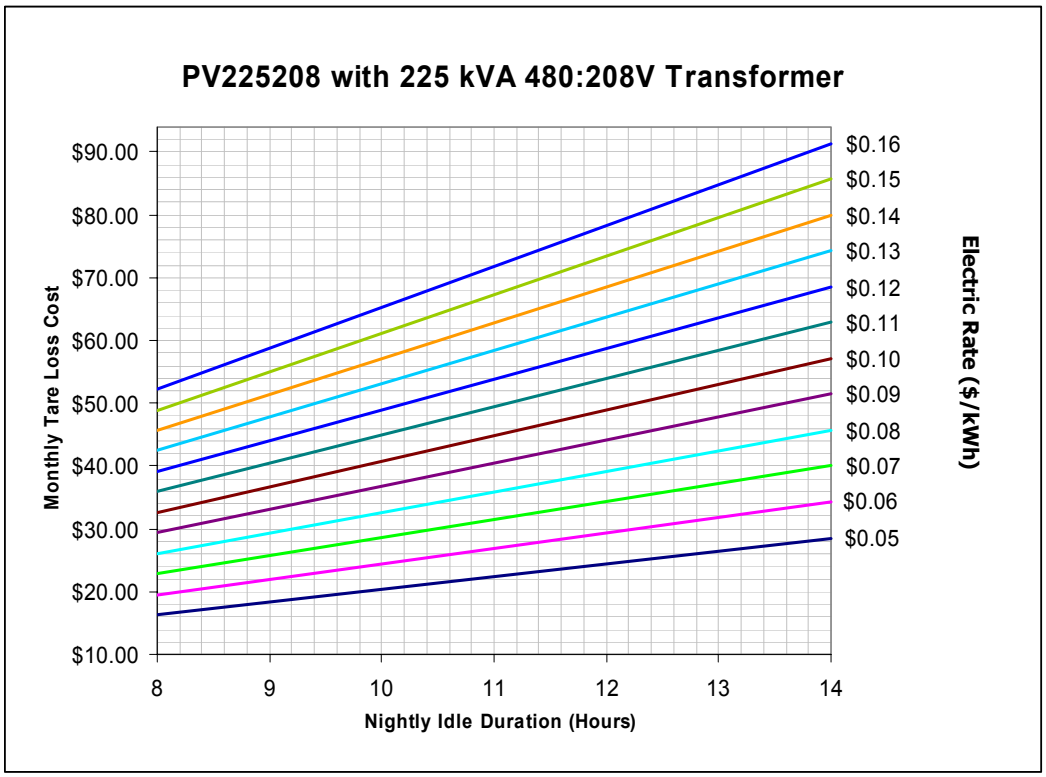

Figure 5. PV225208 Inverter System, 480VAC Interconnection Voltage

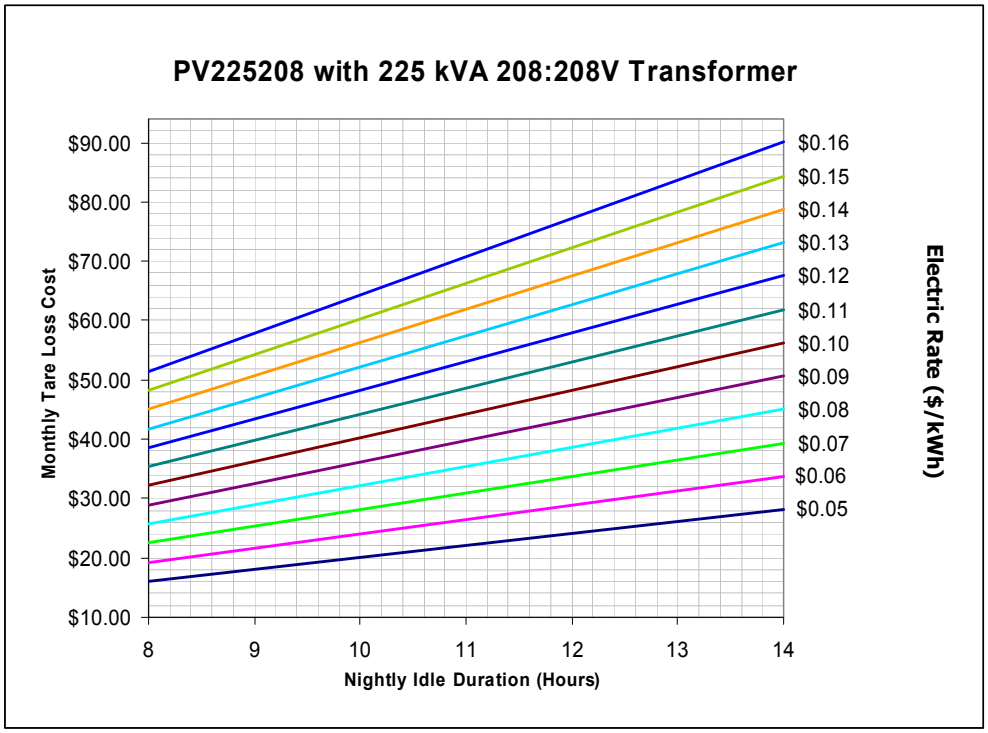

Figure 6. PV225208 Inverter System, 208VAC Interconnection Voltage

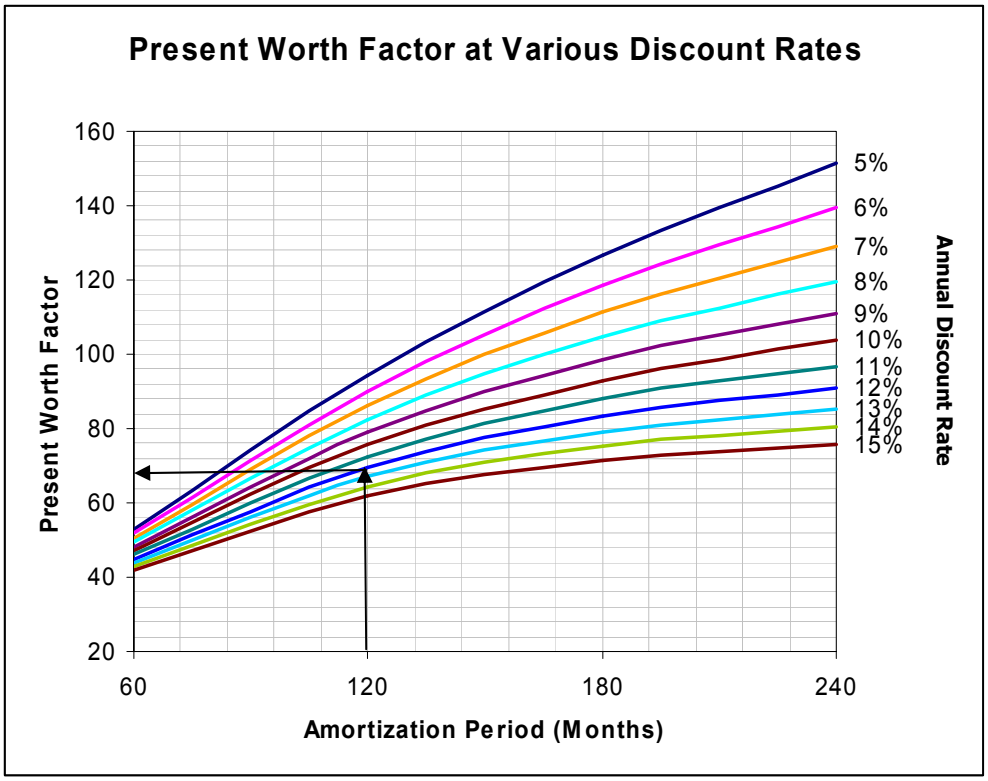

Figure 7. Present Worth Factors at Various Discount Rates