

## Power Quality and Potential Adverse Public Health Affects A Contextualization of Community Concerns about the West Linn Solar Highway

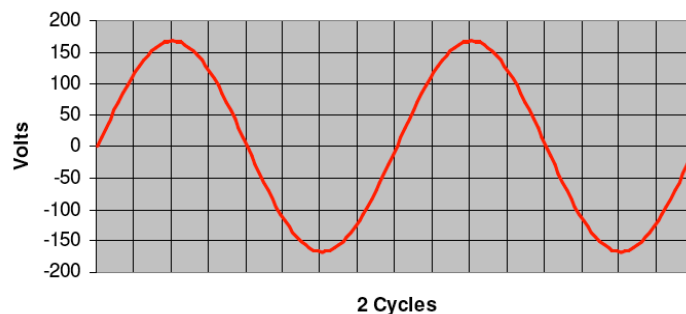
### Overview

This factsheet is a response to the concerns of West Linn residents about the potential of the proposed West Linn Solar Highway project to adversely affect power quality and subsequently harm public health. Some have questioned the potential relationship between voltage transients (so-called "dirty electricity") and adverse public health risks, including the possibility of increased incidence of cancer. However, there is no credible evidence in either the technical or medical literature to suggest that the proposed project will either adversely affect power quality or harm public health.

### Defining Power Quality

In the United States, alternating current (AC) electricity is transmitted and distributed over power lines at a frequency of 60 Hertz (Hz). Under ideal conditions, the shape and form of 60 hertz AC electricity is a sine wave (see Figure 1). The term *power quality* is used to describe the adherence of a power source to the ideal waveform with little or no variation.

**Figure 1: Ideal Sinusoidal Voltage Waveform**



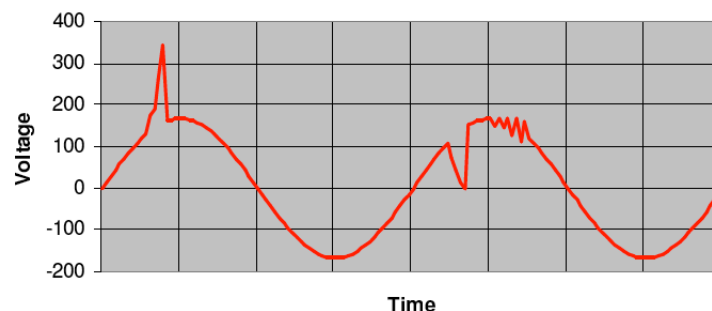
*Courtesy: Efficiency Engineering Incorporated*

However, no real-world power source is ideal and actual waveforms deviate in a number of ways. These deviations are a relatively common phenomenon in the modern electrical grid and are primarily a concern because they can cause certain types of sensitive electrical equipment to fail<sup>1</sup>.

### Defining Voltage Transients

A common power quality concern is the phenomenon of voltage transients. A number of natural and human events such as lightning, the start up and shut down of large motors and the operation of electronic lighting ballasts (e.g., fluorescent lights) can introduce short duration voltage spikes (see Figure 2). These disturbances in the AC waveform are referred to as voltage transients.

**Figure 2: Voltage Transients**



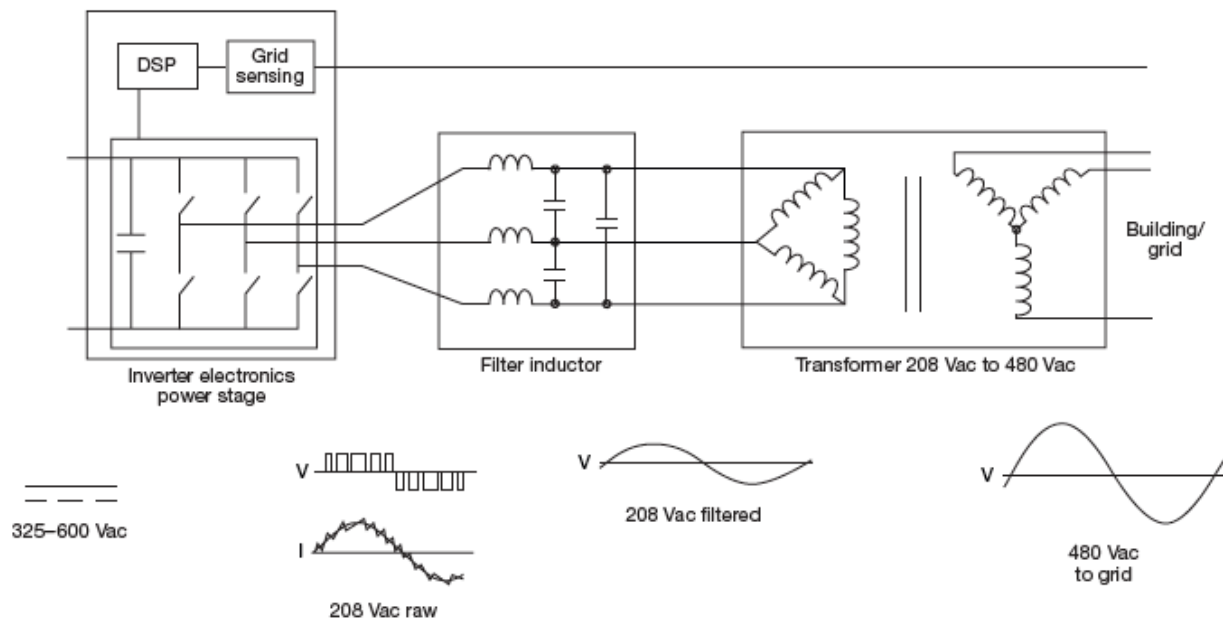
*Courtesy: Efficiency Engineering Incorporated*

## Photovoltaic Power Inverters – Designed with Power Quality in Mind

In order to supply usable electricity to the electric grid, the direct current (DC) electricity generated by a photovoltaic array must be converted into alternating current (AC) electricity. This is accomplished with an electronic device called a *power inverter*, or *power-conditioning unit*.

Modern grid-connected inverters are capable of transforming DC electricity into true sine wave 60 Hertz AC electricity. Inverters use a combination of semiconductor devices including solid-state electronic switches, inductors, capacitors, and transformers to invert, shape and filter the electrical current (see Figure 3)<sup>ii</sup>. A special type of computer chip called a Digital Signal Processor (DSP) monitors and controls the inverter to achieve the desired waveform.

Figure 3: Circuit diagram of typical 3-phase 60 Hz DC to AC power inverter



Courtesy: SolarPro Magazine April/May 2009

The electric utility industries have conducted extensive studies on the effects of grid-connected photovoltaic systems on power quality and, in many instances, the power quality from these systems is better than the surrounding electric grid<sup>iii</sup>.

## Power Quality Standards for Power Inverters

In order to maintain an electrical system in a manner suitable for the operation of sensitive electronic equipment, the Institute of Electrical and Electronics Engineers (IEEE) Standards Coordinating Committee on Power Quality has established a number of industry-accepted standards for power quality (for a complete list of standards see IEEE1159). The IEEE has also developed specific power quality standards (IEEE929 and IEEE1547) for the interconnection of distributed renewable energy sources – such as solar panel based systems. The proposed West Linn project will comply with all of the applicable codes and standards.

## Power Quality and Public Health Research

Some West Linn residents have raised questions about the potential relationship between voltage transients and adverse public health risks including the possibility of increased incidence of cancer. These concerns are not supported by the medical and scientific literature.



The basis for the community concern is a single study published in 2008 by Dr. Samuel Milham purporting to identify a relationship between exposure to voltage transients and incidents of cancer at a school in California. However, according to a state epidemiologist at the California Cancer Registry (CCR), "the findings and conclusions of the report are not supported by the CCR."<sup>iv</sup> Dr. Milham, contrary to the claims made in the study, failed to verify the purported cancer cases with the local cancer registry. The state epidemiologist also criticizes Dr. Milham's study for other data inaccuracies and lapses in accepted research ethics concluding that the study represents "objectionable research practices."

A recent review of the published literature on the potential for high frequency voltage transients to cause adverse health effects also examined the 2008 Milham study, finding a casual association between voltage transients and cancer as "fraught with problems" given weaknesses in the study's methodology.<sup>v</sup>

In addition to the 2008 Milham study, the review examines the credibility of four other studies. The review states the publications, "are all subject to methodological problems casting severe doubt in the reported causality." The review concludes that despite the "severe problems in the methodology and subsequent analysis and interpretation of the data... [the studies are] exploited by interest groups to advocate their cause and for commercial enterprises."

In conclusion, the concerns regarding power quality are founded on studies with deep methodological errors and there is no scientific basis from which point to be concerned with human health effects from the proposed solar project.

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<sup>i</sup> Dugan, Roger, et al. (2003). *Electric Power Systems Quality, 2nd Edition*. McGraw Hill: New York, NY.

<sup>ii</sup> Worden, James and Michael Zuercher-Martinson (2009). "How Inverters Work." *SolarPro*, April/May 2009.

<sup>iii</sup> Katiraei, Farid, et al. (2007). "Integration of Photovoltaic Power Systems in High-Penetration Clusters for Distribution Networks and Mini-Grids." *International Journal of Distributed Energy Resources*, Vol. 3, No. 3 July/September 2007.

<sup>iv</sup> Morgan, John (2009). "RE: A New Electromagnetic Exposure Metric: High Frequency Voltage Transients Associated with Increase Cancer Incidence in Teachers in a California School." *American Journal of Industrial Medicine*, Vol., 52, p350-351.

<sup>v</sup> De Vocht, Frank (2010). "'Dirty electricity': what, where, and should we care?" *Journal of Exposure Science and Environmental Epidemiology*, March 2010.