Satcon Technology Corporation

Request for Information Response for:

Addressing Policy and Logistical Challenges to Smart Grid Implementation for US Department of Energy

November 1, 2010

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1.1 Satcon Overview

Satcon Technology Corporation® (NASDAQ: SATC) is a leading clean energy technology provider of large-scale, utility-grade power solutions for the renewable and distributed energy markets.

For over 25 years, Satcon™ has designed and delivered power-control solutions that enable utility businesses and energy companies to convert clean energy into efficient and reliable power. Satcon's photovoltaic (PV) solutions have delivered millions of grid connected kilowatt (kW) hours of energy across some of the world's largest installations, and have enabled the utility-grade market to leverage renewables as a primary energy source. Some of our utility-scale power electronic solutions are described below.

- Satcon PowerGate® Plus solar PV inverters boost system power production and maximize the overall profitability of commercial and utility-scale solar PV systems through combination of system intelligence, advanced command and control capabilities, industrial-grade engineering, and total lifecycle performance optimization. PowerGate Plus is the world's most widely deployed large-scale, utility-ready solution, with hundreds of millions of grid connected kilowatt hours delivered to date.

- Satcon Solstice® delivers the industry's first complete power-harvesting and array management solution for utility class solar power plants. Solstice enables centralized, intelligent management of the entire PV system along with the flexibility of localized control over every component in the array, from the panel, to a single string, to the inverter, to the grid – thus serving as a total system solution. With Solstice, power output from each string is independently optimized, allowing each string to operate at its full potential all day. As a result, energy production from the entire array is increased by 5-12% as compared to a centralized inverter system.

- Equinox™ delivers best-in-class 98.5% peak efficiency combined with the industry's widest thermal operating range. Equinox comes with a standard NEMA 3R/ IP54 enclosure, and is available in three separate climate packages. Equinox is built on the foundation of Satcon PowerGate Plus and Solstice, the world's most deployed large-scale solar inverter solutions.

- Prism® delivers a factory integrated 1MW medium voltage (MV) solution optimized for utility-scale PV installations. Prism comes complete with factory integrated step-up transformers, MV disconnect switches, power-conversion electronics and an all-climate outdoor enclosure. Prism comes ready to connect to the PV array and utility-grid, enabling fast installation through a modular prepackaged design.

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1.2 RFI Summary

The Department of Energy (DOE) is seeking comments from interested parties on policy and logistical challenges that confront smart grid implementation, as well as recommendations on how to best overcome those challenges. DOE is undertaking this Request for Information (RFI) on behalf of the Administration and in consultation with key stakeholders from state regulatory bodies. The RFI will assist these parties as they seek to assure smart grid deployments benefit consumers, the economy and the environment. In particular, comments on the RFI will help inform the Administration's analysis of policy challenges and possible solutions being developed by the Smart Grid Subcommittee of the National Science and Technology Council's Committee on Technology. The Subcommittee seeks to base its analysis on an up-to-date understanding of the context in which smart grid technologies, business models and policies operate. This is the third in a series of RFIs issued by DOE regarding smart grid implementation. Prior RFIs sought comment on data access, data usage and privacy issues, and on communications requirements for the smart grid. In this RFI, DOE seeks specific input on: the best way to define the term ''smart grid'' for policymaking purposes; the consumer-level benefits from, and challenges to, smart grid deployment; the benefits and challenges associated with smart grid implementation on the ''utility side'' of the meter; the ways in which policy makers at all levels of government can share experience and resources; and the broader, economy-wide benefits and challenges associated with the smart grid. In so doing, this RFI avoids duplicating questions that were raised in prior RFIs.

Satcon Technology Corporation is pleased to respond to DOE's request for information titled ***"Addressing Policy and Logistical Challenges to Smart Grid Implementation for US Department of Energy"***. Our response is summarized in section 1.3 below.

1.3 Satcon Response to Smart Grid Challenges and Recommendations

Satcon views the Smart Grid from the perspective of a major manufacturer of the power electronics equipment that enables the interconnection of renewable energy sources and energy storage devices to the grid. Our view is thus less concerned with the smart loads and communication systems that enable load-side management and empower consumers of electric power. We are more concerned with the process and the problems that we encounter every day as we try to facilitate the integration of sophisticated new generation technology into a power grid that, until very recently, has viewed the advent of distributed generation as an unwelcome development. Unlike some of the Smart Grid conceptual visions, the challenges in this area are real and immediate, with short-term impacts on the availability, operational management, and location of new (largely renewable) distributed power generation (DG) and energy storage plants. In our focus area, we see the following five topics as crucial to the advancement of the Smart Grid objectives. In reality these topics are interwoven and overlapping, but we offer a few salient comments on each, with recommendations on steps that can be taken towards a solution:

1) **Harnessing the potential benefits of new power electronic technology to improve the power quality and the integrity of grid.**

> Renewable resources and energy storage devices are generally connected to the grid through inverters. The control capabilities and speed of response of these electronic generators far exceeds anything that is possible with conventional rotating synchronous machine generators. Specifically: real and reactive power (i.e., VAR) output can be changed virtually

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instantaneously, and independently, on command; output is current-controlled and current-limited, presenting high "impedance" to the grid. These characteristics remove all of the traditional concerns about dynamic stability and short circuit contribution that have dominated the world of synchronous machine generators for over a century.

Moving toward a Smart Grid it is important to categorize *electronic generators* separately from *synchronous machine generators* and apply different rules for their interconnection and operation. All attempts to refine interconnection standards (e.g. IEEE 1547) have bogged down by trying to accommodate the unfortunate characteristics of synchronous machines.

Electronic generators can actively regulate voltage at their point of interconnection, or dispatch VARs on command for system-wide voltage management. Coupled with high-speed communications for command and data collection, the opportunity also clearly exists for a high-speed centralized real-time voltage optimization system that uses this fast VAR dispatch capability to effect changes in the power grid.

Electronic generators can dispatch real power virtually instantaneously, subject to prevailing limits. All electronic generators should therefore be viewed as potential participants in supply-side management for various purposes. When sizeable energy storage is incorporated, an electronic generator can absorb power as well as generate, and can play an important role in frequency regulation, for example.

The security and availability of a Smart Grid would certainly be enhanced if local generation could be used to support islanded grid segments during widespread power outages. Electronic generation, *incorporating energy storage*, is essential to the implementation of this "intentional islanding" concept, in order to maintain the necessary instantaneous balance between generation and load that is consistent with constant voltage and frequency regulation.

High speed electronics can provide other benefits for the grid in the form of fault-current-limiting devices, fast solid-state circuit breakers, etc. These devices are still largely experimental, but hold great promise for a future Smart Grid where speed of response will largely define the integrity and security of the system.

The enabling action for promoting the use of this technology should include:

a) Speeding up the reform of regulations such as IEEE 1547 which generally serve to impede the use of power electronic technology in the grid.

b) Actively promoting demonstration projects that transcend the present regulatory limitations to demonstrate how power electronic technology can be used to benefit the grid.

2) Regulatory environment that governs the interconnection and operation of new DG

Utilities are naturally reluctant to depart from the tried and trusted methods and rules that have evolved, especially in the area of power distribution. Their position in regard to interconnection of DG has understandably been defensive over the past decade.

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As manufacturers of inverters, we have seen rather arbitrary interconnection rules emerge in other countries, and in the US, we have seen individual PPAs that incorporate all sorts of operational requirements as a condition of interconnection. Presently this is a "Wild West" scenario where the sheriff in each town is making his own laws, and in many cases insisting on the provision of ancillary services (VAR production for example) without any compensation.

Many pending high-penetration projects are waiting on approval by utilities, which in turn are waiting on a reasonable standard that they can apply, that gets around the obvious shortcomings of 1547, and allows them to use the capabilities of electronic generators without exposing themselves to liabilities.

The enabling action in this area could include:

a) Sponsoring of a fast-track new 1547 standard specifically for electronic generators, embracing the possibilities and laying down the rules, for new technology to improve the grid.

b) Promoting demonstration projects on live distribution feeders to help allay the fears and concerns of utilities in this area. Essentially, if DOE could absorb the risks associated with these demonstration projects, a quantum leap forward could be made. For example, a live Smart Grid feeder project under DOE patronage, incorporating full utilization of inverter and storage technology for voltage regulation, islanding, etc.

3) Tariff environment and ancillary services market that provides additional incentives (or disincentives) for new renewable and energy storage projects.

In this area, we would only comment that tariffs, incentives, and the potential for selling ancillary services are the principal factors that are shaping the business cases for the implementation of widespread distributed generation. To the extent that these factors are somewhat unpredictable and inconsistent, it is difficult to make the business case for technological remedies to various problems. For example, bulk energy storage can clearly serve to mitigate the effects of variability in renewable generation, but there is no model for penalties and rewards that would justify the high cost of installing energy storage.

Enabling action in this area might include guidelines for pricing such factors as short-term deviation in power production.

4) Liability issues associated with involving non-utility entities (DG owners) in some aspects of grid operation and management.

Utilities carry the statutory responsibility for operating the grid within certain defined operating limits. When electronic equipment, owned and operated by non-utility entities, is allowed (or required) to participate actively and autonomously in the control of the grid, the issue of liability needs to be addressed.

Enabling action in this area might include developing guidelines for PPA agreements that resolve the inherent liability issues.

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5) Supply-side management and power quality issues arising from the variability of renewable power sources

This issue overlaps strongly with 1) above. Renewable PV and wind generation is variable in nature, with low frequency patterns and possible higher frequency components due to passing cloud cover, wind gusts, etc. This variability raises concerns about circuit loading and power quality (flicker) and effectiveness of conventional voltage regulating equipment such as line-regulators, tap changers, etc. Conventional supply-side management is accustomed to handling constant stable generation sources. Managing renewable resources requires a different mindset that harnesses all available technology to best advantage.

Enabling actions in this area may include:

a) Support of projects to quantify the extent of the problem. In other words, does it really matter that the power output from a high penetration of renewable generation fluctuates? If so how much value should be assigned to a solution that produces "generation leveling"?

b) Support demonstration projects designed to demonstrate the effectiveness of bulk energy storage used to offset the variability of the renewable generation.

c) Provide incentives for leveling generated output. Such incentives should be commensurate with the established value of leveling generated power, as determined in 5a) above.

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