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EXECUTIVE SUMMARY

PREFACE

For those of you who aren't familiar with this industry, this preface is a must-read. For those who do know this highly technical field, this preface may serve you as a concise overview of current issues being faced.

For Cheaper Solar, Fix the Inverters, By Kevin Bullis

from TechnologyReview.com (MIT publication), Friday, June 05, 2009

One component of solar panel arrays can cut power output by 40 percent, driving up the cost of solar electricity.

If solar power is ever going to be a major source of electricity, researchers, engineers, installers, and solar panel array owners are going to have to pay closer attention to one essential component of these systems--the inverter.

According to a study of solar arrays in actual operation, poorly designed or faulty inverters--devices that convert the DC power produced by solar panels to AC power that can be used in buildings or sent over the grid--can dramatically lower net power output. In one case, the inverters consumed hundreds of watts at night, decreasing overall power output by 40 percent. High temperatures caused inverter faults, and because the inverters had to be reset manually, about half the time when the sun was shining the array was producing no power.

What's more, the common practice of linking all the solar panels in an array to one inverter means that if there is a problem with one panel in the array, the output of the whole system goes down. So, because of inverter-related problems, solar arrays might produce nowhere near what they're supposed to, and solar power may prove even more expensive than expected.

One option is to install automatic disconnect circuits, which can cut down on parasitic losses. Presumably inverters that reset automatically after temperature faults--or that can operate better in high temperatures--would also help. Several companies are also starting to develop micro inverters or other electronics that can be installed at each solar panel so that if one panel has problems, the rest aren't affected. [<http://www.technologyreview.com/blog/energy/23608/>]

AN INTERNATIONAL PROBLEM¹

“Manufacturers generally feel that designing inverters for longer than 15 years is not practical and in general is not necessary. Most manufacturers say that the more important issue for consumers is lower first cost.”

Xantrex, (French), Managing Director: “Why make inverters with a longer life when the customer is better off replacing the inverter every 10 years or so anyway? The inverters available in ten years will be better products with higher efficiency.”

SMA America, (German-owned), World leader, President: “Why focus on higher reliability? Our customers worry only about first cost. In any case, it’s more cost effective to just replace the inverter in 10 years.”

SMA, Head of Solar: “A 20 yr lifetime is not possible.”

Sustainable Energy Technologies, (Canada) Director of Operations: “A 20 year lifetime for PV inverters is at least 10 years away.”

Mitsubishi (Japan): “A 20+ year life for inverters is impossible. Some parts of the inverters would need to be replaced over such an extended period.”

Fronius, Head of Sales (Germany): “Inverter MTBF may reach 12 years by 2015. A 20 year lifetime can’t be achieved.”

These are all foreign companies with a dominating majority of the renewable energy power conversion market. They have not lowered the cost in a decade.

AN AMERICAN SOLUTION

TEC has American taxpayer-paid research which enables major steps to cure these problems: US energy independence, clean energy, power grid quality, American joblessness, endemic manufacturing capacity, balance of trade, and foreign price dictates on renewable energy costs.

TEC agrees with the statement at the top of the page: first cost should be lower. After this point, TEC diverges from the current industry views.

TEC also believes this is a societal issue, intrinsic to the future of America’s success, and will provide jobs, energy independence, tax revenue, stewardship of the Earth by applying 21st-century solutions, up to 40% energy savings in next-generation consumer appliances, and use of all renewable energy sources, including biomass, solar, wind, tide, and geothermal.

EXECUTIVE SUMMARY: RENEWABLE ENERGY WITHIN REACH

TEC develops future energy power electronic designs and products, to improve efficiency, lower costs, improve power quality, and allow distributive energy to become grid parity ahead of all conventional estimates.

TEC holds the license for worldwide alternative energy applications of IP developed by Dr Jason Lai, including residential, commercial, utility company converter and inverter applications, battery, fuel cells, and far-ranging distributive and renewable energy system components.

TEC's disruptive designs will provide the infrastructure the world needs as it evolves to a renewable energy based economy. TEC's technology has the following disruptive attributes:

- Solves up to 40% energy losses currently in existing solutions. ²
- 1/4- to 1/20- twentieth the weight of existing solutions (1/4: 5kW, 1/20: 100kW).
- 30% to 50% lower cost than existing solutions.
- 20-year service life, twice that of existing solutions.
- Near-theoretical efficiency: 99% inverter efficiency @ 5kW.
- Modularity for maximum applications and minimum re-design.
- Anti-islanding, the ability for a system to remain on even when the grid goes off; *no other product has this capability.*
- Less than 1% harmonic distortion, active ripple current reduction, active phase cancellation, and on-demand reactive power in the intelligent inverter design maximizes power utilization, provides clean power, and accommodates sudden 'start-up' demand.
- Significantly lower parts cost; mass-manufacturable.
- High- and low- voltage DC inputs with wide load range covers all existing renewable sources with exceptional efficiency in real-world use.

TEC products provide the technology solution for the critical power electronics bottleneck that has prevented the widespread implementation of efficient alternative, renewable energy systems. At present, "green" thinking is a big marketing term. In reality, the cost, weight, efficiency, and lifespan of present-day products are not very green at all. For example, if someone has solar power, current 5kW inverters which change the DC solar power into AC power for the house may have a 10-year lifespan, weigh up to 180 pounds, and use large amounts of copper and iron, have around 90% efficiency, and use limited-lifespan electrolytic capacitors. TEC equivalent 5kW products will have 20-year life spans, efficiency near theoretical limits, weigh less than 45 pounds, contain no large electrolytic capacitors, and minimal copper and iron.

TEC is a company dedicated to producing high quality power electronics products that make it possible to deploy alternative, renewable energy systems that are effective, affordable and practical. TEC holds the exclusive, worldwide rights to breakthrough technologies. This technology is manifest in TEC electrical power products. Similar products are required components in every system that produces usable electrical power from solar, wind,

fuel cell, geothermal, tidal and other sources, commonly known as renewable energy sources. These products are designed, prototyped, tested and currently are undergoing pre-manufacturing design adjustments to facilitate automated, volume manufacturing processes. Over and above other power electronics products currently in the marketplace, TEC products facilitate the reduction of energy dependence on fossil fuels and the accelerated implementation of alternative, renewable energy systems by providing the following benefits.

ENERGY THROUGHPUT OPTIMIZATION

Greater throughput of usable energy from source - significantly improving efficiency by using effective switching (soft-switching) and DSP-controlled intelligent adaptive architecture. **Automatic AC power phase correction** - resulting in breakthrough ripple reduction (minimized energy loss) and harmonics elimination (clean power).

IMPROVED RELIABILITY

Vastly improved product life - by eliminating inefficient transformers and capacitors (the primary source of heat damage over time in current products), no ventilation fan required to consume usable power.

SYSTEM DESIGN FLEXIBILITY

Reduced overall system cost and barrier to entry due to mass-manufacturing capability.

Another factor in reduction of cost and marketability is TEC's lower input voltage (37-70VDC to allow many DC sources, including the shading-resistant parallel solar array wiring) which alleviate many problems in current designs related by Kevin Bullis on page 1 of this document. This permits unparalleled flexibility in the use of modularized low voltage power sources --such as photovoltaic (PV) arrays-- thereby reducing engineering and installation costs.

Separate AC interfaces - for local load and power grid connections that enable full operation to local load when grid is down. The unit also has the ability to deliver reactive/surge power to local loads without batteries or capacitors.

Universal Distributed Generation Inverter - one design supports multiple power sources individually or concurrently, including battery, solar, wind, fuel cell, geothermal, tidal and others. It enables Energy Management Systems that provide 380VDC for high efficiency variable speed DC motors in air conditioning and heat pumps and 48VDC for high efficiency DC lighting, as well as traditional 120/240 AC requirements. It also enables cost optimization of power storage and release for time-of-day cost metering.

Modular and scalable – TEC designs are ideal for higher voltage and wattage applications with even greater efficiency at ratings beyond 5kW.

High-voltage input inverter is in design now to accommodate existing consumers who have an installed system which is series-wired. There are over 2 million users in this market. Their inverters have 5- to 10- year lifespans and will need replacing. TEC high-voltage inverters serve as a drop-in replacement, at lower cost, with longer lifespan, and less than 1% harmonic distortion which actually improves power quality whether used by the consumer or sold back to the grid. Properly trained installers could optionally rewire the series-wired array to parallel so that the consumer could opt to replace their failed inverter for the low-voltage TEC inverter, with additional benefits.

Series-wired PV array manufacturers are resistant to changing to parallel-wired due to a 1.5% increase in wiring and installation cost. Parallel-wired solar arrays are much more resistant to shading (clouds, dust, tree shadows),

but current manufacturers' inverters are not as efficient at low-voltage inputs. Therefore, TEC is designing a 200-480VDC input inverter (mentioned above) to accommodate series-wired arrays in a much more cost-effective manner. This will support the existing market as replacement inverters are needed, plus drive the market to utilization of parallel-wired solar arrays in climatic areas and single-phase environments where it is clearly needed. The American home is single-phase, and anyone who doesn't live in the desert will be in the target market for parallel-wired low-voltage solar array systems. Furthermore, single-phase homes using TEC designs with less than 1% harmonic distortion actually improves the quality of the grid when sold back to the utility company. In essence, TEC designs provide 3-phase benefits within a single-phase environment.

REDUCED DIRECT AND INDIRECT UNIT COST

Major weight reduction - TEC converters and inverters weigh less than 25lbs for a standalone, non-grid-tied system and 40lbs for grid-tied system to enhance reduced shipping and installation costs.

Major reduction in unit cost - TEC converters and inverters are designed and engineered to reduce manufacturing cost through mass manufacturing capability.

MARKET IMPACT

Current TEC products are designed and developed to facilitate reliable, affordable and, therefore, rapid deployment of alternative, renewable energy systems utilizing solar, wind, fuel cell, geothermal, tidal and other sources. The initial products are rated at 5 kilowatts and target residential power production applications. They are modular and scalable to commercial levels of energy production without sacrificing efficiency. Up to 20 5kW units may be stacked to provide 100kW output. Higher capacity products are in development for commercial and utility applications.

TEC products provide for the engineering and deployment of core renewable energy systems that become the foundation for growth of the system as needs arise and are economically within the reach of a much larger universe of potential consumers. Lower input voltage requirements permit the use of a greatly reduced array of photovoltaic modules, for example, as little as 12% of the current industry standard. Modularity assures that as the system grows, additional input energy sources and components can be added or removed as required. Efficiency, reliability, reduction in size and weight and remarkably reduced unit cost further drive down the overall system expenditure.

Projected cost for these core systems can be made more affordable compared to current systems costing \$20,000 - \$100,000 and beyond for a similar capacity. With a core system engineered around TEC products, alternative energy production is suddenly economically practical.

Profoundly reduced core system and installation cost, power utility provider incentives, surplus energy purchase programs and federal tax incentives come together to provide the consumer with lower capital outlay, greater return on investment and a shorter payback period. Whether producing renewable power within the current power grid system or as an off-grid replacement source, count on TEC products to put alternative energy within reach.

Future markets that may be significantly and positively affected by TEC products and development may include automotive, agriculture, recreation and others.

SUMMARY

At a time when worldwide reliance on fossil fuel is affecting a profound redistribution of wealth, TEC products bring technology to the marketplace that will simply reverse that trend. Whether reducing the carbon footprint in the most industrialized of nations or providing third world countries with much needed resources that are more affordable, TEC products will usher in a new era of energy independence.

These technological breakthroughs will enable American job creation and extension. Nearly every device which uses DC-DC conversion and DC-AC inversion will benefit, creating demand in products in broad spectrum markets. Taxpayers in the USA and sponsors of these research programs will receive significant economic and societal return-on-investment which provides superb political, PR, and altruistic benefits, regardless of political or social affiliations. The achievements of Dr Lai should be perfected in short order, then exported to 2nd and 3rd tier countries after adequate testing and proper adherence to intellectual properties. Non-compliant nations, if they honor the royalties, can be outfitted with their own manufacturing facility to which would be sold key IP components in the form of DSP (custom ASICs). This is a chance of true energy independence for every participant. TEC designs will keep the energy money in a country to generate taxes (over 20 cents per dollar) annually retained to feed and grow the society. All TEC asks is that the movement be towards an enforced international legal standard.

1- From "A Review of PV Inverter Technology Cost and Performance Projections" Presentation to National Renewable Energy Laboratory .This work was supported by the U.S. Department of Energy's (U.S. DOE) Office of Energy Efficiency and Renewable Energy (EERE) under National Renewable Energy Laboratory (NREL) Contract No. KACX-4-44451-04. January 12, 2006

2-National Renewable Energy Laboratory Technical Report NREL/TP-550-37542, "Lessons Learned from Case Studies of Six High-Performance Buildings" P. Torcellini, S. Pless, M. Deru, B. Griffith, N. Long, and R. Judkoff. June 2006.



TOTAL ENERGY COMPANY

OVERVIEW

- Large Global Market – Accelerating Double-Digit Growth
- Disruptive Technology
- High Value Partnership Opportunities

TEC – TOTAL ENERGY COMPANY

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- 30% to 50% lower cost than existing solutions.
- 20-year service life, twice that of existing solutions.
- Near-theoretical efficiency.
- Modularity for maximum applications and minimum re-design.
- Anti-islanding, the ability for a system to remain on even when the grid goes off; *no other product has this capability.*
- Less than 1% harmonic distortion, active ripple current reduction, active phase cancellation, and on-demand reactive power in the intelligent inverter design maximizes power utilization, provides clean power, and accommodates sudden 'start-up' demand
- Significantly lower parts cost.
- High- and low- voltage inputs with wide load range covers all existing renewable sources with exceptional efficiency in real-world use.

THE TECHNOLOGY OF DR JASON LAI

The inventions of Dr Lai in power electronics have been the biggest breakthroughs in the past 120 years. His brilliant innovation in true 21st century electricity and power electronics will become benchmarks by which all other designs are measured.

- Dr. Lai is Director of Virginia Tech's Future Energy Electronics Center.
- Dr Lai's main research areas are high power electronics converter topologies, motor drives, and utility power electronics interfaces and application issues. He has published more than 100 technical papers, two books, and has been awarded **eight U.S. patents**.
- Chair of the 2000-2001 IEEE/DOE Fuel Energy Challenge and Chair of the IEEE Power Electronics Society Standards Committee.
- Director of DOE Freedom CAR project for National Transportation Research Center 2004 Program Chair of The Applied Power and Electronics Conference Exposition (APEX)
- Founding chairman of Vision 2030 for DOE, to modernize utility grid
- Published in more than 150 reference conference proceedings
- Forty-five IEEE publications
- Chaired 2008 National Science Foundation Conference on Power Quality
- High Voltage SIC device testing for Northrop Grumman and Powerex
- **Three of Dr. Lai's patents** are in direct application **within TEC products**: [1] Intelligent DC Boost Converter, [2] Anti-Islanding (enables grid-tied inverter to work even when grid goes off), [3] DC/AC Transformer.
- **Inventor of first full soft-switching converter** (all switching at zero-current and zero-voltage transitions), with the following features:
 - active circuits for ripple reduction,
 - active circuits for very low (<1%) harmonic distortion,
 - support for surge power for inductive loads without batteries or capacitive banks,
 - anti-islanding, giving ability for grid-tied inverter to operate even when grid fails.

THE RENEWABLE ENERGY MARKET

Renewable energy represents 10% of energy consumption in 2009. DOE is projecting the growth rate of renewable energy to double every three years. This is an exponential projection, and this market has outperformed every projection made to date.

Solar power is growing at 57% annually in the US; 62% worldwide.

In 2007 [grid-connected photovoltaic](#) electricity was the fastest growing energy source, with installations of all photovoltaic systems increasing by 83% in 2007 to bring the total installed capacity to 8.7 GW. Nearly half of the increase was in [Germany](#), now the world's largest consumer of photovoltaic electricity (followed by [Japan](#)). Solar cell production increased by 50% in 2007, to 3,800 megawatts, and has been doubling every two years.

Markets for Power Inverters:

- Solar (PV) market is \$1.8 billion
- Wind energy market in 2007 was \$9 billion
- Geothermal will have 100GW capability by 2050
- Micro-turbines (wind), \$2 billion by 2012
- Micro-hydro market is \$30 billion
- Fuel Cells market \$387 million in 2006
- Wave power, over 600MW worldwide over next 8 years
- Motion-energy recapture from roadways in US alone could be \$1.8 billion

THE PRODUCT

The Initial Products and Markets

- **Residential / Commercial 5kW converter, 5kW inverter, and both combined.**

The advantage over existing inverters and converters are listed on page 1 of this document, and it bears repeating they are not incremental advances, they are game-changers.

TEC inverters (DC-to-AC) integrate with the current market (120VAC, 240VAC, the common electricity of today's residential and commercial use).

TEC converters are DC-to-DC boost converters which are compliant with all existing DC uses, plus the emerging standards being established by NIST, EPRI, Emergent, ZIGBEE Alliance and others. DC devices (HVAC, refrigerators, motors, computers, all consumer and commercial devices) are 30-40% more efficient in motors, data centers, and digital devices, and 90% more efficient in lighting (such as LED lights). These standards are centering on 48VDC and 380VDC. TEC designs are already compliant with existing and emerging needs.

- **Utility Company grid-based 100kW inverter** with either 48VDC or 200-480VDC inputs (the latter can be fed by twenty 5kW TEC converters). Modularity creates new market solutions.

- **Utility Company grid-based 100kW converter.** *Note*: the 100kW converter and inverter are both stackable up to 10 units, yielding 1 million watt (MW) supply.

- **Devices compliant beyond the 1547 standard:** TEC brings to the market inverter innovations which imply a new standard should be developed by the IEEE to recognize inverters which improve utility power when interconnected. The standard should define inverters which [1] are more robust and do not cycle on/off due to under or over voltage situations; [2] exhibit firm handshake with grid, but also have enough intelligence to recognize when to disconnect; [3] when generating power to the grid will provide dispatchable (on-demand) reactive power to the grid; [4] reduce harmonic distortion; [5] anti-islanding. Reactive power helps to solve distortion (maintain power unity) on the grid when large loads are started elsewhere on the grid. Anti-islanding allows an inverter to provide local power when the grid goes off. These are 21st century breakthroughs which set the bar higher for the market with which only TEC products will be able to comply.

OTHER OPPORTUNITIES

The developments in power electronics of Dr Lai have been the **biggest breakthroughs in the past 120 years:**

Full soft-switching (all switching at zero-current and zero-voltage transitions),

- active circuits for ripple reduction,
- active circuits for very low (<1%) harmonic distortion,
- active phase cancellation,
- supports surge power for inductive loads without batteries or capacitive banks.

The implicit breakthroughs Dr. Lai has provided include clean, less costly power, and technology which can improve power electronic products. These products would do the same amount of work while using 30% less energy, i.e., more efficient use of the power which has been generated.

One example is vampire power elimination: wall-wart & other AC adapter power supplies cause at least 5% increase in electric bills in the US; as much as 12% in Japan. Intelligent power electronics could greatly reduce this wasted energy, amounting to 18 power plants in the US alone.

Another example is the 30 to 40% savings in computers and digital devices which currently use AC-to-DC power systems. There are myriad applications.

INVESTMENT STRUCTURE

We have numerous opportunities available for interested, qualified investors at all levels. These opportunities are time-sensitive and would be highly beneficial to all parties concerned. Please contact us to discuss your investment or partnership interests. Financials are available upon request.