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2008
RESOURCE GUIDE

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Welcome to the first stand-alone issue of the Battery Power Products & Technology Resource Guide. Within these pages you will find listings of manufacturers and suppliers in the battery industry and the products and markets they serve. Batteries are categorized by chemistry and type for easy reference. The guide also covers battery supplies, from cables and enclosures to integrated circuits and watering systems.

Additionally, Frost & Sullivan has contributed a feature article on Green initiatives, which starts on page 4. There is also a preview of Battery Power 2008 on pages 24-25.

We hope you will find the 2008 Resource Guide and useful reference tool. As always, we welcome your feedback.

Shannon Given, Director of Content
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Battery Chemistries/Types

Alkaline, Lead-Acid	10
Lithium, Li-Ion	14
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Silver, Thermal, Zinc	21

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An Era of *Green* Initiatives

Vishal Sapru, Industry Manger

Frost & Sullivan's Power Systems Group

Extreme weather patterns are observed throughout the world. From rising temperatures to a combination of melting glaciers and extremely harsh winters, global warming and climate change are hot topics. These factors significantly affect the existing ecosystem and call for environmental friendly power generation technologies like renewable energy to reduce impact of harmful greenhouse gas emissions, largely from fossil fuel power plants that cause global warming.

Changing Face of Energy

- Greater awareness of fossil fuel effects on the environment
- Rising gas prices
- Rising residential electricity prices per kilowatt hour; prices have doubled since 2005
- Concerns about increasing frequency of brownouts and blackouts
- Move toward renewable/alternative energy sources in demand such as solar power and wind energy
- Grid-tied connectivity expects to be major segment of renewable energy-based systems, especially in developed regions of the world
- Off-grid segment to cater to distributed power generation requirements in isolated and rural regions

Major regions of the world can significantly contribute toward increased installed capacity of various renewable energy systems by effectively utilizing the abundant resource potential in biomass, small hydropower, geothermal power and solar energy. There is an ongoing effort to promote the renewable energy industry through government incentives, non-govern-

mental organizations (NGOs) initiatives and extensive public support. This is likely to increase the role of renewable energy in power generation in the coming years. Chart 1 represents the key drivers and restraints in the renewable market.

Market Trends

Some key market initiatives taken by governments and companies include the following:

- US production tax credit for wind power
- State renewable portfolio standards
- Numerous European indicatives in green energy, especially Germany
- China approved funding of 17 clean energy projects based on self-developed technology
- Brazil energy independent, major potential source for ethanol
- GE: Ecomagination
- Honda: Environmentology
- BP: Beyond Petroleum
- Dow: The Human Element
- Toyota: Sold over one million hybrids
- Shell: Involved in wind, solar, hydro, geothermal and biofuels
- Rolls Royce: \$1 million dedicated to renewable energy

Energy Storage Markets

Overview

When one thinks of energy storage, the first technology that comes to mind is batteries. There are a number of battery chemistries that have evolved, from the age-old lead acid to nickel-based chemistries and most recently, lithium chemistries. However, these chemistries are best fit for certain specific applications among the plethora of existing applications. Lithium batteries have captured the electronics markets to a large extent. Their superior performance and technology specifications imply great value and potential for the automotive sector. Lithium-based technology and its suitability for automobiles is under investigation. This comes at a time when there is an emphasis on technology innovation to identify good energy storage mechanisms for a world that is fixated on reduction in gas consumption, especially for big economies such as North America and Europe. On the other hand, the current market scenario suggests that NiMH batteries are predominantly used for hybrid electric vehicles. A combination of battery chemistries is likely to be of greater use in the market and reduce gas consumption.

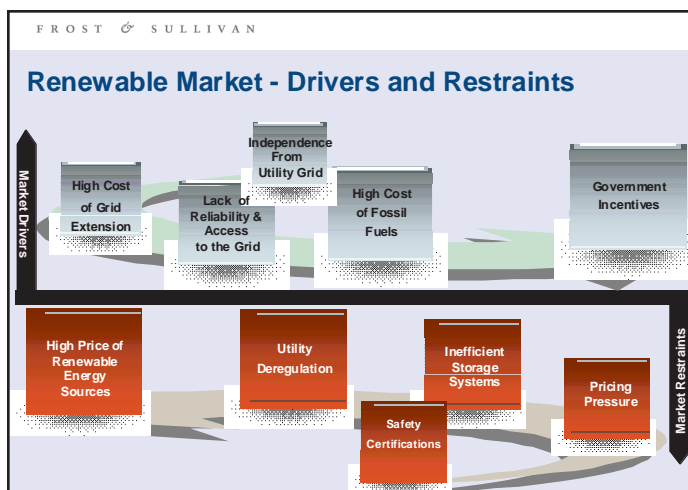


Chart 1

Frost continued on page 6

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NiMH and Lithium-Ion Chemistries

The markets for Lithium-ion and Lithium-ion polymer batteries were \$6.40 billion in 2007. Similarly, markets for NiMH batteries were \$1.16 billion in 2007. A prime driver for these markets in the future could be the automotive segments due to their ability to have a truly "green" effect to reduce dependence on the depleting oil resources in the world. Additionally, they will enable nations that are highly dependent on outside sources for oil to strengthen their weakening economies with the help of in-house technology to efficiently store energy.

Clean Alternatives - The Flywheel and the Ultracapacitor

Another area gaining attention is clean energy storage solutions such as flywheels and ultracapacitors. These technologies are commercial and seen on many levels in various applications. A significant drawback for both technologies is the inability to provide power for longer durations. They provide power from 10 seconds to a minute although they charge easily. These technologies are considered suitable in tandem with existing battery technology to either extend the life of the battery, or to add more power for finer features. These markets have yet to achieve high adoption rates. Additionally, the increased cost involved in purchasing these systems is high. Hence, these technologies are set to make an impact on the markets once their price points are on par with battery technology.

Renewable Energy-Based Inverter Market

With a move toward renewable and alternative energy-based solutions, there is a need to convert raw electrical energy into usable power. This is where products like renewable power inverter come into play; for converting direct current (DC) to alternating current (AC) that can be used for different applications.

The demand for the renewable power inverter is likely to increase during the forecast period as the need for "green" increases. Sales of power supplies for renewable energy systems are dependent on the expansion of new renewable energy

system installations. Increasing energy costs and a depleting reserve of conventional fossil fuel sources have made these systems essential; past demand was driven by environmental issues. Recently, economic challenges caused by skyrocketing fuel prices have sparked renewed interest in renewable energy systems. Power supplies used in these systems are typically inverters. Core elements of the system harness the natural renewable energy sources, such as wind, solar and fuel cells to provide electrical energy, while the inverters convert the electrical energy produced to a usable form. Chart 2 shows the revenue forecast of the non-renewable and renewable power inverter market.

Market Characteristics

Salient Features

- Inverters are a component of the balance of system (BoS) in the renewable energy setup. Though they perform a critical function in these systems, their consumption is completely driven by the expansion of the installation base of renewable energy systems.
- Inverter vendors in the market are powerless in terms of the influence they create in the market. Any amount of technology development or price reduction does not translate into increased demand, but it does help in building a competitive advantage.
- Incentives and government policies indirectly control the demand for inverter products used in the renewable energy systems. Incentives for installation of renewable energy systems indirectly drive the demand for inverters.
- Most inverters are manufactured by vendors that specialize in power electronics, because strong technical knowledge is essential to produce, sell and service these products. Most of the designs in the market are proprietary and difficult to replicate.
- Solar inverters, especially with grid-tied capabilities, require a strong technical knowledge for vendors to develop an effective power conversion solution. Apart from the core conversion function, vendors offer a wide range of control and monitoring equipment that make the system more efficient and user friendly.
- Inverters are used primarily in small-scale wind systems, which have limited installations in the market due to lack of proper promotion or support through federal policies.
- Most of the small-scale wind energy systems are stand-alone and are located in isolated areas. There are few grid-tied systems in this end-user segment. In most of the cases, the inverter is used in a battery-backed wind energy system wherein they convert the battery DC power into AC power. In many other cases, inverters used in hybrid systems are a combination of one or more alternative systems such as wind turbines, micro-turbines, diesel generators and solar energy systems.
- Unlike the solar energy systems, wind energy systems require very specific surrounding conditions for proper efficiency and effective wind energy harnessing. Therefore, small wind energy systems are installed in rural and isolated regions.
- Small-scale units have a much higher installation and maintenance cost per unit of power than the utility scale wind energy

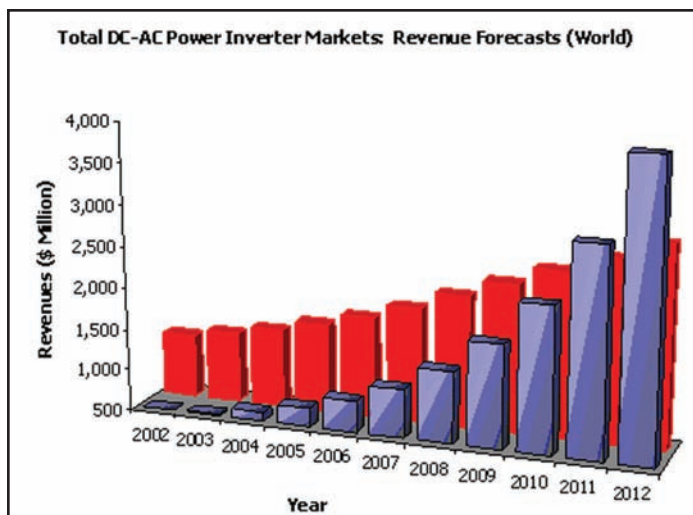


Chart 2

Frost continued on page 8



Power Up!

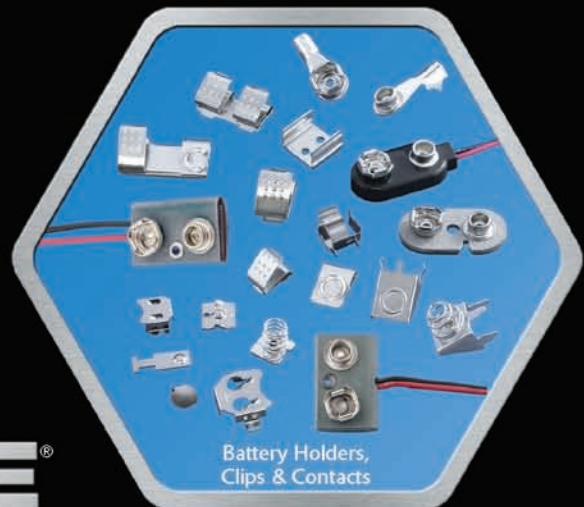
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systems. Inverters tend to be a major component of the total small wind energy system.

- Inverters in the fuel cell energy market are currently sold in very low volumes, primarily in the stationary fuel cells segment. The primary reason for this is the elusiveness of a proper fuel cell design that can be developed at a low cost and create the required commercialization of the fuel cells in the market.
- Very few vendors manufacture inverters for fuel cells as they do not generate enough demand and are less profitable, but this is expected to change when fuel cell technology becomes fully commercialized.
- Inverters used in fuel cell systems are being designed to properly handle the variations in output from fuel cells. As a result of the improved designs, the inverters cost is slightly higher in comparison to the general application inverters. This leads to a high inverter cost contribution to the total fuel cell system.
- Inverters in this market typically cater to the fuel cell market with two different power ranges, primarily the small (below 5 kW units), and mostly in the above 50 kW segment. Stationary fuel cell units typically exist as small (below 10 kW) and large (above 10 kW, averaging close to 200 kW) power units. The high-power segment has been the largest contributor to the renewable energy power systems market in term of megawatts installed. The high power units (up to 300 kW), have very low volume demand and vendors cater to it with relatively customized products.
- Small fuel cells are becoming popular in the form of CHP (combined heat and power plants) units that involve the generation of both power and heat in the same unit.
- In comparison to the other two renewable energy sources, such as wind and solar, the inverters used for the fuel cells tend to have higher cost.

Chart 3 illustrates the percentage of revenue by renewable power inverter type.

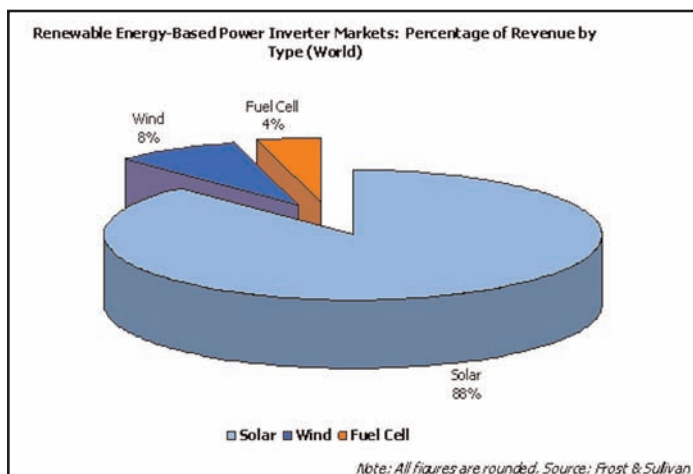


Chart 3

Market Analysis of Each Renewable Power Inverter Type

Solar Energy Power Inverters

- The market is growing at a CAGR of 30 to 35 percent.
- The inverter markets are dependent on the developments in the solar photovoltaic markets.
- Demand driven by incentive programs offered by local governments.
- Vendors are offering a wide range of control and monitoring equipment that make the system more efficient and user friendly.
- Most of the inverters are manufactured by vendors who specialize in power electronics.
- Most of the designs in the market are proprietary and are normally hard to replicate.

Fuel Cells Energy Power Inverters

- The market is growing at a CAGR of 20 to 25 percent.
- Inverters in this market are currently sold in very low volumes.
- Very few vendors manufacture inverters for fuel cells.
- In comparison to wind and solar, inverters used for fuel cells tend to have higher cost.
- As the fuel cell market heads towards commercialization, larger demand is expected, leading to a proportionate increase in the consumption of inverters.

Wind Energy Power Inverters

- The market is growing at a CAGR of 25 to 30 percent.
- The focus of the figure is on the non-utility scale or small scale (below 100 kW) wind energy systems.
- Most of these systems are stand-alone and located / installed in rural and isolated regions.
- Requires surrounding conditions for proper efficiency and effective wind energy harnessing.
- Higher installation and maintenance cost per unit of power than the utility scale wind energy systems.

Conclusion

It is clear that renewable energy has gained special importance in the minds of policy makers as well as the corporate world. High growth, government initiatives and technology development have proved to be significant pointers to growth of renewable energy markets. Solar energy, wind energy and fuel cells are technologies that have a promising future among other contributors. With these explicitly defined initiatives and the right amount of enthusiasm to move ahead, this era of green initiatives is set to transform the direction of energy for the upcoming century.

For more information regarding this article, please contact Johanna Haynes at johanna.haynes@frost.com.

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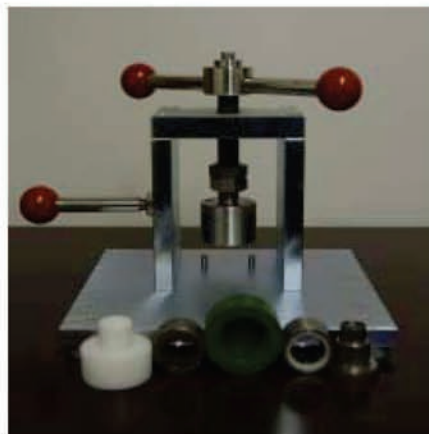


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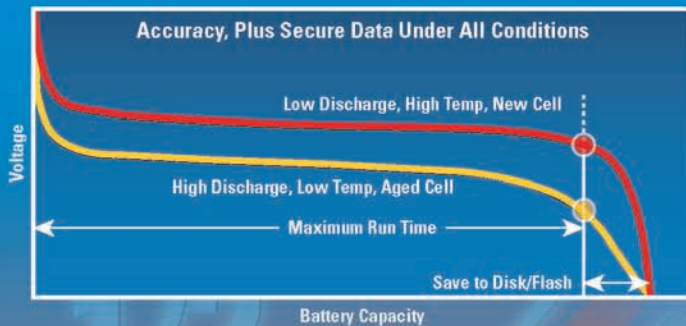
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Quallion was founded by biotechnology entrepreneur and philanthropist Alfred E. Mann and Dr. Hisashi Tsukamoto.

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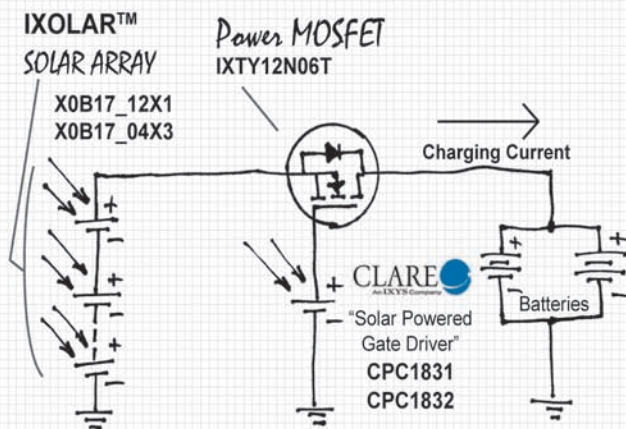
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Battery Power 2008 will feature more than 35 technical presentations. To view the full program, please visit www.batterypoweronline.com/bp08_index.htm

Keynotes

Market Trends – Markets, Technologies and Major Players

Ying Wu, Ph.D., Senior Analyst • Lux Research, Inc.

Turning Up the Heat on Battery Safety: A Guide to Battery Safety Testing

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*Richard Baxter, Ardour Capital Investments, LLC
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Steven J. Powell, General Manager and Director, Security Solutions • Eastman Kodak Company

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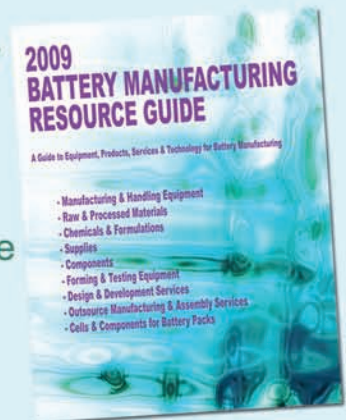
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4-5 - Battery Power 2008, New Orleans, La. Contact Webcom Communications at 720-528-3770 or at www.BatteryPowerOnline.com

14-18 - Intelec 2008, San Diego, Calif.

23-26 - 11th European Lead Battery Conference, Warsaw, Poland

October

8-10 - Batteries 2008, French Riviera

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5-6 - Remote 2008 Conference & Expo, Atlanta, Ga.

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