



**Planning Energy for Future  
Generations in a Sustainable World**

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## Hybrid Generation Technology for Renewable Distributed Generation and Deployment of Micro grids, using advanced EES

### **Summary:**

*Complementary to our product portfolio for solar and wind generation also outlined in this report and in order to attend the growing demand for Rural Electrification and Distributed Generation based on Hybridizing renewable and fossil power sources, Zigor has launched a new range of Hybrid Inverters for micro, small, medium, and high power solutions, covering from 0.3KVA to 1350 KVA and based on four different topologies: KIT assemblies of DC/AC inverters and battery controllers (for low cost requirements), ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT (for small power micro grids for domestic and small power remote stations), HIT3C (for medium power mini-grid and centralized systems for rural remote communities) and HIT3D for multi MW installations where it is more suitable to distribute the Generations Resources along the micro-grid. Also Multi MW hybrid solutions with EES (Electrical Energy Storage) and without are described.*

**Keywords:** *Solar and Wind Energy, Photovoltaic, Hybrid Renewable Micro grid, EES (Electrical Energy Storage), Rural Electrification, Distributed Generation, Mini Wind, Multi MW renewable Integration, Energy Saving.*



## 1. The Role of Renewable Energy and Global Sustainability



Unprecedented world rates of population growth are one of the major concerns of our polity planner community where limitation of resources might soon force to change the consumption patterns and resources usage. Unless that we do not care about the long term heritage for the future generations.

Cheap Energy has been and will continue to be a must to drive development. So far we have been relying on burning fossil fuel and this might be the case for the following decades due to the inertia of changes in this energy sector.

The governments support to renewable during the last years has urged a new industry, renewable, that has encouraged to major energy player to seriously participate to create new business opportunities and probably a new global awareness of a new revolution related to energy innovation as a key to compete in global market.

In addition to the cost reduction of solar and wind energy forms of electricity generation, together with the world initiative and concern with CO<sub>2</sub> emissions reduction and environmental barriers to expand existing infrastructures, are slowly facilitating the development of cheaper new more atomized forms of distributed generation both grid-connected and autonomous.

EES (Electrical Energy Storage) and the hybridization of electricity generation is no longer a technological challenge, but an opportunity to feasibly select the most cost-competitive investment and lowest possible kWh cost for many sites were previous technologies were uneconomical or unfeasible and as a result, ESS plus hybridizing technology are pushing the development of new remote areas worldwide.

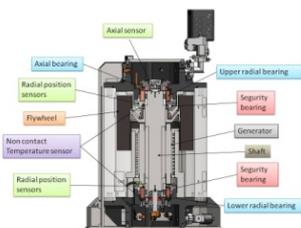
Zigor concerns with world sustainability and innovation is presented in this report with our offer of solutions and technology to support our customer projects in new Hybrid Generation Technology for Renewable Distributed Generation and Deployment of Micro grids, with and without different available EES solutions, both mature and innovative ones.



## 2. Zigor Innovation and Technology Commitment

Our compromise with global sustainability and technology in distributed generation is not only the result of the effort done to offer a comprehensive portfolio of advanced on-grid inverters, from small power string models to multi MW utility scale ones, developed during the last decade.

In addition and as a result of many years of experience in back-up systems, for an heterogeneous set of industrial sectors: Telecom, Utilities, Industries, we have deployed thousands of battery based systems ranging from small to multi MW solution: UPS, battery chargers, EES for grid control. Valuable information about our solution could also be found at <http://www.zigor.com>.



Within EES we have a threefold compromise with our customers: Firstly to continue offering the best price per value using mature battery technologies where appropriate, secondly to offer innovative solutions based on advanced new EES technologies, i.e. advanced batteries (lithium, redox, others), Ucaps, Flywheels, etc. and thirdly to guaranty the correct energy integration using the latest available power electronics solution again to guaranty the highest yield in the different generation systems.

Within this report we present the result of several years of research in advanced power electronics and EES applies to provide reliable cost competitive hybrid system.

## 3. Photovoltaic On-grid Inverters

Zigor technology achieves maximum solar plan yield with our proprietary design topology offering a comprehensive range of products, namely:



The SP1 and XTR3 string inverters are easy operation devices that have been designed to cover the needs of grid connected solar generation plants. In an effort to improve the yield of solar plants, the ZIGOR SOLAR XTR3 inverters offer a very high efficiency, exceeding 97%. The ZIGOR SOLAR XTR3 and SP1 also offer a powerful web server



application, accessible through its SNMP connection. In addition to this, the new ZIGOR SOLAR SP1 and XTR3 range provides a local LCD display and a powerful, where the customer is able to access all inverter information, including production data.

The ZIGOR SOLAR T3, TL3, MV45 and CTR3 have been specially designed for medium and big power grid connected solar generation plants. An outstanding feature of ZIGOR SOLAR MV45 125 and 166 KW inverters is their 98% efficiency. ZIGOR SOLAR MV45 inverters provide high reliability and guaranteed operation. Another outstanding function is the high energy efficiency of its MPPT, which is over 99%. Other important feature is its automatic regulation of reactive power and communications tools between the inverters and the centralized supervision and control system. All its parameters are configurable both locally and remotely. ZIGOR SOLAR inverters comply with all existing grid codes.



Zigor offers PV solar market a plug-and-play solution to reduce the engineering and civil works while designing and building a Megawatt PV plant. The ZIGOR SOLAR Power Station-SPS3, available in 250 KW, 500 KW and 1 MW power is the key solution to improve reliability and yield of solar plants. It has been designed to optimize wiring and size as well as to easy PV plant construction. The ZIGOR SOLAR Power Station is delivered completely finished with the internal wiring fully done. The customer is just a “turn-key” away of connecting the solar field to the AC.

#### 4. Multi MW Solar and Wind Generation Integration

Already current cost for medium and big solar and wind plants could offer short to medium term savings to operate in parallel with the diesel plants.

Zigor offers a very competitive solution to integrate our ZIGOR SOLAR and ZIGOR WIND on-grid inverters with thermal power station. In other words, our technology for regulation and control of the grid stability and fuel saving offers an easy to integrate solution for solar and wind plants.



Both the ZIGOR SOLAR HIT3C and HIT3D allows the integration of medium and big wind turbines into the systems. The ZIGOR SOLAR HIT3C offers integration of wind turbines via rectification and the ZIGOR SOLAR HIT3D allows the integration of standard on-grid turbines into the grid offering a full control of the grid voltage and frequency. The advanced frequency and voltage control of the ZIGOR SOLAR HIT3D topology is ideal to high power storage and storage less mini grid.

Typical application where the ZIGOR SOLAR HIT3D could offer high value is in remote high demand user that normally operates 24 hours with high power gen sets, i.e. remote mining, oil and gas development wells, etc. In these installations the ZIGOR SOLAR HIT3D and the solar inverters could be designed with or without energy storage.

## 5. Electrical Energy Storage Integration

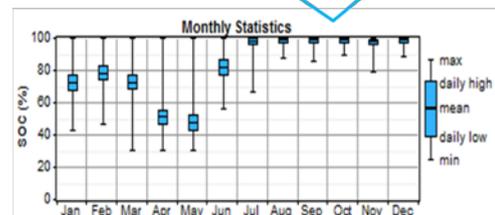


Mature Batteries (Lead, Ni-Cd, Lithium) are still expensive nowadays as a mass electrical storage for long periods of regulation of renewable production. Nonetheless the right sizing criteria of renewable resource, battery capacity and the correct dispatching strategy, together with the optimum gen set operation point might result in a cost competitive levelised cost of energy as compared to plain diesel based forms of

generation.

Our Hybrid technology offers an easy and flexible setting mode to fit the correct charging method. They also offer an easy integration of AC and DC where the Renewable PRIOR MODE provides an effective energy/fuel saving capability. The Special SILENT MODE set up brings the possibility to prioritize the energy use of the Battery for night operation. With the Battery Peak Saving MODE, the battery only play a role of covering the demand during short periods of time till the AC sources enters into generation. In this way, this MODE expands the battery life.

Selectable discharge strategies are available: Silent or Night Mode and Peak Saving Mode





The Get Set Control System embedded within the hybrid controller not only starts and stops the generation when it is required, but while operating the actively maintain the Gen Set at the minimum required regime with the corresponding reduction of fuel consumption.

Peak Saving and short periods (seconds to a few minutes) reserve based in mature technologies is today offering short term return on investment for hybrid systems. This niche application is also covered with our hybrid technology.

Long term back up time (hours) storage of electrical energy represents a challenge in terms of cost and become more critical as we move from thousands of kW to MW, however we are already offering multi MW battery based systems for grid EES integration with our bidirectional charge and discharge inverters capable to manage Lead Acid, Ni-Cd, Lithium and Flow batteries.

## 6. Distributed Generation, Micro grids, ESS and Hybrid Technology

In order to attend the growing demand for Rural Electrification and Distributed Generation based on Hybridizing renewable and fossil power sources, Zigor has developed a range of Hybrid Inverters for small, medium, and high power solutions, covering from 0.3KVA to 1350 KVA and based on four different topologies: KIT assemblies of DC/AC inverters and battery controllers (for micro low cost requirements), ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT (for small power micro grids, domestic uses and remote sites for telecom and other small power demand), ZIGOR SOLAR HIT3C (for medium power mini-grid and centralized systems for powering small communities, water pumping, etc) and ZIGOR SOLAR HIT3D for multi MW generation where it is more suitable to distribute the Generation Resources along the micro-grid. The Hybrid Inverter Range ZIGOR SOLAR HIT3D has been specially designed to build distributed hybrid micro-grid, allowing sharing the electricity generation from several different sources based on renewable as well as other generating sources and EES.

In summary, we offer three different products for different customer's topologies requirements, namely:

The Range of Hybrid Small power Inverters ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT . This product has been designed to offer professional solution to rural electrification, remote telecom sites and domestic micro grids. This system has already been adapted to use LiFeO4 batteries for frequent cycling applications, i.e. daily discharge. The powerful web server eases the integration with utilities dispatching centres for demand side management.

The Range of ZIGOR SOLAR HIT3C for small/medium size mini-grid and centralized systems.



The Range of ZIGOR SOLAR HIT3D for medium/big power installations where it is more suitable to distribute the Generation Resources along the micro grid. The ZIGOR SOLAR HIT3D together with standard on-grid inverters such as ZIGOR SOLAR PV Inverters, ZIGOR WIND Inverters and the ZIGOR SOLAR BG3 bidirectional Inverter for EES, complex yet powerful Micro-Grids can be designed and built.

The inverters always satisfy the demand giving priority to renewable, filling the peak demands from the battery if the wind or sun resource is not enough and lastly the AC source is used (Gen Set or Grid). When the demand is lower than the renewable resource available, then either the gen set or the grid (AC source) enters into generation to fulfil the demand and charge the battery immediately. When the AC source enters into generation, it only provides the difference between the demand and what is provided by the renewable resource and therefore saving fuel in the case of gen set operation or consuming only the minimum required energy from the grid.

The battery charger is compatible with Lead Acid, Ni-Cd, Flow and Lithium Batteries. Selectable discharge strategies are available: Silent or Night Mode and Peak Saving Mode.

Typical applications for our hybrid technology are:

- Home and Small Micro Grid Remote Rural Electrification
- Distributed Mini grid and Interactive Micro Grid
- Peak Saving
- Wind and Solar UPS
- Demand Side Management with Storage
- Gen Set Fuel Saving
- Multi MW solar and wind Storage-less hybrid with Power Plants
- Hydro and Solar Hybrid Systems

Advantages of our Hybrid Technology

- BEST EFFICIENCY
- COMPETITIVE DISTRIBUTED GENERATION
- PROFESSIONAL RURAL ELECTRIFICATION
- HYBRID SOLAR, WIND, BATTERY, GRID, GS
- RELIABLE ENERGY MICRO GRID
- MAINTAINABLE, MODULAR AND SCALABLE
- EASY TO TRANSPORT, INSTALL AND REPAIR
- WEB SERVER REMOTE MONITORING

### 6.1. ZIGOR SOLAR HIS1 COMPACT: Hybrid Reliable Micro grids



The ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT system is based on Hybrid Inverter architecture capable to generate AC current from different inputs: Renewable (solar panel and small wind turbines), Battery and Fossil based generation. A set of modular converters allows different patterns of Solar, Wind, Battery and Gen Set or AC Grid.



ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT allows building mini-grids from 4kW to 6,6kW of power. It could be built for different output voltages: 230V, 120V, 108V, 100V+100V and 50Hz or 60Hz. The Battery Controller allows different battery technologies and capacities: Lithium, Lead, NiCd and Flow Batteries. Multiple Controllers could be installed in parallel to satisfy different PV and Wind powers. PV solar panel ranges from 4kWp to 25kWp. As for Wind turbines, powers of 600W, 2kW and 6kW could be also connected.



## 6.2. ZIGOR SOLAR HIT3C : Hybrid Professional Micro grids



The ZIGOR SOLAR HIT3C system is based on Hybrid Inverter architecture capable to generate AC current from different inputs: Renewable, Battery and Fossil based generation.

ZIGOR SOLAR HIT3C allows building three phases micro grids from 30kW to 100kW of power. It could be built for different output voltages: 3x220V, 3x380V, 3x440V, 3x480V and 50Hz or 60Hz. The range of ZIGOR SOLAR HIT3C hybrid inverters is designed to meet power requirements in locations not covered by the grid, hybrid rural electrification and distributed generation. The main feature of hybrid ZIGOR SOLAR HIT3C inverters is that they are capable of generating electricity from Solar or Wind resources, from Batteries, from the Grid or from a Gen set. The Battery Controller allows different battery technologies and capacities: Lithium, Lead, Ni-Cd and Flow Batteries.



## 6.3. ZIGOR SOLAR HIT3D : Utility Multi MVA Hybrids ESS

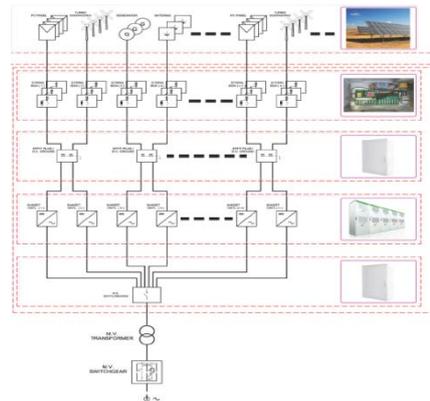


In order to attend the growing demand for Rural Electrification and Distributed Generation based on Hybridizing renewable and fossil power sources, Zigor has developed a range of Hybrid Topology for medium and high power solutions, covering from 150 KVA to 1350 KVA.

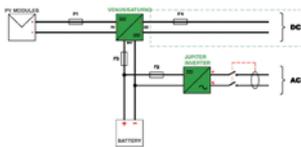
The Hybrid Inverter Range ZIGOR SOLAR HIT3D can also be connected to Fuel Generators so that avoids any blackout in the micro-grid in case the renewable generation cannot cover the load demand.



The Hybrid Inverter Range ZIGOR SOLAR HIT3D is also capable to be connected to existing distribution grid. In these cases, the ZIGOR SOLAR HIT3D Inverters will manage the energy flow between the micro-grid and the Distribution Grid. This functionality makes possible the energy return to the Distribution Grid when the generation exceeds the consumption as well as to work autonomously even if the Distribution Grid is not available. Additionally, the ZIGOR SOLAR HIT3D Inverters can be installed with both Distribution Grid and Emergency Fuel Generator.



#### 6.4. KITs: Hybrid Cost Competitive Micro grids

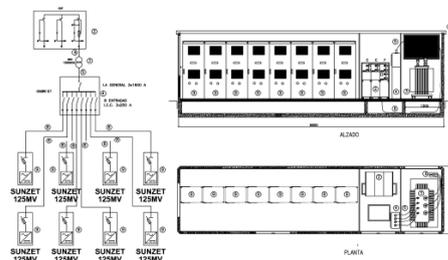


There are many applications where solutions can be built from small inverters and solar battery charging controllers. For this market of integration, Zigor has wide range products. Typical applications are small isolated systems of telecommunications, small isolated houses, pumping stations, etc.

The Venus (PWM) and Saturno (MPPT) regulator controls and stabilizes energy production from solar panels to be stored in the battery, and avoids overloading, battery: accumulates the energy collected by the solar panels and Jupiter and ZIGOR SOLAR HIS1 inverters transforms DC from the batteries into AC. Jupiter is a top quality DC/AC inverter and the ZIGOR SOLAR HIS1 range also allows the integration of a back-up grid or gen set.



#### 7. Design Engineering Service and Service Support



Zigor also offers a System Design Service to provide Customized Solution. For instance, Zigor may provide the customized Shelter Design for the complete set to comply with the specific site specs: Battery Size, Gen Set Integration, Maintenance By-Pass, MV transformer, etc.



## 8. Micro Wind Generation



Although not as predictive in terms of yield on a daily basis as solar energy small wind could play an important role in special sites and as a complement to solar panels might be use to improve the average availability. Zigor also offers a complete set of small wind turbines in the power range of 300W, 600W, 2000W and 6000W both for on-grid and hybrid off-grid integrated with our ZIGOR WIND inverters and our ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT respectively.

Typical applications that our robust micro wind products match perfectly with our advanced ZIGOR SOLAR ZIGOR SOLAR HIS11 COMPACT are:

- Remote homes and farm utilities (electric fencing, irrigation, etc.)
- Street lighting and road signalling
- Complementary installation with photovoltaic modules
- Water pumping
- Cathodic protection
- Remote monitoring sites
- Telecommunications

## 9. Remote Control and Monitoring



Zigor products are equipped with a powerful controls and monitoring web server based SCADA is embedded into the system offering: Multilanguage Platform, Friendly user interface, Real Time Energy Monitoring, Easy Parameterization, Logging Capability, Multi-Comm: TCP/IP, MODEM, etc. and Remote firmware update.



## 10. Off-Grid Reference Projects

### **Zigor Chile installs several remote telecom sites in the Andes**



The system is capable of providing telecommunications equipment with power, autonomously and independently of the mains electricity. For this purpose, a photovoltaic solar power system has been provided with a high-capacity storage system based on jellified and sealed lead electrolyte batteries.

### **Zigor do Brazil installs a mini-grid with hybrid system ZIGOR SOLAR HIT3C 50KVA in the State of Maranhão, Brazil**



Zigor in collaboration has finished and set up successfully an autonomous mini-grid (photovoltaic with energy storage) in Brazilian territory. This installation is a mini-power station that will generate electricity for the population of the island "Ilha Grande", located on the Northwest coast of Maranhão State, north-eastern Brazil. This new infrastructure is based on a photovoltaic solar field, an emergency generator, an energy storage system and a hybrid inverter of 50 KW model ZIGOR SOLAR HIT3C 50. The mini-grid has been designed to support current energy needs as well as the expected future growing demand of energy by the community, when the continuous and reliable electricity generation is established.

### **Zigor India Pvt. Ltd. installs successfully its first Solar Photovoltaic Hybrid Inverter, ZIGOR SOLAR HIT3C 100 kW**



Zigor India Private Limited, the branch of Zigor Corporación, S.A. in India, has recently announced that its first Solar Photovoltaic Hybrid Inverter, ZIGOR SOLAR HIT3C 100 kW, installation has been successfully completed by the end of March of 2012 at the location of Lonavala, Maharashtra. This project may be considered an important milestone in new applications of Renewable Energy in India.



### **Domestic system installation in the town of Tunquen**



Zigor developed a system based on non-conventional renewable energy, in the town of Tunquen, located in the central coast of Chile, an ideal place for photovoltaic and wind system installation. Zigor conducted a previous feasibility and engineering study of the site and then began the civil and electrical work for implementation of a hybrid system (photovoltaic and wind). The project included the installation of mono crystalline solar modules PSM 175 Watts, voltage regulator Saturno, three wind turbines of 600 watts, 8 kVA ZIGOR SOLAR HIS1 hybrid inverter, batteries, assembly and electrical connections, installed and provided by Zigor, who has developed these products to high quality standards and requirements by the customer. Currently the system serves 100% of home energy needs consumption, all guaranteed by Zigor.

### **Zigor México installs a Solar Photovoltaic Hybrid Inverter, ZIGOR SOLAR ZIGOR SOLAR HIS1-6K**



Zigor México has installed a Photovoltaic Hybrid Inverter, ZIGOR SOLAR HIS1 6kW, to autonomously power the lighting systems of a Stadium “Polideportivo de Cd. Serdan”. It power the lighting system based on solar energy at a soccer field located in Ciudad Serdan, Puebla. The average back-up time is 4hr per day.





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