



Editorial Message

Dear Reader,

The increasing demand for energy, rising fossil fuel prices and growing concern over climatic changes arising out of carbon emission have turned the focus on alternative source of energy. Owing to these reasons, the need for tapping solar power and popularising its use is gathering pace in India. The Indian government has set a target of achieving overall solar generation of 100GW of power by 2022, under the Jawaharlal Nehru National Solar Mission (JNNSM) initiative.

To accomplish this, the government is taking necessary steps to boost both grid and off-grid solar segments. As a result, it is quite likely that solar Photovoltaic (PV) based power plants will become an exciting business opportunity.

Building a solar grid connected plant and selling energy is fast emerging as a sound investment option. This provides huge opportunities for solar players to get into the power generation business. However, to enter and explore this new opportunity, the players need to understand and focus on key requirements like land availability, strong financial backing, right technology mix, right talent etc. to undertake solar energy projects and partner those who can setup and support the solar PV plants operation.

In a Solar PV plant, besides PV panels, balance of system such as wires, switches, control system, inverters, and labour for installing solar modules represent more than half the cost of such a system. Solar micro inverters are an emerging segment of the solar power, which will change the solar installation perspective. An article on "A Micro Inverter" gives an insight into this technology.

When it comes to large-scale solar plant, it requires technologies to improve power system reliability. C&A has an answer to it with its G-Vertor RECon (Solar Grid Inverter) which efficiently distributes and manages locally generated solar energy from panel DC output to the grid connection.

In the case study section, we have featured the Welspun solar project where we have supplied our SCADA system for 50 MW solar PV plant in Rajasthan.

At C&A, we are committed to promote green energy for creating a low carbon future and accelerating economic growth. Towards this, our business unit offers a range of robust solutions for solar Photovoltaic (PV) plants. C&A has developed indigenous capabilities to offer balance of system and the requisite power evacuation systems from 'concept to commissioning' basis for utility scale solar PV.

We hope that you will find this issue of Canvas informative and useful. Looking forward to your responses and constructive feedback.

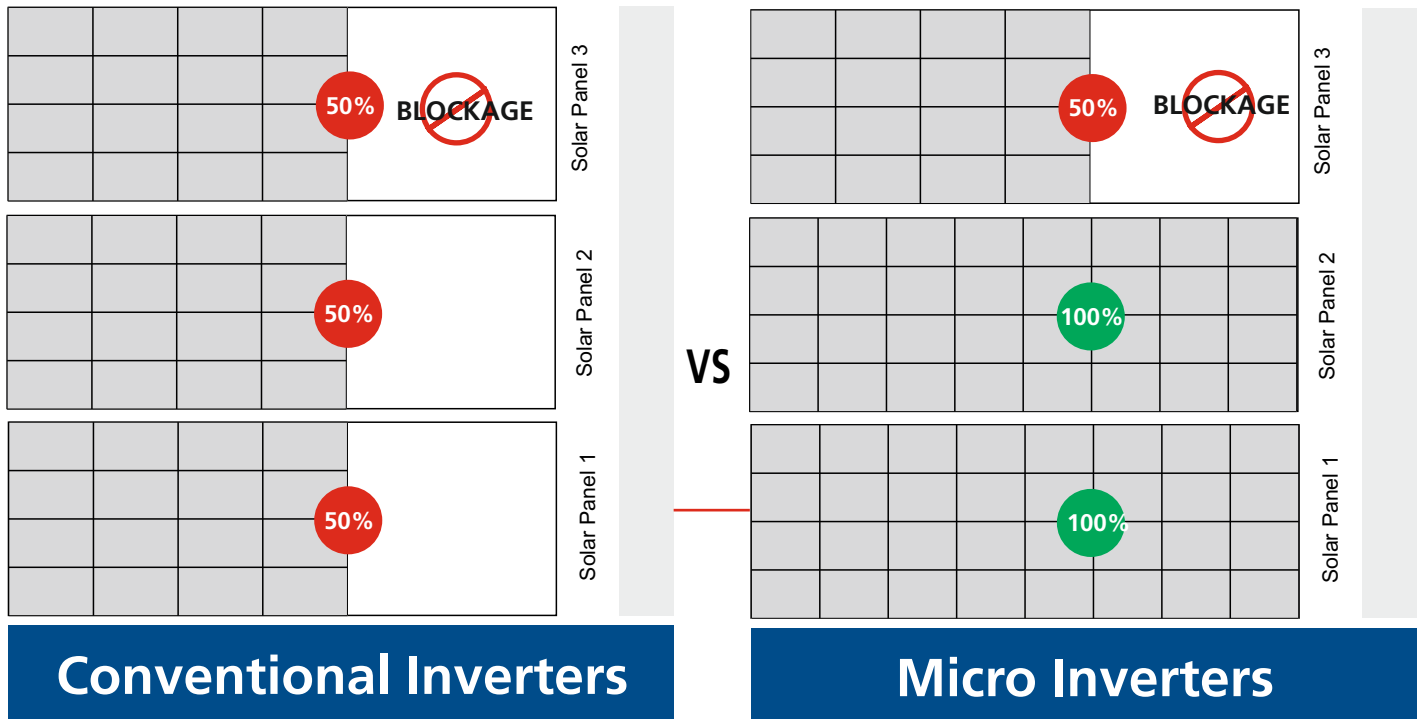
Happy Reading !!



J. K. Chattopadhyay



The Micro-inverter: Transforming industry perceptives



Make in India is one of the major policy initiatives of Prime Minister Narendra Modi which covers almost every sector. Solar, as a part of renewable energy, is one of the focused sectors which is expected to grow to 100GW by 2022. Increasing demand for clean energy along with government incentives has expanded the solar market, but the high initial cost of photovoltaic (PV) systems is still inhibiting its widespread adoption.

A PV system typically consists of the PV array, inverter and other protection systems that form part of the balance of systems. In the PV array, individual solar cells that produce DC power are grouped together into a solar panel or module. Several of these are then grouped together to form a PV array.

The DC power from the solar array needs to be converted to alternating current, or AC power, before it can be connected to the utility grid. Thus, inverter becomes an integral part of any solar power system. It plays a key role in the utilisation of solar energy for the end user by feeding it to the existing grid. It converts solar power direct current (DC) to alternating current (AC) through a delicate electrical switching process. Advancements in inverter technologies are making them smarter and more critical to the success of solar power generation. There are majorly three different types of grid-tied inverters available - micro, string and central. Each inverter has its own advantages and disadvantages based on the application.

Traditionally, choosing an inverter for a commercial system would begin with determining the PV system size. A central inverter is used to convert the entire PV array into grid-synced AC. This

inverter can be placed indoors or be outside with some protection. Solar installations of megawatt scale typically have a large central inverter that takes the direct current generated by a group of panels and converts it into AC for the electrical grid.

The industry standard string inverter solar system comprises a number of solar panels linked together in series forming strings. The voltage and current of all panels is combined into a single output that is fed into the inverter. The problem with this is that any drop in current or voltage within one panel affects the entire string; a decline in the performance of one solar panel and will automatically hamper the performance across the entire string which is also known as Miss-Match losses.

Micro inverters are able to address this issue since they are electrically connected in parallel rather than in series. What's more, they optimise the power conversion process by adapting the system to changing environmental conditions (shading, dust and debris, non-uniform temperatures, sub-optimal irradiance angles etc.). So if one panel suffers from environmental interference or a panel failure, it does not affect the entire array. The electric power from several micro-inverters is combined and fed into an electrical grid.

These small sized inverters have some distinct advantages over central inverters and the string inverters. Besides reducing the miss-match losses, each micro-inverter obtains optimum power by performing maximum power point tracking for its connected panel, thus improving efficiency and reliability.

One of biggest advantages of using micro-inverters is that there is no limitation to sizing the plant capacity. To increase the size of a solar plant, you can simply add single or any number of panels of different wattages and even different manufacturers in parallel to the existing power plant. It even gives the liberty to curtail the start-up cost and can be expanded in the later stages.

Other advantages of Micro-inverters:

- Micro-inverter is easy and faster to install as compared to traditional inverters. It reduces the wiring time and removes the need for DC switching points.
- The installation of Micro-inverters is not limited by string design, marginal designs, co-planarity, and miss-matched modules.
- MPPT (expand) is applied to each individual panel which yields in 5-25% increase in power as compared to systems using string inverters
- It is possible to monitor each panel and inverter performance which helps in maintenance. The life of micro inverters is more than traditional sting inverters as they are not exposed to as high power and heat loads as central inverter.
- Micro-inverters typically come with a warranty of 20-25 years – 10-15 years longer than central inverters. With minimal budget, one can start implementation as it is flexible and scalable. One can add new solar panels as and when required.

With a micro inverter, it becomes an AC module system, and the installer's crew or the maintenance personnel are not exposed to high voltage DC which is highly dangerous and unsafe to work with, even in terms of operation and maintenance.

In traditional string inverter, DC bus voltage is as high as 600V DC or 1000V DC so while installation and performing maintenance, a user has to de-energize the AC distribution which results in service interruption. In case of fire, shutting off power with circuit breakers only shuts off the centre inverter and not the DC voltage generated from the panel. As a result, it is dangerous to spray water as it can actually make a fire worse.

Major Drawbacks of Micro inverters compared to String Inverters

Primary disadvantages of micro inverters are that they have a higher initial cost per peak watt than a central inverter, and second, as they are located near the panel, they may be harder to reach and maintain. But these problems could be overlooked by their higher durability, efficiency and ease of installation.

Micro inverters are placed individually to the rack below each panel, due to which these are exposed to hottest part of system and could lead to problems in case of insolation areas. Typically, they are used for smaller size systems. For large scale power plants, it becomes economically and technically difficult to implement.

Looking at the large number of advantages, many inverter manufacturers have engaged in research and development to overcome the challenges in the implementation of Micro-inverters. In the near future, the market would provide AC rated power generating solar modules with plug and play mechanisms to ease the clean energy requirements.

iVision_{max} -SOLAR™ **SCADA for PV Plants**

Today monitoring and performance analysis of solar PV plants has become extremely critical due to the increasing cost of operation and maintenance as well as reducing yield due to performance degradation during the lifecycle of the plant equipment. This means that the use of centralised monitoring & control system is essential to ensure high performance, low downtime, and fault detection of a solar PV power plant during the entire lifecycle.

Keeping in mind the need of the industry, L&T-C&A's has developed a solution for Solar PV - **iVision_{max} -SOLAR™** - an advanced, ideal best in class monitoring & control tool to manage your solar photovoltaic plant. It enables centralized control & operation from a central location and incorporates all the basic features available in a high-end Generation SCADA system and primarily used at:

- Local level: Best in class to manage your solar photovoltaic plant locally
- Remote level: Enables clear overview of complete plant for remote monitoring
- Head office: Centralized monitoring of key performance indices of various solar plants integrated with head office system over internet.

It offers

- Open architecture allows easy upgrading to new technology Enables Plant parameter Monitoring, Electrical Control in a plant
- Weather Data –Solar Irradiance, Wind Speed, Wind Direction, Ambient Temperature, Relative humidity, Particulate Meter & Rain Gauge
- Formulas and rules to the parameters measured to obtain efficiencies, trends, performance ratios and estimation of losses at the solar plant
- Communication health monitoring

Basic features

- Electrical Network Monitoring & Control
- Inverter & String Performance Monitoring
- Tracking Control
- Alarms & Events logging
- Trends & Reporting
- Email and SMS Alert
- Secured User Administration
- Dashboard / KPIs of the Solar Photovoltaic Plant in real time

Advanced Features

- Asset Management
- Security Surveillance
- Power Evacuation
- Yield Reports
- Performance Ratios O&M Calenders



Energize your Solar PV Plant



At Larsen & Toubro (L&T), we realize the tremendous potential of solar energy and are committed to harnessing this non-conventional resource to promote green energy for creating a low carbon future and accelerating economic growth. Towards this, the Control & Automation (C&A) business unit offers a range of robust solutions for Solar Photovoltaic (PV) plants that includes Grid Inverter, String Monitoring Box, Solar SCADA MVIHV Switchgears and Compact Containerised Substations.

The **g-Vector**'s RECon Line of solar inverter from Larsen & Toubro is ideal for large-scale solar power generation which helps reducing the cost of Balance of System(BOS) of entire solar plant. It complies with all specifications laid down by Ministry of New and Renewable Energy (MNRE) under National Solar Mission for Solar projects.

Drawing on decades of L&T's expertise in power electronics, the ReCon Line of central Inverter is highly reliable, efficient and offers essential features designed for large Solar applications.

The inverter's modular industrial design makes it easy to install, operate and maintain, which improves the durability and efficiency over the entire life cycle of the inverter.

The built-in MPPT features ensures maximum performance from solar modules under all operating conditions. Designed for harsh environment, the inverter operates in a wide operating

temperature range of -10°C to $+55^{\circ}\text{C}$.

It guarantees performance and reliability in tough conditions which makes it an excellent option for installations across India. L&T Control & Automation also offers a service contract to cover spare support and warranty extensions.

Recon Line key features:

- Scalable to meet the requirement of megawatt power plant
- Optimised for High efficiency upto 99.3%
- Built-in Control, Protection and power Regulation
- Compliance to country specific grid code requirements

Life cycle services for **g-Vector**

L&T offers entire span of value added services from pre-installations, maintenance to training that maximises uptime and performance of the entire system.

L&T facilitates operation and maintenance services through service level agreements which includes on-site predictive, preventive, and corrective maintenance..

To increase effectiveness in the operation, maintenance and trouble-shooting of your inverters, we train your operators, electricians and supervisors by offering training and workshops to improve plant availability. This is backed by L&T's strong service network across the country covering :

- Annual Maintenance contract
- Operation & Maintenance services
- Spares Support
- Strategically placed Service centers across country
- Upgrades & Migration Services
- Training services
- Remote monitoring and assistance

Features that ensure high reliability

Compact and Modular design

- Fast and Easy installation
- Industrial design suitable for harsh environment
- Effective design for thermal management
- Efficient utilization of space

Higher conversion efficiency

- Efficiency as high as 99.3%
- Low auxiliary power consumption
- Maximum power point tracking

Communication

- Standard Industrial communication options
- Ethernet / RS-485 / RS-232 / USB

- Internal Memory storage in case of communication failure

Grid Compatibility

- Compliant to Indian grid code
- Automatic power factor correction
- Power Management functions

Protection Systems

- Integrated AC and DC side protection
- Surge protection
- Ground Fault Detection, Indication and Protection
- Anti- Islanding

Balance of Systems (BOS)

An efficient and robust power system infrastructure is a vital part of large scale solar plants. Therefore it is important to design and implement power systems to achieve plant's availability and profitability.

L&T C&A has indigenous capabilities to deliver power evacuation systems from "concept to commissioning" basis for utility scale solar PV Plants. Our "Balance of System" (BOS) solutions comprises of HV/MV switchboards, RMUs, relays, transformers, meters, SCADA and control system. L&T-C&A offers design, engineering, manufacturing, testing & installation services covering electrical systems, electrical protection, control systems, civil installations adhering to prevailing electrical standards.

Experience of over 3 decades in power projects, in cooperation with almost all the major industry consultants, has helped L&T-C&A deliver optimum solution for power plants. We deliver integrated BOS solution with the help of state of the art engineering & manufacturing centre, dedicated life cycle support team and vendor ecosystem; tailored to different types of requirements, across industry sectors.

Other Solar Solutions:



G-RayStation -

Outdoor Substation

It is a "plug & play" - Container based compact substation equipped with inverters, transformer, medium voltage switchgear, metering, surge arresters, protection and control equipments, auxiliary power and control system.



G-RayBox -

String Monitoring Box

L&T's **G-RayBox** allows the monitoring of the performance of each string of the PV plant through high accuracy direct current measurement.



G-RayCon -

Solar Controller

The **G-RayCon** is a comprehensive industrialized solution for monitoring & data acquisition of the complete solar PV Plant, seamlessly integrating with the subsystems in the plant.



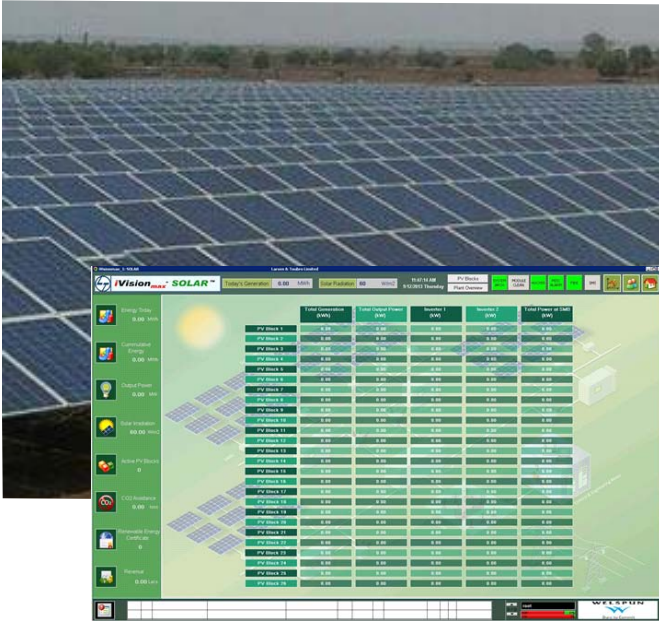
iVision_max-Solar -

Solar SCADA

It is suite is a cost effective tool which continuously controls and monitors the plant, thereby resulting in lower downtime and enhanced improvement of the plant's overall profitability.



C&I Package for Welspun Solar 50 Mw Solar



About Customer

Welspun Energy Ltd. (WEL) is an leading power company based in New Delhi, India. It is a subsidiary of Welspun Group which has interests in power generation, infrastructure, exploration and production of oil and natural gas, steel pipes and textiles. Aiming to commission 1,700 MW of solar and wind power projects across India by 2016, WEL has successfully commissioned around 320 MW capacity of solar PV projects on a turnkey basis well in advance of the stipulated timelines. Currently, cumulative solar and wind projects are under construction in 5 states in India. Welspun Energy has thus achieved a leadership position as the Solar EPC market in India.

Need

To meet the challenges of climate change and address India's energy needs, the Government of India launched a major initiative - The Jawaharlal Nehru National Solar Mission (also known as the National Solar Mission) as solar power is abundant and offers a solution to fossil fuel emissions and global climate change.

The objective of the National Solar Mission is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible.

Welspun Energy, committed to supplying clean energy to power India's growth, won the contract of building 50 MW solar project near Phalodi, Jodhpur district in three phases (15, 15 and 20 MW) through a competitive bid under Batch-2, Phase-1 of the Jawaharlal Nehru National Solar Mission.

Solution

As a part of this project, L&T-C&A was awarded a contract by Welspun Energy to provide Control & Automation system for India's largest Solar PV Power plant based on Thin Film Photovoltaic Technology (50 MW) in the national renewable energy programme. C&A was selected by Welspun Energy for providing the technically superior and economical solution in a competitive bidding. The extensive knowledge of control systems, project management and solar technology gave C&A an edge over the others.

As part of the contract, C&A was responsible for Design, Engineering, Supply, Installation, Commissioning of complete Control & Automation package covering

- RTU based Control System with 25 Nos of RTU panels
- State of the art SCADA system (*iVision_max*) for control, monitoring & data acquisition
- IT hardware including the Servers and Engineering stations and networking hardware
- Weather Monitoring System
- Fire Alarm System
- CCTV System
- OFC cable network

The communication was established between RTU panels with field equipment like String Monitoring Units, Weather Monitoring System, Inverters, Multi Function Meters & Relays in the Switchgear panels. After establishing communication with the RTU, the data from the above equipment was monitored and controlled through the start-of-art *iVision_max* SCADA system. The reports were generated that could be effectively utilised at various levels of the organisation.

The RTU panels were connected to the switchgear panels to monitor and control breakers in the panels. CCTVs were commissioned across the plant for perimeter surveillance of the solar PV plant, where all the cameras were connected to the central control room.

Fire alarm system with multi sensor type smoke detectors were commissioned in the inverter, switchgear and control rooms. This equipment was further connected to RTU system for remote monitoring. The Weather Monitoring System was deployed for providing ambient Temperature, Module Temperature., Incident solar radiation through pyranometer and wind speed. This equipment was further connected to RTU system for remote monitoring.

The plant was commissioned and is in operation since March 2014.



L&T-C&A bags Balance of Systems (BoS) order from ACME



Control & Automation, a leader in delivering Integrated Electrical & Automation Solutions has won a contract from ACME Cleantech Solutions Private Limited for supply of an Electrical Balance of System (BoS) for 30MW Yemmiganur Solar Power Project, Located at Kadivela - Village, Yemmiganur Mandal and 20MW Pathikonda Solar Plant, Kuunool Dist, Andhra Pradesh, India.

The project includes design, engineering, supply and commissioning of turnkey Electrical System for Balance-of-system that will connect the plant to the national grid. C&A will supply switchgear, control protection, & metering incorporation consisting of inverter transformer, HT power cables, LV Power Cables, MV Switchboards, Lightning Arrestors, CTs, PTs, ABT meters, SF6 Circuit Breakers, Lighting Protection Systems etc to optimize operations and ensure maximum efficiency.

The project is expected to be completed by the mid of December 2015. To meet the tight project deadline, C&A is geared-up to complete engineering and supply on time.

ACME has an existing portfolio of over 1.5 GW including Telengana 486MWp, 110 MWp in Punjab, 192 MWp in Andhra Pradesh, 120 MWp JNNSM Phase II Projects in Rajasthan and other projects in the states of Gujarat, Madhya Pradesh, Rajasthan,

Odisha, Telengana and Chhattisgarh. The company aims to generate 7500 MW by the year 2017.

Solar sector is playing important role in adding power capacity with minimal environmental impact,

L&T-C&A focuses on renewable energy in the Indian offers wide range of solutions that includes Inverter, String Monitoring Boxes, Solar SCADA, Balance of Plant systems (BoS) including Electrical Systems, Surveillance, Weather Station, Power Evacuation with Auxiliary Systems, Enterprise Level Monitoring and Reporting Package to operate and Maintain a Solar Plant efficiently.

Prior to this, L&T-C&A also successfully supplied and commissioned C&I package for World's largest, 125 MWe Concentrated Thermal Solar project of Reliance power at Dhursar, Rajasthan.



Customer Speak



Interview with Mr. Viren Doshi, Director, WAAREE Group about their ambitious plan in Solar Industry and L&T-C&A's performance as a solution provider for Solar Photovoltaic Power Plants.



Over the past few years, your esteemed group has witnessed an impressive growth in Solar in Industry. Can you please share a brief about your company's journey so far and forthcoming plans?

Established in 2007, we are one of India's most diversified and fastest growing solar power solution company with a presence across the solar power value chain. We operate in the field of manufacturing solar PV modules, design engineering, procurement, construction, operation & maintenance of solar PV Power Plants.. At WAAREE we believe in delivering the best to our customers and provide real time operational support & maintenance to large scale solar power plants with a proven experience of over 150 MW. We are very committed to solar energy, today we have India's largest solar PV module manufacturing capacity of 500 MW, being scaled up to 1000 MW by the end of 2015. This expansion is very much in line with our Hon'ble Prime Minister Shri. Narendra Modi's vision of 'Make in India'.

L&T has provided WAAREE with Solar Solutions that supports your plant operations and helps to meet generation requirements. Can you describe the background to your requirement, the solution and the results it has achieved

Solar power plants are often located at remote area. To

improve operational effectiveness, we have invested in various automation platforms which plays a vital role in sustainable Solar Generation. It helps in reducing risk, limit cost and improve operational effectiveness. L&T-C&A provided a tailor-made automation solution comprising of String Monitoring, Control System, SCADA to meet our needs which provides remote monitoring, control and diagnostics to maximize plant availability, productivity and efficiency.

Why did you select L&T-C&A for this project?

L&T C&A has solutions, know-how and services for all Solar PV Plants These well - proven solutions are designed for optimizing project cost and maximising plant performance. We decided to work with L&T to provide electrical and automation solution for Solar PV plant on the basis of its quality of solution and engineering, timely delivery, price considerations and local support available across country. Being Large System integrator company, L&T-C&A undertakes end-to-end responsibility of engineering, supply and installation & Commissioning and support.

Would you like to continue your association with L&T-C&A for your forthcoming projects?

India needs economically viable and cleaner energy to keep pace with its growing economy Waaree is geared up to exceed the expectations of our customers and make substantial contribution to India's solar power growth plans. To deliver projects on time we need a partner with the ability to deliver robust solution and support to minimise our exposure to risk. L&T-C&A has the capability, experience and a track record in this space. In future we shall continue to associate with L&T-C&A for our various needs.