

# INVERTER MANUFACTURERS GEAR UP FOR NEW PV ERA

Meet the world's largest dedicated solar inverter company  
as it bears the fruits of its R&D origins



**UNDER THE HOOD**  
INSIDE THE INNOVATIONS  
CHANGING THE INVERTER  
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## SUNGROW

The solar industry is booming at all scales. Sungrow's R&D driven approach has created a product portfolio that can cater to every project's individual requirements.

Email: [info@sungrow.cn](mailto:info@sungrow.cn)  
Website: [www.sungrowpower.com](http://www.sungrowpower.com)

Find out more at:  
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Intersolar South America, [Booth F08](#).  
PV Taiwan, [Booth K0130](#).  
Renewable Energy India, [Booth 3.137](#).  
All Energy Australia, [Booth 2914](#).

# Introduction

From residential rooftops to sprawling utility-scale plants, solar modules have rooted themselves in the public consciousness as the 'face' of the industry. They also garner the most scrutiny from analysts, press and project financiers. But the real beating heart of any project is the inverter.

A range of factors; poor performance, low durability, incompatible component selection, a lack of functionality, can all choke the performance of a project. It takes a combination of ingenuity, manufacturing rigour, intelligent software and exquisite after sales support to ensure the inverter is a booster not a bottleneck to any given PV system.

A variety of companies with a variety of backgrounds jostle for position in the inverter market but there is one that could truly be called a solar company. Sungrow has built its business up on the foundation of solar inverter manufacturing, its origins lie in PV. Manufacturing and selling inverters is not just one small cog in a much bigger machine.

In this special collaboration between PV Tech and Sungrow, we'll investigate the company's roots, its technology, its stable finances and its all-encompassing product line up covering every solar application.

We'll take a deep dive, no pun intended, into what many are calling the third pillar of PV, floating solar. Mark Osborne will assess the market for floating solar and where Sungrow's place in this emerging sector lies in the wake of its research and development efforts.

Together with Sungrow, we'll also demonstrate the company's product selection philosophy and meet some of the key customers already putting Sungrow at the heart of their work. We'll look at how Sungrow is matching the market's requirements, be it for central or string inverters or even the inclusion of energy storage.

Sungrow's pedigree in research and development (its testing facilities are approved by UL, CSA, TÜV Rheinland, and TÜV SÜD) comes to the fore when we look at the company's leading position in emerging product trends. Be it incorporating energy storage or 1500V system architecture, Sungrow's R&D team (the largest dedicated inverter team in the industry) has a track record of transferring innovation from the lab to the real world.

In the following pages we'll assess all of these market trends as we robustly explore Sungrow's claim to be the largest dedicated inverter manufacturer in the solar sector.

## Sungrow Milestones

**1997**

Founded by university Professor Cao Renxian

**2002**

Supplies projects for Chinese government's rural power initiative

**2011**

Floats on Shenzhen Stock Exchange

**2013**

Manufacturing capacity reaches 1GW per month

**2016**

Launches energy storage manufacturing

**2017**

Revenue tops US\$1 billion for first time

**2018**

Opens the new factory in India



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John Parnell  
**Technical publishing director:**  
Mark Osborne

**Design & production**  
**Design and production manager:**  
Tina Davidian  
Sarah-Jane Lee  
**Production:**  
Daniel Brown

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# Firm footing: How Sungrow's financials power growth and breed confidence

**Sungrow saw strong performance in 2017, including overtaking its main competitors in annual revenue, and being highly rated in an international ranking of renewable energy businesses**

Sungrow has reported revenue for 2017 of over 8.8 billion (US\$1.4 billion), a 48% increase from 6 billion in 2016. The company also reported net profit growth of around 1.18 billion, 77% higher than its profit of 66.8 million in 2016.

Net profit attributable to the owners of the parent company was 1.04 billion, an increase of 88% from the same period of 2016. The basic earning per share was 0.72, a year on year rise of 76%.

The 2017 results took Sungrow past European rival and former leading PV inverter supplier, SMA Solar Technology, for the first time (SMA having reported preliminary figures of €890m (US\$1.08 billion)). Sungrow had for several years outstripped SMA Solar on a gigawatt shipment level, but had not exceeded its annual revenue figures.

During the 2017 reporting period, the company's operating income was 8.9 billion, an increase of 48% from 2016. Its operating profit of 1.1 billion represented a 78% increase; total profit of 11.9 billion was 77% higher than in 2016; while net profit attributable to shareholders of 1 billion was 88% higher.

Sungrow put its performance down to record growth in PV installations in China, which hit 53GW in 2017. However, overseas market expansion also supported the increase in revenue over the previous year.

A report published in January by analysts at Shenwan Hongyuan Group cited the rapid growth of the company's distributed power plant system integration business over 2017 as being behind its record growth. Its domestic photovoltaic market was mainly driven by policy, it noted.

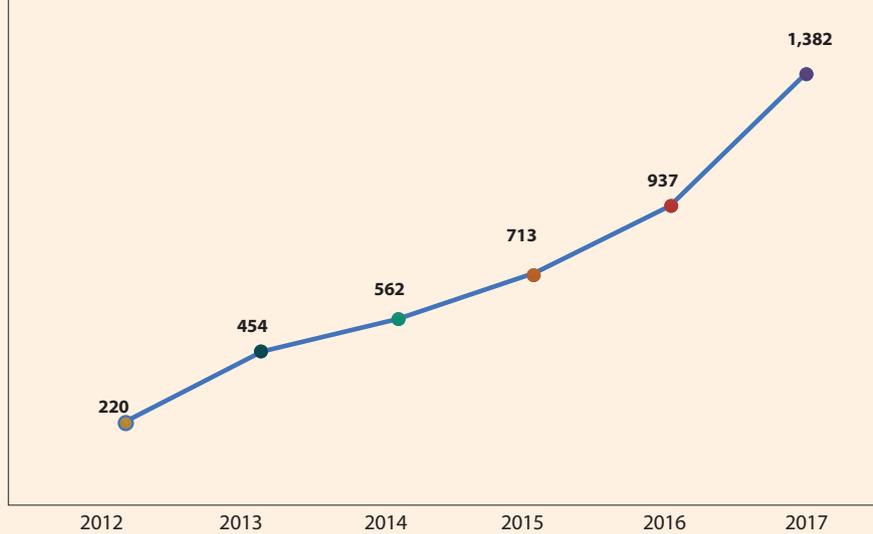
"Sungrow is the global leader in inverters, and its domestic market share has remained stable at around 35% for a long period of time. Shipments have ranked the top three in the world," the report stated.

"Market concentration will continue to increase in the future, and the company's inverter business is expected to continue to grow rapidly," it added.

## **Top 25 global company**

A major achievement for Sungrow in 2017 was being ranked in the top 25 companies globally in renewable energy by Thomson Reuters. The list recognises leaders in the energy sector worldwide, not just on the traditional financial metrics of revenue growth, operating income and return on investment, but also considers factors such as supply chain risk, pending litigation, social responsibility, technological

Sungrow Power Co: Annual Revenue (USD Millions)



	2017	2016	% change
Total operating income	138,233	93,672	48
Operating profit	17,065	9,569	78
<b>Total profit</b>	<b>18,424</b>	<b>10,425</b>	<b>77</b>

Profit (USD ten thousand)

innovation and environmental governance.

The analysts hail businesses that score highly on all these metrics as the “renaissance organisations”, the “energy industry’s decathletes”, who best succeed at both commerce and regulation. These firms compare favourably to companies that may have outsized financial results, but at the expense of outsized risk.

Thomson Reuters notes that the companies it has selected in the renewable energy sector represent in particular a “highly sophisticated approach to managing complexity”, and are “rising stars, who demonstrate a remarkable level of fortitude in balancing oftentimes conflicting demands confronting today’s energy businesses”.

**Strong financial record**

Sungrow’s 2017 performance builds on the robust record the company has established since it was listed on the Shenzhen Stock Exchange in 2011. At the beginning of 2016, Sungrow’s board decided on the company’s business plan, which it said would have the guiding ideology of

“one heart and one mind, hard work, lean management, customer achievement”.

In 2016, according to its full year audited financial results, it reported revenue of over 6 billion (US\$ 956 million), a 31% increase from 2015, when it posted revenue of more than 4.6 billion. This in turn was a strong leap (49%) from 2014, when it reported revenue of 3,062 billion.

In 2017, Sungrow continued to lead the global inverter market with total global shipments reaching 16.5GW

**Shipments**

In 2017, Sungrow continued to lead the global inverter market with total global shipments reaching 16.5GW. Domestic shipments reached 13.2GW, a year-on-year increase of 35%, while overseas shipments reached 3.3GW, a year-on-year increase of 170%.

Product	2016 (MW)	2015 (MW)	% change
Photovoltaic inverter (domestic)	9,885	7,732	27.8
Photovoltaic inverter (foreign)	1,217	1,175	3.6
Wind turbines	403	546	-26.2

Shipments

During the reporting period, more than 10 new products were released, covering large-scale photovoltaic power plants, photovoltaic poverty alleviation, distribution, front runners and other markets.

Last year’s performance was an increase from 2016, when Sungrow shipped around 11.1GW of PV inverters. The majority of these (9.9GW) were distributed domestically, a 28% rise from the 7.7GW shipped in 2015. PV inverters shipped overseas equalled 1.2GW in 2016, a 4% rise from 2015.

These shipment figures confirm that mainland China remained Sungrow’s main market in 2016, with revenue of 5.5 billion (\$US 880 million) from this region, up from 4.2 billion in 2015.

Sungrow earned 1.1 billion from its top five clients, equal to 19% of its total revenue. Its biggest client is Jiangxi Jinko-Solar Engineering, followed by Chaohu Jiaoyang New Energy and Yongdeng Hongyang New Energy Power Generation.

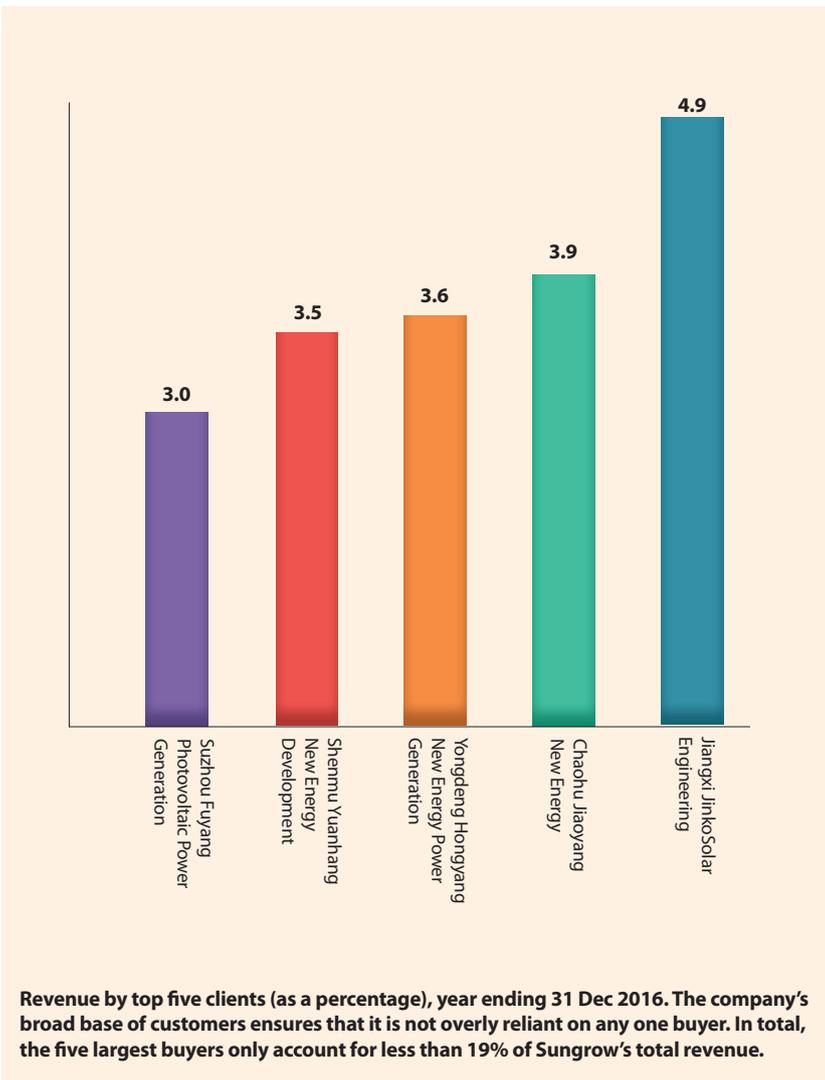
Revenue in the rest of the world, including Macao, Hong Kong and Taiwan, equalled roughly 8% of Sungrow’s total earnings, at 471 million (US\$75 million). Sungrow’s sales from this region rose from 378 million in 2015, a 25% increase, though the proportion of its total revenue from this region remained roughly the same at 8%.

The company is expanding its market overseas and 2017 saw some big achievements. It won a contract to supply 205MW of central inverters for a utility-scale solar project in California’s Central Valley – its largest project win in North America to date. Its product is one of the first 1500V Inverters and the SG2500U device is listed with the UL 1741-SA certification required for most projects in North America.

Sungrow has offices in Gurgaon, Mumbai, and Bangalore and supplied more than 2GW of PV inverters to India in 2017. Renewable energy developer Mytrah Energy has awarded Sungrow a contract to provide 150MW of central inverters for its projects in the Indian states of Telangana and Punjab. The firm is also targeting Thailand and Malaysia, where it expects to gain around 50% market share.

Japan is another growth market, and one in which the company wants to be long term. In 2017 Sungrow secured a deal with Blue Capital Management for the supply of 200MW of SG2000 central inverters.

This year will see the firm also target the



MENA region with its 3.125MW 1500VDC Turnkey Station as well as its SG125HV, the world's most powerful 1500VDC string inverter, after showcasing them at the World Future Energy Summit held in Abu Dhabi in January.

According to Cormac Gilligan, research and analysis manager at IHS Markit, Sungrow's strength has been to recognise, since day one, that it needed to have a diverse business in terms of both product and geographical spread.

"This dual approach, plus its willingness to expand into new emerging technologies, such as energy storage, including the partnership with Samsung SDI, has enabled the company to continuously expand into new markets and so keep on growing," he said.

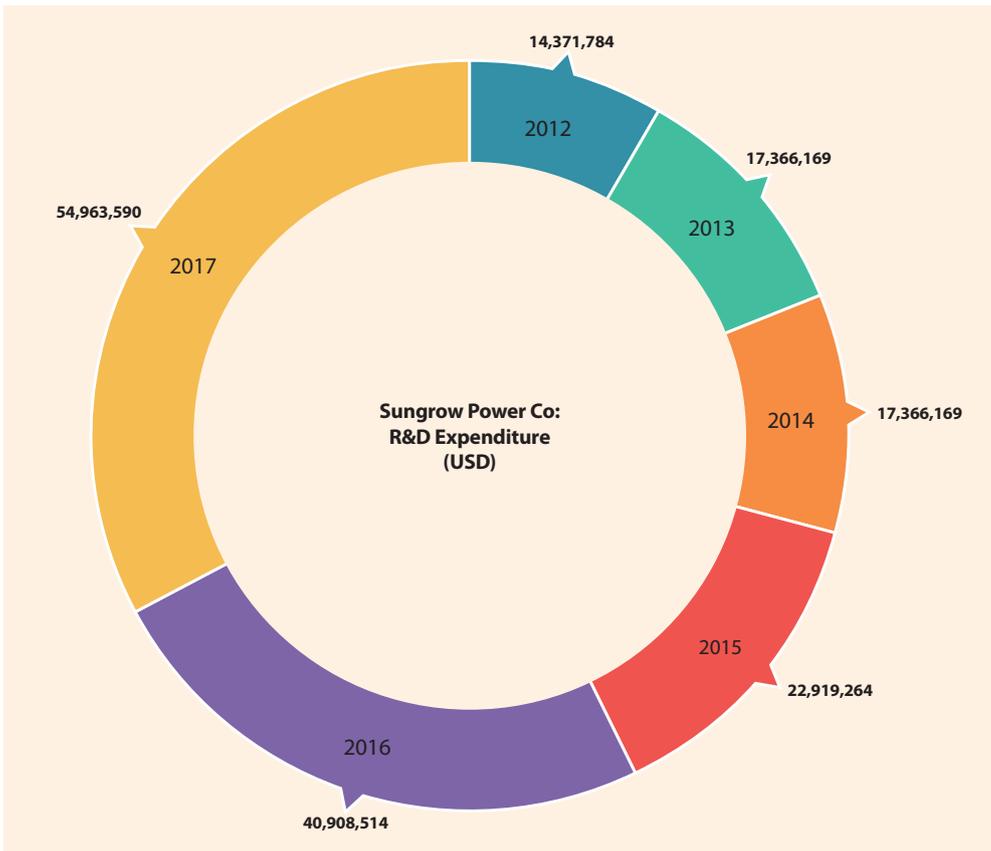
Some of Sungrow's most important markets outside China in 2017 were India, the US and Australia, he added.

**R&D takes centre stage**

Sungrow places a strong emphasis on innovation, with a research and development (R&D) team which accounts for more than 35% of the company's workforce. The company has also undertaken more than 20 major national science and technology projects, and drafted a number of national standards. It has products approved by UL, CE, Enel-GUIDA, AS4777, CEC, CSA, and VDE.

Region	Year ending 31 Dec 2016		Year ending 31 Dec 2015	
	Revenue	Cost of sales	Revenue	Cost of sales
Mainland China	862	663	653	506
Overseas (including Hong Kong, Macao and Taiwan)	73	44	59	37
<b>Total</b>	<b>936</b>	<b>706</b>	<b>712</b>	<b>544</b>

Revenue and cost of sales by region (USD millions)



In August 2016, the firm raised around US\$400 million in new capital, principally to increase investment in R&D and, in particular, innovation related to its PV inverter and energy storage products. The money is a significant investment, equal to nearly 70% of its revenue of 2015.

The company has not publicly divulged the timeline for spending the money, however, in 2016, Sungrow spent more than 261 million on research and development. This spend is equivalent to a 78% increase from 2015, and accounted for 4.4% of operating income for the period.

In 2017, Sungrow continued to work on a number of strategic R&D projects to further its business opportunities and meet dynamic customer demand across residential, commercial and industrial (C&I) and utility-scale markets including floating solar (FPV) and energy storage as well as wind energy and electric vehicles.

Over the year, Sungrow continued to increase investment in R&D, which

reached over 352 billion, accounting for 3.96% of total record revenue in the year. This was an increase in spend in this area on 2016, which was 262.1 billion.

Thomson Reuters notes that the companies it has selected in the renewable energy sector represent in particular a “highly sophisticated approach to managing complexity”

In 2017, more than 10 new products were released, covering large-scale PV power plants, PV poverty alleviation, distribution, Top Runner and other key markets. R&D activity led to 195 new patents being authorised in 2017, which included 19 foreign patents, 94 domestic invention patents, 71 utility model patents and 11 appearance patents.

A further 308 new patent applications were submitted in 2017 and were under

review. This included, 104 domestic invention patents, 74 foreign patents, 118 utility model patents and 12 appearance patents.

At the end of 2017, Sungrow had obtained a total of 737 patents, including 249 inventions, 420 utility models and appearance patents. Sungrow has actively promoted the development and optimisation of related standards in the PV industry and has organised and drafted a number of Chinese national standards.

In addition, Sungrow opened its 10m Anechoic Chamber, which has the highest power distribution capacity and one of the most advanced designs in the PV and energy storage system (ESS) industry.

The anechoic chamber, also known as electromagnetic compatibility (EMC) chamber, will facilitate tests for new products and help develop EMC solution technologies and products accordingly.

The chamber, which cost around US\$5 million and took two years to plan and construct, covers an area of over 700m<sup>2</sup> and has an internal height of 7.8m. As the first of its kind in the industry, it can test large electrical equipment like a PV inverter turnkey station as large as 5MW and weighing up to 20 tonnes at a distance of 10m, which is required by relevant standards. By employing the ROHDE & SCHWARZ EMC testing system, the chamber can replicate a test accuracy equal to that of major third-party testing organisations.

Sungrow’s independent testing centre is equipped with the most advanced testing systems, with accreditation from UL, CSA, TUV SUD and TUV Rheinland as their witness laboratory.

At the same time, the company has

continued to establish and improve the ISO9001:2008, ISO14001, OHSAS18001 management system, and strictly promoted the “three-in-one” quality and environment occupational health and safety management system. The company’s products have passed UL, TÜV, CE, Enel-GUIDA, AS4777, CEC, CSA, VDE, as well as achieving many other international authoritative certification and testing approvals.



The company's solid finances also enable it to make meaningful investment in its R&D capabilities including the largest EMC room in the PV sector.

In 2016, Sungrow had projects worth more than 958 million (US\$153 million) in construction, up from 162 million (US\$25 million) in 2015. These ranged in size from the 120MW Lingbi QingyangYugou project to the 50MW Datong Zuoyun 50MW photovoltaic power station.

In 2016, the Company established several new subsidiaries including Sungrow Power Supply (Jinzhai) Co; Sungrow India; Sungrow Power (France) and Hefei Sungrow Zhong'an New Energy Investment Management Co, which it established jointly with Railway Fund and

High-Tech Investment.

Sungrow has also invested in innovation for the residential market. The company's home solar business has exceeded expectations, according to Shenwan Hongyuan Group, and in 2017 it distributed home solar systems to 300 dealers. It is targeting 1,000 in 2018, and expects to complete the development of 5-10 million household power stations, the analysts said.

According to IHS Markit, Sungrow's heavy investment in R&D has allowed it to stay abreast of the latest inverter trends,

such as 1500V central and string inverters, high power inverters such as 100kW+ string inverters and 3MW+ central inverters as well as both AC and DC-coupled energy storage inverters.

"Sungrow is one of the few global inverter suppliers with a full inverter portfolio that can serve residential, commercial and utility-scale installations including energy storage applications," Gilligan says.

Re-investment of profits in next generation inverters that can serve new

### Warranties: The currency of a stable vendor

The physical and financial link between a client and their chosen inverter or module partner is the warranty. No two warranties are created equal and the value of any written guarantees is determined by the likelihood of a company fulfilling its obligations.

Speaking to PV Tech as far back as 2016, European EPC BayWa r.e. said that there were no bankability issues surrounding the major Chinese inverter manufacturers in large part because of the improved technical awareness in the investor community and the quality of due diligence work.

The field test of bankability is surely the level of performance and the responsiveness of the vendor to fulfil its obligations inside and outside the requirements of the warranty. Module lifespans are stretching beyond the long-standing industry standard of 25 years.

Older projects in Europe have suffered as inverters produced by companies that have since exited the market begin to fail. In some cases entire retrofits have been necessitated. This is an extreme example of what can go wrong if your inverter vendor fails. Since 2009 they have failed at a rate of around two a year.

Warranties and after sales service have long been a primary consideration for inverter buyers but the implications of what can go wrong have not been so starkly laid bare until failures in mature European markets began to rear their heads.

A dedicated solar inverter manufacturer, rather than a larger company serving solar as one small vertical in its operations, is the least likely partner to walk away from the PV industry. Sungrow's significant R&D investment keeps it future-proofed and its history of organic growth that tracks the industry offers further evidence that a Sungrow warranty is indeed a guarantee.

"Sungrow is one of the few global inverter suppliers with a full inverter portfolio that can serve residential, commercial and utility-scale installations including energy storage applications"

high-growth market opportunities such as floating solar, energy storage applications, micro-grids, and 1500V string and central inverters is paramount for leading inverter manufacturers.

"This willingness to expand beyond its core competencies has enabled it to stay at the forefront of inverter innovation and as a result maintain its ranking as one of the leading global suppliers," Gilligan concludes. ■

# Sungrow diversifies manufacturing footprint with new India factory

Sungrow launched its Indian factory in Bengaluru on 27 July in order to meet growing demand.



Chinese inverter manufacturer Sungrow has officially opened a new manufacturing facility in India.

The 3GW plant in Bengaluru will produce both central and string inverters for customers in India and beyond. India is already a strong market for the company, which claims to have had 2GW of its inverters installed in the last two years.

“Sungrow has taken one further step to stabilize its position of the world’s No.1 solar inverter company,” it said in a press

statement, alluding to the recent inclusion of solar inverters in the scope of US trade sanctions.

Modules, cells and polysilicon have long been subject to trade wrangling with complaints raised in the EU, China, India and the US. The latter has recently included inverters in the scope of an assessment of future trade duties to be levied on a raft of Chinese products.

Sungrow remains relaxed about the situation with the new factory contributing to that.

**The new facility has an annual capacity of 3GW. Source: Sungrow.**

“In response to the growing market demands, Sungrow established the factory in India, which will greatly improve the company’s global delivery capacity and better serve customers. To some extent, the new factory launched will also reduce the political crisis and PV market implications, restoring market confidence. Sungrow is always committed to present versatile resources to meet our customers’ needs,” its statement continued.

# The 1500V solar market set for steady growth

It was a natural evolution, an inevitability that large-scale solar plants would seek the advantages of stepping up to 1500V-based architecture. Mark Osborne explores the shift in more detail and the products matching that demand

In the rapidly evolving large-scale PV utility power plant sector, higher-voltage systems have been making inroads that have been in the gigawatt level in recent years, making the 1500V system market highly desirable for PV plant owners, developers, engineering, procurement and construction (EPC), firms and suppliers of components from inverters to PV panels.

A simple but key attraction is the 1500V PV systems enable longer strings, which allow for fewer combiner boxes, less wiring and trenching, and therefore less labour, reducing capex and opex for lower levelised cost of energy (LCOE) and improved return on investment.

## Origins of 1500V PV systems

Typically much of the world is 1,000 Vdc, a trend set by Europe, but the US solar utility sector was the first to bring 1,500 Vdc systems to market, with First Solar behind the innovation in modules, and GE behind that in inverters. Going to this maximum voltage will allow for a consid-



The world's most powerful 1500V string inverter

erable reduction in current, reducing the system losses on the DC side.

Europe's electrical standards body, the International Electrotechnical Commission (IEC), considers 1,500 Vdc the low-voltage limit and enables certification to that voltage. The first partially 1,500 Vdc systems were installed by Belectric in Germany in 2012 using inverters and electrical equipment developed by GE, with technology from Converteam, and Padcon. These systems used bipolar configurations, where positive and negative 1,000 Vdc strings were combined to switch at 1,500 Vdc.

In the US, the leading proponent of 1,500 Vdc has been First Solar, which hopes to use 1,500 Vdc to help make up for efficiency limitations of its CdTe (Cadmium telluride) thin-film modules and lower associated balance-of-systems cost.

First Solar's Series 4 module was among the first 1,500 Vdc modules to the market and the company has aggressively pushed its partners to develop compatible system components. In 2014, First Solar became the first to install a fully 1,500v (DC) system with two pilot projects in Texas.

## Growing market

The market is potentially growing for

## 1500V and the tests of time

It's fitting that Sungrow was the first manufacturer to bring both 1500V string and central inverters to the market. Unlike power engineering firms that count solar as one of many verticals that they cater for, or high tech firms extending their reach into the solar sector with string or micro inverter products, Sungrow is the largest dedicated solar inverter manufacturer. It has a 15% global market share, according to BNEF. With 1500V products closing in on becoming the majority architecture for utility-scale plants, maintaining that market share, naturally, means being able to supply market leading 1500V products.

Having confidence in 1500V products as they become available means having confidence in the technology that underpins them. This is where Sungrow draws upon its rich heritage of R&D spending and investment, the kind of legacy you would expect in a company founded by a university professor.

Its testing facilities are UL, CSA, TÜV Rheinland and TÜV SÜD accredited. Its anechoic, or electromagnetic compatibility (EMC) chamber is the largest in the solar and energy storage industry. It can test a 20 tonne inverter at a distance of 10m pushing the firm's testing capabilities towards those of the major third-party testing houses.

"The EMC chamber strengthens our capability for product tests and will help us develop more efficient and reliable products for our customers worldwide," said Professor Renxian Cao, president of Sungrow.

1500V Vdc as bidding on utility-scale projects is replacing feed-in tariffs. Bids are getting lower and lower in terms of the cost of energy per kilowatt hour, so an increasing number of countries are looking for 1500V Vdc systems such as India, Middle East North Africa (MENA) and Brazil to meet low bids and still make a profit.

Floating solar (FPV) power plants are

## Sungrow's 1500V 125kW inverter now UL 1741-SA certified

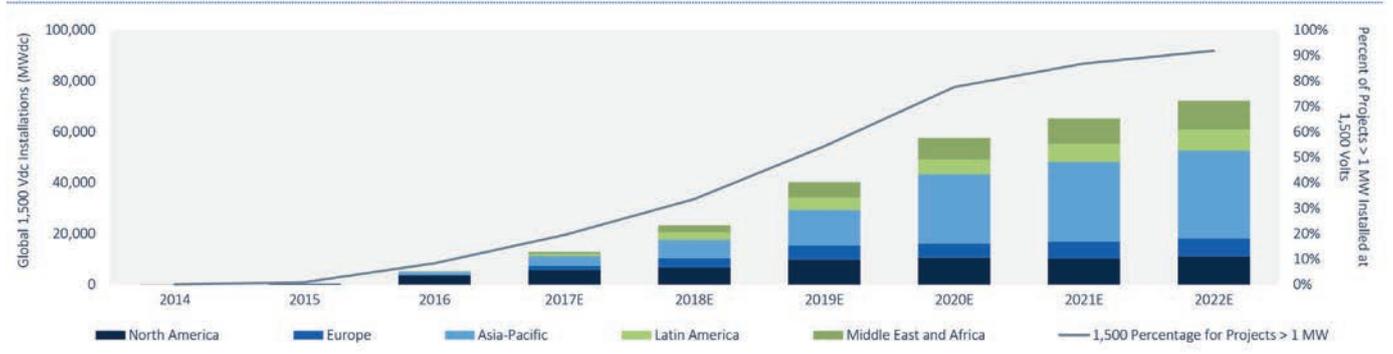
Sungrow has been displaying its SG125HV and the SG2500U systems at a number of major solar trade show events such as Solar Power International in the US. The company has received its long-anticipated UL 1741-SA certification for the SG125HV, which is one of Sungrow's flagship products with a 125kW power output rating-the highest rating in the world for any string inverter.

The company has intensified its focus on global markets and international expansion with exports expected to grow exponentially, and North America remains a high-priority target for the company. With the SG2500U central inverter also receiving the UL 1741-SA certification, Sungrow has become the first provider that has 1500 Vdc inverters of both types receiving the stringent certifications required for North American projects.

"The UL 1741-SA certification is a new requirement for grid-connected inverters in North America, and also one of the most stringent and difficult to obtain. We are excited that our products are up to date with the latest industry requirements and standards. Sungrow remains steadfast in its mission to power the world on cleaner energy," said Professor Renxian Cao, president of Sungrow.

## GTM Research 1,500-Volt Installation Forecast

1,500-Volt PV System Installations by Region, 2014-2022E



Credit: GTM Research

### The global growth of 1500V system architecture

also a new multi-gigawatt market for 1500V systems (see our floating solar special feature in this edition on page 19, which highlights Sungrow’s involvement in the largest (40MW) FPV plant built in Huainan province, China).

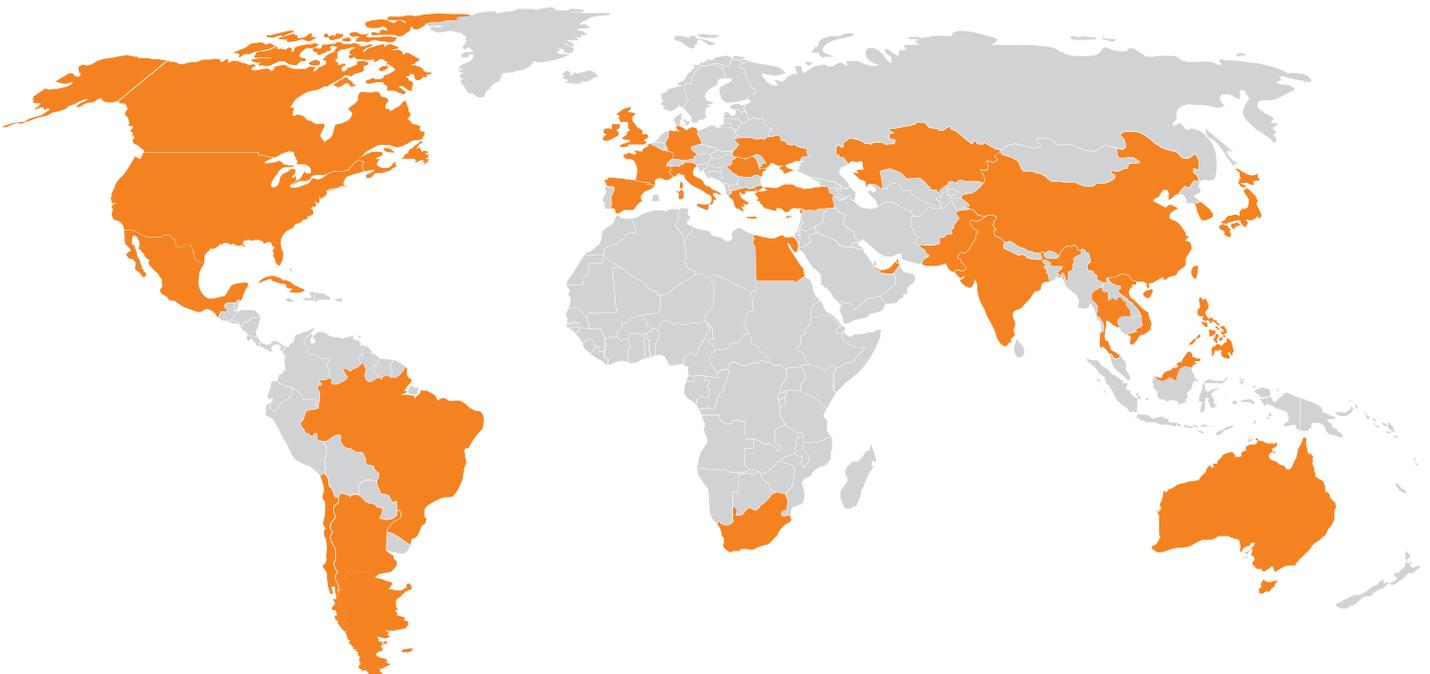
#### Approaching ubiquity

The development of 1500V was to be expected but we are now approaching the tipping point whereby 1500V

will become the dominant technology for global solar installs. Sungrow’s well-documented R&D investments mean that as this point has arrived, the company is able to offer a full suite of 1500V products. Whereby in the past, a 1500V model, be it a module or inverter, was merely something to create the focal point for a booth at an exhibition, Sungrow has scaled its 1500V offerings in tandem with the industry. It has been

setting the pace rather than trying to keep up.

GTM predicts 1500V products to take more than a 50% share of the global market as early as 2020 (see graph). Without the foresight to scale manufacturing capabilities and recognise the pace at which the solar industry can switch to and adopt new technology, the sector as a whole cannot take advantage of the gains on offer from 1500V architecture. ■



## GLOBAL SERVICE LAYOUT

Offering a wide range of solutions and services, Sungrow is committed to provide clean power for all.

# 1500V product briefing

## Sungrow's 1500Vdc SG125HV string inverter enables 5MW PV power block designs

Sungrow's 1500 Vdc string inverter is designed to significantly reduce installation and balance of system costs for utility-scale PV systems. Sungrow was the first inverter manufacturer to introduce a 1500 Vdc string inverter with its SG80HV, which has a power output of 80kW. The latest inverter, SG125HV, comprises 125kW of capacity in a suitcase-sized cabinet weighing just 76kg. At a higher rated voltage, the SG125HV is claimed to further reduce installation and balance of system costs.

### Challenges

1500 Vdc solar systems are expected to dramatically reduce system costs and improve power generation efficiency. The solar industry has long demanded a 1500 Vdc string inverter to reduce LCOE for commercial and utility-scale PV power plants. Increased power block designs enable longer PV module strings with a reduction in components required, while reducing DC line losses for higher overall energy yield.



### Benefits

The SG125HV comes with Sungrow's patented five-level topology design, which enables the inverter to raise the maximum efficiency up to over 98.9%. Max. (Euro efficiency 98.7%. Max and CEC efficiency 98.5%. Max) with a 5MW PV power block design reducing AC transformer and labour costs, while eliminating the need for AC

combiner boxes. DC side cabling costs can also be reduced significantly. The company claims ~€1.1/Wp system cost saved (Inverter cost not included) on a 100MW power plant, providing lifetime savings of over US\$1.1 million.

### Key features

The SG125HV weighs only 76kg and therefore does not require heavy machinery for loading, unloading and installation. The inverter can be installed by just people. Due to its compact design and natural air cooling (NEMA 4X (IP65) fan cooling, with no de-rating up to 50°C, it can be installed at flexible angles and is therefore adaptable to different conditions and reduces maintenance access issues.

The SG125HV can be installed at one place next to the MV transformer, also reducing efforts for maintenance. The system is compatible with third party SCADA for all grid support requirements. Complies with standards: UL1741, IEEE 1547, IEEE 1547.1 and California Rule 21. Grid support including LVRT, HVRT and FRT.

## Sungrow's 3.4MW 1500V turnkey station designed for extreme heat conditions

Sungrow launched the SG3400HV in early 2018 as the company's latest 3.4MW 1500 Vdc turnkey station at the World Future Energy Summit, the most visited event for renewable energy in the MENA region, held at the Abu Dhabi National Exhibition Centre.

### Challenges

Desert conditions with extreme temperatures that can reach 50°C and above provide central inverters with a number of challenges, not least maintaining peak efficiencies and preventing damage from sand and dust.

### Benefits

The SG3400HV containerised solution integrates PV inverter power conversion together with block monitoring, an auxiliary power supply, and Night Static Var Generator (SVG) functionality in a standard 10-foot container. This enables significant savings in initial investment and future operating costs.

Coming with 3-level topology and

a smart cooling design as standard, it reaches a peak efficiency of 99% and can work without derating at 45°C. This makes the SG3400HV ideal for the MENA region, by enabling sustained power yield for PV plants, essential for good project economics, despite the scorching heat.

### Key Features

Developed for large-scale utility plants, the product also features a high DC/AC ratio of 1.5, and 6.8MW block design. The system supports best in practice operations and maintenance requirements such as integrated current and voltage monitoring function for online analysis and fast trouble shooting, along

with its modular design for easy and fast maintenance. Grid support is covered with compliance with CE, IEC 62109 standards and the device has low/high voltage ride through (L/HVRT) to stay connected in short periods of lower electric network voltage. It also has an active and reactive power control and power ramp rate control.





# Best of both worlds: Under the hood of the SG125HV string inverter

Sungrow offers an in-depth look at the SG125HV string inverter and how through clever system design, projects can lean on the advantages of central and string inverters simultaneously

Utility-scale solar power systems have been designed with the largest capacity central inverters available. With the introduction of string inverters, systems with capacities in the range of 1MW to 10MW have been successfully designed and installed using three-phase, 1000VDC string inverters with capacities in the 30kW to 60kW range. 1500Vdc solar systems can reduce system costs and improve power generation efficiency. Increased power block designs enable longer PV module strings with a reduction in components required, while reducing DC line losses for higher overall energy yield.

Sungrow's introduction of the SG125HV, a 1500VDC string inverter with a 125kW capacity has made even the largest utility-scale solar power systems within the range of the string inverter system architects.

## High efficiency

Sungrow's SG125HV was designed to have a power converter platform that was more efficient than previous generations of products. Utilizing a 5-level converter bridge, the SG125HV provides extraordinary best-in-class efficiency, further increasing project ROI by maximizing input vs output power conversion efficiency and minimizing loss. The maximum efficiency of SG125HV can reach 98.9%, and the Euro. efficiency is 98.7%. Greater efficiency equals to greater AC power yield.

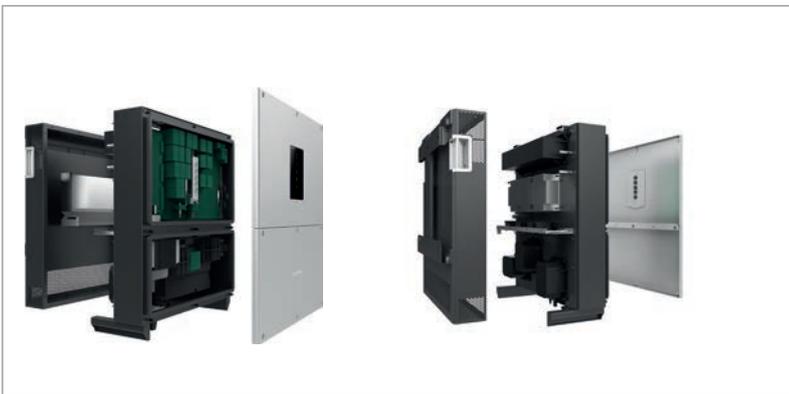
## Operating in harsh environments

SG125HV is one of the largest string inverters in terms of power rating and it has a high power density. Smart forced air cooling technology can lower the internal and component operating temperature

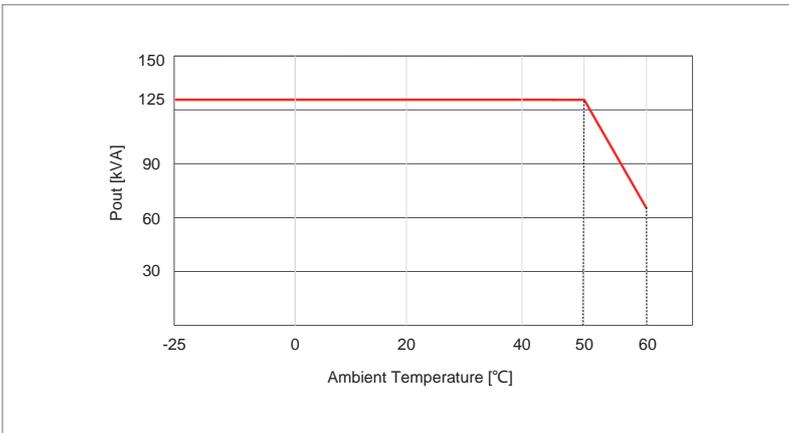
and make the operating temperature range wider with no de-rating up to 50°C. It will make the inverter longer lifetime and brings high yield.



Fig.-1 SG125HV



**Fig. -2 IP65 Protection for all parts**



**Fig. -3 Temperature Dependent Power Derating**

The enclosure ingress protection rating for all chambers is IP65 and anti-corrosion design with C5 protection degree. Electronics and motor of fans are encapsulated in polyurethane, fully dustproof and waterproof, the ingress protection rating for fans is IP68.

Sungrow's SG125HV has one of the widest operating temperature ranges available in the industry, rated for 125,000W at ambient temperatures up to 50°C. At temperatures above 50°C the inverter will ramp down power or 'derate' in order to maintain control of internal temperature and losses. The derated operation will continue until the ambient temperature exceeds 60°C.

**High DC/AC ratio**

High DC/AC ratio is becoming increasingly common with modern PV plant ROI economics. On the DC side of SG125HV, the max. DC short-circuit current is 240A, which allows the DC/AC ratio more than 1.5:1. Compared to 100kW inverter with 12 inputs, which the DC/AC ratio can only be 1.2:1, the whole system cost can be saved over 1¢/Wp.

**Virtual Central Solution**

With increasingly enhanced voltage grade and per-unit power for solar systems, Sungrow is proud to introduce its "Virtual Central Solution" firstly. Specifi-

cally, since there are combiner boxes required in the system architecture for the SG125HV, it can be thought of as a "mini central inverter" or as an integrated power module of a Virtual Central Solution. Multiple string inverters close to medium-voltage transformer are installed centrally to cut down system costs and improve convenience of maintenance and operation. The Virtual Central Solution can be adapted to varied application scenarios, achieving advantages of both string and central inverters.

The Virtual Central Solution can be customized to suit the needs of the site more effectively than with a central inverter that has a fixed output capacity. Since the SG125HV can be paralleled in

**Fig. -4 (top) Virtual Central Solution of SG125HV**

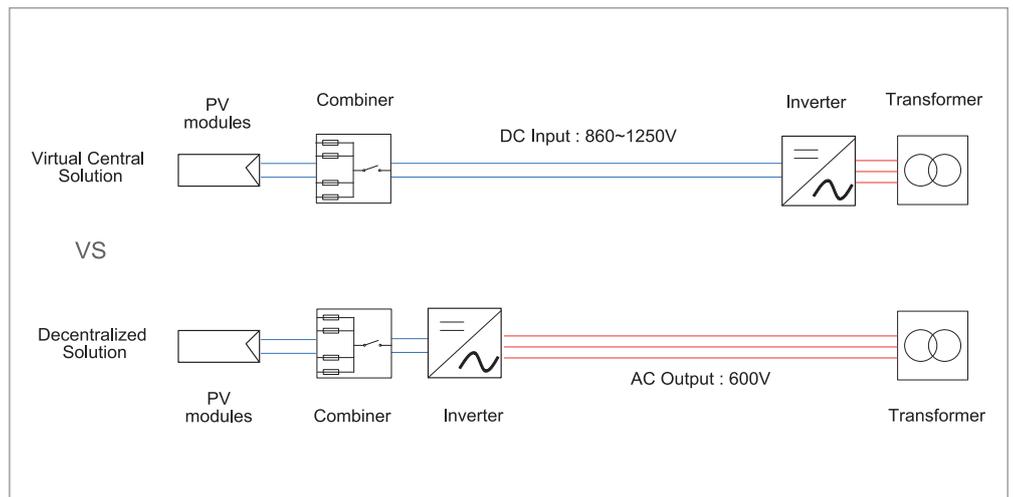
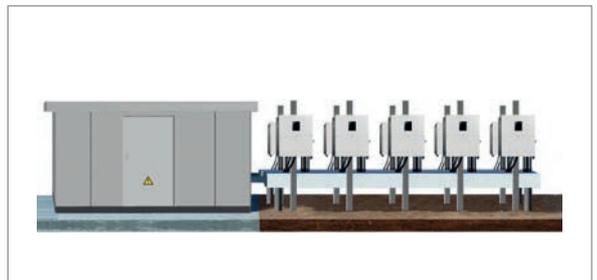
**Fig. -5 (bottom) Virtual Central Solution vs Decentralized Solution**

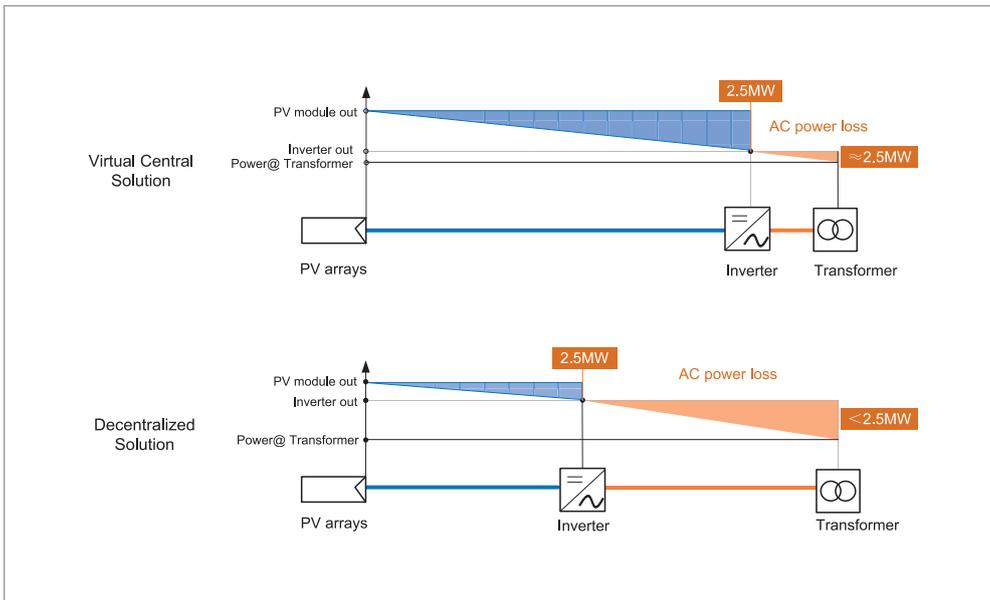
almost any quantity and connected to a single, LV winding of an MV transformer, the capacity of the resulting power station, or Virtual Central Solution, can be set at any multiple of 125kW.

For example, ten of the SG125HV inverters can be integrated together to make a 1250kW inverter and 20 can be paralleled to make up a 2500kW inverter. The integration of the ten, or fifteen, or twenty inverters can be done at the site or pre-integrated off-site and brought to the site as a sub-system. Due to the low weight of the inverter and the small size, it can be mounted to the array structure itself.

**Less cable cost, save CAPEX**

Sungrow's in-depth project design analysis and CAPEX economics reviews have determined that in most cases it is overall more cost-effective to have the 1500V DC SG125HV inverter located nearer the AC POC than the PV array field. Utility-scale project cabling costs are dominated by voltage drop concerns and longer runs of two cables (DC+/DC-) at 1500V are simply less expensive than running three cables (A, B and C phases) at 600V AC. In order to facilitate the recommended design scheme that uses external (i.e. mounted within or immediately peripheral to the PV array) combiner boxes with longer DC+/DC- 'homeruns' back to the inverter located near the POC, the Sungrow





**Fig. -6 (top) Cable Loss Comparison between Different Solutions**



**Fig. -7 (left) Inverter App Facilitating Site Commissioning & Monitoring**

SG125HV inverter utilizes a single DC input architecture that allows larger homerun cables or even trunk bus cables to be connected directly to the inverter without the need for fusing or other maintenance-intensive components within the inverter.

Since the nominal DC voltage is closer to 1050V, the DC current is closer to the same as the max AC current of 120A at 600VAC nominal output. The savings in wire cost comes by way of the two wires on the DC input side vs. the three wires on the AC output side.

In the bigger picture, the reduction of the number of string combiner boxes

needed for a 1500VDC system compared to 1000VDC systems, the savings realized in using the DC wiring for the longer runs, and the ability to centralize the location of the inverters, has the combined impact of reducing the total costs. The actual savings will vary depending on several variables, but the net effect will be positive in most cases.

**Less cable loss, high yield**

Virtual Central can increase the yield. The DC voltage is high (1500V), high-voltage brings low current and low power loss. Besides, high DC/AC ratio can compensate the DC cable loss and

shadow loss etc., the output power of the inverter can reach the rated power. Additionally, for Virtual Central Solution, the AC cable from the inverter to the transformer is very short, so the AC loss is little and the power to POC can be guaranteed.

**Easy communication and fast response to grid control**

For user convenience, the SG125HV includes an LED HMI display panel to indicate inverter operating status and other system parameters such as Bluetooth connectivity, serial communications status, and fault and ground impedance status.

Customer communications to the SG125HV inverter are done through the serial RS485. Additionally, SG125HV supports communication via Bluetooth using smart phone with an IOS or Android system. Choose the inverter you want to connect to and log onto the user interface. It can check the operating information and historical records, set parameters, download the logs and update the firmware through the app.

Besides, customers can log in to the Webport of Logger3000 to achieve the data collection, parameter setting and firmware update remotely.

Virtual Central Solution for the fastest command-response times, the parallel RS485 input normally used for tracker control can be used. If dedicated to the command and control, this parallel input can achieve response times in the area of 200ms or less. This type of rapid response time will be required by utilities going forward.

Having one SCADA interface for a large power block, with response times in the 100ms to 200ms range is as good as a central inverter.

With the 1500VDC SG125HV inverters, the best system architecture is more like central inverter architecture with the inverters located closer to the point of connection (POC).

The SG125HV virtual central solution makes it possible to design solar systems more flexibly through combining the advantages of both central and string inverters. Continually cutting down initial investment of solar systems and O&M costs and enhancing yields are developing trends in solar industry. The SG125HV is expected to be widely used in the future large, utility-scale PV plants considering the value it brings to users.

Case study

**Vital Statistics:**

Project Size: 50MW  
Project Location: Shanxi, China  
Inverters: SG125HV

**Customer Value:**

Virtual Central Solution brings less cable cost, save CAPEX;  
Virtual Central Solution can increase the yield;  
Virtual Central Solution is easy for O&M.



# Rethinking the central inverter to reduce LCOE

As profit margins for projects narrow, every gain is crucial. This means central inverters need to deliver economies of scale under all conditions and minimize losses from failures. That requires an innovative approach to the classic central inverter

In the current global market, the feed-in tariff continues to decline, profit margins for investors narrow putting great pressure on manufacturers to deliver savings and efficiencies. The demand for larger capacity inverters with an optimised LCOE becomes stronger. Sungrow launched to the market the new SG3400HV in early 2018, the company's latest 1500V turnkey station for the next generation of utility-scale PV plants, with a power rating of 3400kVA and max. output power 3593kVA.

Balancing power density while keeping a compact and efficient design is a trademark feature of well-designed central inverters. Sungrow's SG3400HV is designed within a 10ft shipping container enclosure and includes an effective cooling system. Using Sungrow's advanced development platform, the SG3400HV has an excellent reliability and performance track record accompanied by a high-efficiency rating. Moreover, the inverter's containerized design simplifies logistics, site installation, and commissioning. All serviceable components are easily accessible externally upon opening the enclosure doors. This maximizes inverter uptime and reduces costs related to O&M. Particularly for central inverters, these costs can greatly affect the ROI of any utility-scale plant given the large size

of the installation; thus, making sure a central inverter has the technical features to account for these cost considerations is essential.

## High-efficiency and reliability

Sungrow's SG3400HV was designed to have a power converter platform that was more efficient than previous generations of products. Utilizing a 3-level converter bridge, efficient modulation algorithms, and innovative magnetic and switching devices, the SG3400HV maintains a high peak efficiency leading to greater energy yield and higher project ROI. The maximum efficiency of SG3400HV can reach 99% and Euro. efficiency is 98.7%, verified through Sungrow's rigorous product development and testing process. Sungrow has focused primarily on inverter development and manufacturing for more than 20 years, achieving a strong track-record of reliability along the way.

## Wide operating temperature range

Many utility-scale PV plants are located in areas with harsh climatic conditions. Depending on inverters operating temperature range, there can be significant fluctuations in uptime, efficiency, and power output. Sungrow's SG3400HV has one of the widest operating temperature ranges available in the industry, with full

power available from -35°C to 45°C and in rare cases, derated operation possible in temperatures reaching up to 60°C.

Temperature control methods play a key role in product lifetime and reliability. The speed controlled fans that are used for SG3400HV keep internal temperatures low, which leads to reliable operation, longer lifetime and lower power consumption.

In terms of power output, maintaining peak output at the extremes of an inverter's operating temperature range is a good measure of actual power yield. The SG3400HV is rated for 3593kVA at ambient temperatures up to 25°C and it is rated to 3437kVA up to 45°C. The S3400HV, already known for its high-efficiency and power output, impresses even further with its track record of maintaining peak output and efficiency even at the fringes of its operating temperature range. SG3400HV can keep a flat, sustained line fixed at peak performance for a wide temperature range. This illustrates how a high-performance inverter maintains its stated output and efficiency consistently; while many inverters can market a high power output or efficiency, it does not necessarily mean that power is sustained when challenging environmental conditions arise.

## Pre-integrated features

Pre-integrated features save time and capital expenditures throughout the entire process from site design to installation and commissioning. Equipment suppliers that include pre-integrated features can help reduce overall project costs through pre-packaging required equipment and designing products for faster on-site integration. Sungrow's SG3400HV has numerous pre-integrated features that require less initial capital investment and installation cost. Examples include an integrated re-combiner into the DC side cabinet and power supply panels which



Fig-1 SG3400HV



include 415Vac (400Vac,380Vac) and 240Vac (230Vac,220Vac) which can be used for the tracker motors, control box, communication box, etc. As a result, there is no need for extra power supply panels, transformers and other BOS equipment. This will save the space for site installation work, which means the initial investment will be further reduced.

**Advanced mechanical design**

As mentioned previously, the SG3400HV standard containerized design simplifies logistics. The container itself is power-dense with 3.4MW of power. However, inverter power-density often presents challenges related to inverter uptime. When a central inverter fails, it loses its ability to convert its entire block of power, which for utility-scale plants is quite costly. However, Sungrow’s inverter design has separated its 3.4MW output into three distinct inverter units inside the enclosure that share the same DC input. These three inverter units are working in parallel; however, if one unit fails, the other two can still maintain uptime, thereby reducing the power loss due to inverter failure. For many other lines of central inverters, failure equates to a total loss of power.

Sungrow’s SG3400HV is designed for easy operation and maintenance. This 3.4MW unit has a touch screen located on the front door, all of the inverter running information and settings can be viewed and changed on this touch screen, which is easy for site operation. All components of the inverter are accessible externally, resulting in lower MTTR and simplified repair. The SG3400HV uses Sungrow’s patented air filter design, which makes the inverters dust-resistant. The inverter is easy to install, with Sungrow providing the installation accessories reducing the time and other resources in plant construction. All of the interface/plate for installation is designed to be removable

and easy to be punched, which will be convenient for customer to install the conduit and connect the cables, all of those design lead to less site work and in hence reducing the installation cost.

**Flexible DC/AC radio**

The SG3400HV can accommodate 21 DC inputs, with each input terminal being able to be connected to a 400mm2 cable. The number of DC inputs can be customized according to specific requirement (max.28 inputs). The maximum DC current is 4718A, however, this current value does not represent a limit on the amount of DC current the array connected to the inverter can be sized to. With the flexible DC side configuration, the DC/AC ratio can be up to 1.5; DC/AC sizing flexibility is becoming more essential in current PV plant project economics, with only premium inverters having such technical capability. With the application of SG3400HV, the plant design can be more flexible and simple. On the AC side, the SG3400HV can either connect to a step-up transformer via busbar or cables, which can bring customer flexible design.

**Excellent grid support function**

The ride through settings of SG3400HV can be adjusted to support the grid according to interconnection requirement such as

**Fig-2 High Integration, Pre-assembly**

BDEW, making it ready for deployment in utility-scale projects across the global market.

SG3400HV has good reactive power capability and can inject rated active power with power factor 0.9. Moreover, the inverter can supply reactive power to the grid at night to support the grid, thereby saving the costs needed for SVG equipment.

**6.8MW solution**

The 6.8MW consists of two SG3400HV and one MV station, the MV station integrates a MV Transformer and a MV switchgear inside a 20ft container. It is completely pre-assembled for easy setup and commissioning, reducing time-consuming labor processes in the field and minimizing installation risk, further decrease the LCOE. Offering unmatched convenience and flexibility, the 6.8MW can be used with multiple options from Sungrow, providing a standardized process for integrators who are working on PV projects. It also includes a multitude of configurable options to meet the needs of any plant.

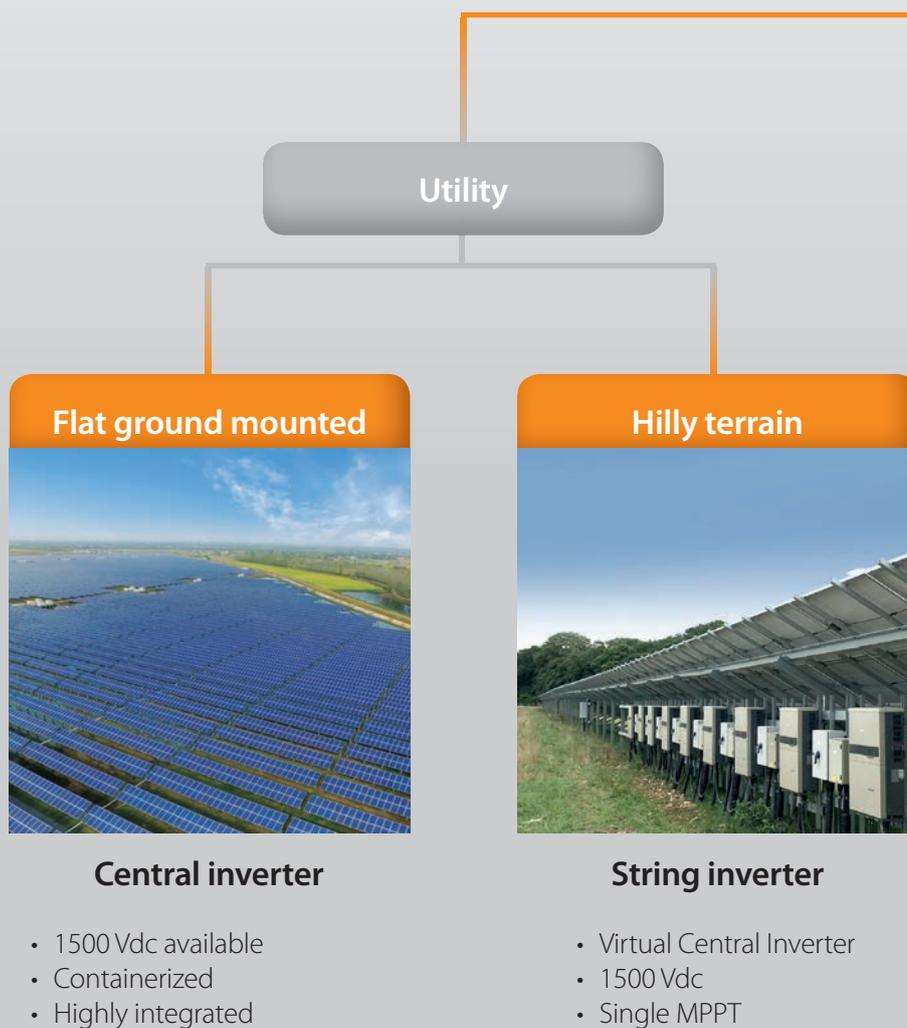
Technical features in central inverters play a large role in the stable operation, reliability, and power generation capability of all PV plants. With projects getting larger as technology progresses, the impact of these features on overall project economics becomes even more accentuated. Having an inverter that is designed for reliability, quick and easy maintenance, simplified installation, and other factors resulting in better ROI should be of paramount concern for project developers. Moreover, SG3400HV was already certified by TUV SUD as it will bring greater reliability to utility grids and will reduce interconnection risks. Whereas most companies would see these as a burden, Sungrow views them as instrumental steps in modernizing utility grids worldwide.

**Fig-3 Package Solution with Inverter and MV Station (6.8MW)**



# The Sungrow Product Selection Philosophy

As the largest manufacturer with a full portfolio of products, including 1500V string and central inverters, Sungrow offers customers the best choice for their project. Here they present their Product Selection Philosophy to guide partners towards the best family of products.



For projects with level terrain and no chance of partial shading, output is likely to remain consistent over large areas. In this situation the opportunity to use central inverters means a reduced capex and improved yield with shorter cable runs delivering lower energy losses. The reduced cabling and transformer costs also lower the capex.

Whether it is an extremely hilly site as is often seen in Taiwan and parts of Japan, or merely an undulating site, the modules must be broken down from MW-scale blocks to strings in order to account for the variable output. In return, string inverters deliver greater, but more complex grid control, higher yield courtesy of the increased number of maximum power point trackers (MPPTs) and reduced capex from the reduced number of combiners. The site may also lack an accessible location for a cluster of central inverters.

## Design Meets Demands

Commercial



### String inverter

- Multi MPPTs

A large commercial-scale rooftop system may reach the sort of output covered by a central inverter but string remains the natural choice. The size and weight of a central inverter is the first obvious factor. But with the greater likelihood for shading and mismatch issues on a rooftop system, string inverters also provide greater reliability and improved yield. They also provide more flexibility for system design. This means lower O&M costs throughout the lifetime of the system as well.

Residential



### String inverter

- With or without optimizer

Module level MPPTs, together the best system design, can dramatically lower the impact of shading when present. WiFi-enabled Sungrow inverters can give homeowners the power to keep tabs on the system's performance using their smartphone. Sungrow's residential inverters are designed to make less noise than household appliances and cool naturally.

## UTILITY CENTRAL INVERTERS



SG3400HV IEC



SG3400HV-MV IEC

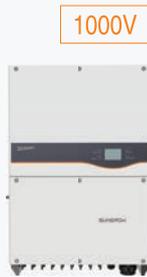


SG2500U-MV UL

## UTILITY STRING INVERTERS



SG125HV IEC UL



SG80KTL IEC



SG60KTL IEC



SG50KTL-M-20 IEC

## COMMERCIAL

## RESIDENTIAL



SG2K-S/SG2K5-S  
SG3K-S  
(IEC AS4777)



SG3K-D/SG4K-D  
SG5K-D/SG6K-D  
(IEC AS4777)

## ENERGY STORAGE



SH5K IEC



1500V

SG2500U UL



1500V

SG2500HV-20 IEC



1000V

SG2500 IEC



1000V

SG2500-MV IEC



SG50KTL-M IEC



SG33KTL-M  
SG36KTL-M  
(IEC)



SG15KTL-M  
SG20KTL-M  
(IEC)



SG10KTL-M  
SG12KTL-M  
(IEC)



SBP4K8 IEC



SC50HV IEC



SC2500HV IEC

# DESIGN MEETS DEMANDS

# Why design must meet demand in the modern inverter market

The inverter market is full of nuance and tasked with keeping pace with the solar sector's relentless changes. We spoke to analysts at Green Tech Media (GTM) for a snapshot of the global inverter market, and examine Sungrow's leadership role within it



Credit: Sungrow

The global solar industry has been growing. With growth, it has also diversified. The geographies undertaking substantial deployment are more numerous and spread more broadly than we have ever seen. From Scandinavia's midnight sun to the deserts of Chile and Saudi Arabia and (almost) everywhere in between, the conditions under which solar operates have never been more different. As a result, the best system designs for rooftop and ground mounted projects are equally diverse.

Enabling this mind-blowing rise in demand, be it on the ground, on rooftops or on water, are inverters. Module technology has undergone a degree of regionalization with ruggedized panels and low-light performance factored into selection. The selection of an appropriate inverter for each application and in the prevalent local conditions can have an even greater impact.

The evolution of the solar inverter market has been coloured by these

demands. The expectation for increasing functionality, improved reliability and the most bankable systems possible has placed ever more stringent requirements on manufacturers. This means dedicated research and development for the changing needs of the solar industry are a must. Inverter manufacturers need to be agile but diligent. Innovative and reliable.

## The shape of the market

A consistent trend in the inverter market has been the growing success of Asian inverter suppliers, which has been largely driven by serving regional demand. That success continues, and according to GTM Research, the five largest inverter manufacturers in the world have enjoyed a growing market share for the past five years. Shipments of three-phase string inverters surpassed that of central inverters for the first time in 2017, according to the firm's latest inverter market report.

The leading players have seen their market share grow for five consecutive

years, says Scott Moskowitz, senior analyst at GTM Research. Over this time, string inverters have taken a greater share of utility projects than central inverters, he says.

"We expect those trends to continue but it's not that simple. Prices are still declining and the technology is quite mature. A maturing market is typically not defined by continued price declines. But there are still a number of technology developments that will contribute to price declines for several years and that will mean the market continues to shake out," he adds.

This means not every market player can keep pace with the new developments and the new demands and expectations placed on their product portfolio. GTM's 2017 inverter outlook tracked 20 suppliers that shipped more than 1GW. The top five suppliers took a 62% share of the global market. In China, the top five providers have 90% of the market. Of the global top five, Sungrow is the only one born



Credit: Sungrow

of the solar industry with a background in PV research and organic growth that has tracked or exceeded the sector's own expansion.

### String theory

As GTM identified, string inverters have displaced central inverters as the dominant technology in the utility sector. The key to the success story of string inverters has been the emergence of markets where it is the best choice.

"The trend started in Europe when small utility-scale projects started to be built with three-phase string inverters for a number of different reasons. Since then we've seen trends in three-phase string inverter technology that has shown that they work well with progressively larger systems," explains Moskowitz.

The success and scale of string inverter shipments in China has been a huge driver of the trend for string inverters, but their progress is by no means constrained to China.

"Turkey uses a lot of three-phase string inverters because of the undulating nature of the land. Projects are not often block shapes, they have to be [shaped] appropriately, which makes them well-suited to

**Sungrow is unique in being able to serve all sectors of the solar industry including both string and central utility-scale products.**

three-phase string inverters.

"In other markets, such as Central America, string inverters work very well. That is one of the drivers behind the growth in 2017, and we expect to see more growth in both Latin America and the US. The main reason is that the technology is changing," he says.

To dig deeper into those changes, we have to move onto another trend in the inverter market poised to make an impact on the scale of string inverters.

### 1500V inverters

Increasingly prevalent, including in the use of string inverters, is 1500V system architecture. There have been almost a dozen introductions of 1500V string inverters in the past year or two. These compete much more effectively with 1500V central inverters than their 1000V predecessors did with their equivalent central inverters, says Moskowitz.

"The threshold where string makes obvious sense rather than central has changed, which only makes string more popular," he adds.

The technology is growing its share consistently and Moskowitz envisions it becoming the dominant force in the next

few years.

"They are a lower cost way of designing, installing and operating solar. They are inherently more power dense, inherently more efficient. They are simply a better way of deploying utility-scale solar. The barriers for building them in the next couple of years are justified, but this is likely how the majority will be built in the medium-term," he says.

Despite 1500V having taken a very large share of the global utility scale market, it is still not the majority.

"There are places where 1500V is ubiquitous, and there are places where it is still very nascent. In the US and Mexico, 1500V is absolutely ubiquitous for utility-scale projects. There are now many gigawatts' worth of 1500V modules and inverters installed and they have a very obvious price advantage over 1000V products in those markets.

"However, that doesn't mean that 1500V is an obvious [choice] for everyone. There are certain places where developers prefer 1000V inverters because they still have much longer, established track records, there are some places where the economics are also not as overwhelmingly obvious.

"In places like India and China, the price of PV componentry is so low that the benefit for installing a 1500V system over a 1000V system is not enough to overcome the lack of a track record for those products in those markets. People don't just want to see 1500V operating globally, they want to see the track record in the markets where they are operating."

The issue of component cost savings is not the only dynamic at play when system selection is being made for projects in emerging economies.

"Often the cost of financing is one of the most significant barriers rather than the cost of componentry. In projects like that, developers are not always after the lowest cost system design. They want to make sure they have the best system design with the least risk, and then get the most attractive financing available in those markets."

### Big data's big influence

The demands for live performance data and monitoring capabilities creates an extra pillar of product development and operations that is well-suited for a company with a background rooted in academia.

Enabling asset managers and project owners to scrutinize every unit of generation and, more importantly, react when things do go wrong, is vital. Moskovitz says the companies that are not able to provide this are going to get left behind.

"Most people are buying an inverter because they are getting the most bankable product, the one most technically sound for the project, not because the interface aspects are the most sophisticated. But if the company is not able to provide [that capability], they can't win. It's something that all these companies are thinking about very closely," he adds.

The importance of big data is only growing as the energy sector, its infrastructure and its marketplace, becomes increasingly digitized. The outcomes for companies that can or cannot provide this are also binary; survive or fail.

### Regional markets

From one market to another, solar develops via different segments, under different environmental conditions and with various electrical standards. This can mean that the smaller players, with smaller areas of expertise and a more limited pedigree can have their geographic reach constrained.

"What's interesting about the inverter

market is yes, 20 firms shipped 1GW or more, but it's actually quite regionally consolidated," explains Moskovitz. "The market is very nuanced. Every market has different electrical requirements, different economic and technical requirements, and because of that it's very difficult to be really good in every market segment in every country around the world."

Some companies have the resources to work out ways around this, but inevitably some will fall behind in some markets, he says.

"In any given regional market, there are typically only four or five players that own a very large share of the market. That's true in practically every market," he says, adding that there can be space for more players if there happens to be sufficient deployment at all scales.

"It's very hard [for a manufacturer] to do each of those things well all of the time."

The end result is that smaller players could be drawn in and out of markets.

Sungrow's product portfolio means it can commit to a market without being dependent on the ongoing success of any given segment. It also frees it up from reliance on a smaller patchwork of markets, which can open manufacturers of any given component to more exposure to market shocks.

A company with products covering everything from the residential rooftop to utility-scale central inverters can offer not only tailored solutions, but also stability. It will not have to cherry pick where it operates at any given time, allowing it to form longer-term relationships with customers and stronger after-sales networks.

### Consolidation

A mixture of forced consolidation, as struggling companies drop out the market, and productive consolidation, as others look to exploit one another's strengths, mean change is coming.

In either case, question marks are raised over the longevity of service provision, availability of spare parts and in the worst situation, the validity of warranties. In Europe, projects have been replacing their entire inverter supply because the existing units are no longer supported. An inverter refit can be a cheaper and more predictable outcome than repeated fire-fighting of technical problems without the support of an active manufacturer.

"There will certainly be scenarios in which companies acquire one another

strategically when they are looking to enter other markets or when they don't have a full portfolio of product types," says Moskovitz. "There will also be companies that cannot keep up with price declines, with market shifts that will likely have to exit the market or look for some other type of acquisition. As the largest dedicated solar inverter manufacturer, and a profitable, debt-free one at that, Sungrow's bankability is beyond doubt."

### Round pegs for round holes

Having developed in lock-step with the solar industry, it is logical that the largest dedicated solar inverter manufacturer caters for the myriad applications and geographies that are now active. It is also one of the reasons that Sungrow is able to straddle the regional consolidation of the sector.

From a procurement point of view, it puts Sungrow in the unique position of being able to objectively assess the inverter needs of a specific project and integrate it into the design. Firms with partial portfolios may find themselves having to convince buyers that the narrow band of the products it offers overlaps with their system's sweet spot.

Customers in Taiwan for example, do not want to be strong-armed into selecting central inverters for a project on an undulating site with a complex-shaped boundary.

### Reliability

As the brain and beating heart of any solar project, the correct choice of inverter is crucial. From the R&D that feeds into each product's development, to the way that it is then selected and integrated into the system, the reliability of both the product and the producer is paramount.

Day-to-day efficiency and up-time mean better returns. The interface creates transparency and trust between asset owners and the partners that integrated the plant. The speed and quality of response during the lifetime of the inverter benefits investors, and the reputation of the solar sector as a whole. In April 2018, ratings agency Standard & Poor's released a report stating that solar was now the most reliable renewable resource. Generation is exceeding expectations and the degradation of components is slower than anticipated. Protecting that reputation and enhancing it is a responsibility every player in the industry should take as seriously as Sungrow. ■

# DESIGN MEETS DEMANDS



**SUNGROW**

Sungrow Power Supply Co., Ltd.  
Add : No.1699 Xiyou Rd., New & High Tech Zone,  
Hefei, 230088, China.  
Tel: +86 551 6532 7834  
Email: [info@sungrow.cn](mailto:info@sungrow.cn)  
Website: [www.sungrowpower.com](http://www.sungrowpower.com)



RESIDENTIAL PV INVERTER  
2kW-5kW with single or dual MPPTs  
RESIDENTIAL HYBRID INVERTER  
5kW with up to 14.4kWh battery packs

# The future is now, the future is solar and storage



Credit: Sungrow-Samsung SDI

**The next big step towards putting clean electricity at the heart of the global system is energy storage, not only for storing power generated during the day for use at night, but also to stabilise grids**

**E**nergy storage inverters are a vital component of any battery system. One of the keys to the provision of effective renewable energy smoothing, microgrid development, peak power management and frequency balancing services, a good inverter can significantly improve power quality through a whole system, help integrate variable renewable energy output and stabilise grids.

Sungrow has more than a dozen dedicated products and solutions aimed at several of the world's biggest or fast-growing markets. At industry show Solar Power International (SPI) last year in California, Sungrow showed off a 250kW turnkey solution suitable for providing two to four hours of storage, which can be deployed at commercial or utility-scale. This device is primarily aimed at the fast-growing commercial and industrial (C&I) sector in the US and can handle anything from 250kW to 1MW.

That US C&I sector is driven forward by business' needs to reduce their electricity costs, by lowering the amount of time spent using expensive power from the grid at peak times, when demand is high across the network. These costs can be as much as 50% of the electricity costs of a factory, hotel, or other business. While that cost is not entirely eliminated, the reduction is enough to have already encouraged many customers to sign up to schemes that guarantee savings on electricity bills at little to no financial risk.

Many other sectors and opportunities exist for energy storage around the world. For example, South Korea is now in a strong position in both C&I and grid-scale storage after utility KEPCO procured around 400MW of energy storage for frequency regulation, and the government created tariffs to incentivise clean energy solutions. In Australia, strong sunshine and high electricity prices make self-consumption of solar very desirable.

Other markets, pushed forward by more than just government incentives and policy support, are catching up. At SPI, Sungrow also displayed its DC-coupled storage solution specifically for pairing batteries with solar power plants, and batteries produced through a joint venture with battery player Samsung SDI.

### Joint venture creates a new big player for BESS

In addition to Sungrow's own work and products in energy storage, the company is now partnered with one of the world's biggest advanced battery makers to further the cause of clean energy.

Created in 2016, an alliance between one of the world's biggest and best inverter manufacturers in Sungrow and Samsung SDI, by many metrics a leader in lithium-ion battery production, resulted in the creation of the Sungrow-Samsung SDI joint venture (JV).

It is a logical match for two leading

**Sungrow has supplied and worked on projects pairing solar and storage around the world.**

players in such closely related industries to make that final connection from upstream manufacturing to real-world deployments. The Sungrow-Samsung SDI JV has already demonstrated its capability to deliver effective energy storage for solar projects in key markets and strategic locations.

The pair made their collaboration official in 2014, the same year Samsung SDI opened a factory for EV batteries in China. Now, they are aiming to enable 2GWh annual production capacity for energy storage technologies.

Despite the short time in which lithium batteries have become the technology of choice for advanced battery energy storage system (BESS) projects, demand is almost beginning to outstrip supply. How better then to confront this situation than by working with a clear-cut leader in delivering lithium-ion batteries in Samsung SDI?



**Self-consumption of solar is a great reason for deploying storage as feed-in tariff rates fall.**

### Systems for the post-subsidy era

Many countries, after using feed-in tariff (FIT) and other incentive policies to encourage the growth of solar energy, are now lowering the rates of those subsidies or losing them altogether. This is a logical step which demonstrates how mature the solar market and PV technology have now become.

Self-consumption of solar from PV plants already built to receive high levels of subsidies, but that no longer receive them, will be the key to maximising the benefits of solar energy. Solar-plus-DC storage from Sungrow-Samsung SDI can raise extra income from selling surplus energy to the grid, while helping PV system owners enjoy using their own solar power as much as possible.

The solutions come with Maximum Power Point Tracking (MPPT) modes supported, which allow the systems to track PV modules' maximum power status and charge the battery directly from the array, enabling a high system efficiency. They are of course also equipped with energy management systems (EMS) that enable the system to switch intelligently through the various generation to storage functions.

### Sungrow's DC storage system

In action at a 100MW PV plant in Jinchang City, Gansu Province, China, Sungrow's DC storage system consists of a bi-directional DC inverter, lithium-ion batteries, HVAC, fire suppression system, pressured exhaust ports, battery control cabin and communications equipment.

The DC busbars of the complete system's PV modules and PV inverters are in a shunt connection with the DC converters and lithium batteries, allowing the system to continue to be operated in MPPT mode, without altering the AC system settings on the PV plant.

Surplus energy stored can be fed into the grid when needed, allowing generation to exceed grid connection capacity and adjust output to meet peak demand. It requires no new grid connection application, batteries can be flexibly configured, the standardised 20ft container design reduces costs and integrated power equipment eliminates the need for new cabling, inverters and transformers.

### Massachusetts's first community project

Sungrow was responsible for Community Solar & Storage, a project just launched



Credit: Origin Energy

### Proud community members at the inauguration of the Sterling Municipal Light Department Project with Origin Energy

in April 2018 in Massachusetts, USA, for utility Sterling Municipal Light Department (SMLD).

While not one of the biggest projects in the world to combine solar energy with storage, with 1MW / 2MWh energy storage, it is the first such project built on a community basis for Massachusetts. It is also one of the clearest examples in the world today of how solar energy can be made dispatchable for whole communities on a cost-effective basis.

It pairs just over a megawatt of rooftop solar PV with the storage, equivalent to the energy required to power around 228 homes, and in a year could save 1,118kg of carbon emissions from entering the atmosphere.

Sungrow supplied battery inverters, system integrator and energy storage software specialist Greensmith provided its proprietary control software platform, GEMS. The company was also responsible for operation and maintenance (O&M) services under a 10-year agreement.

Speakers at the project launch included Kelly Speakes-Backman, CEO of the US' national Energy Storage Association and Massachusetts Senator Dean Tran. Photos showed local residents proudly posing with solar panels, demonstrating just how strongly supported clean energy is by communities and their leaders alike.

It also shows what a robust business proposition such installations have become, with developer Origin Energy brokering a long-term power purchase agreement (PPA) with SMLD. Around 1.7MWh of baseload energy can be dispatched from the system each year, with utility customers able to sign up to a subscription programme to participate. The rates those participants will pay is protected for 25 years.

"Sungrow is glad to be part of this Origin solar-plus-storage project in Massachusetts to push energy storage to the next frontier," Sungrow-Samsung SDI managing director Mizhi Zhang said.

"With the advanced technology and expertise of Greensmith Energy and Origin Energy, this system will certainly help to provide reliable solar power and cost savings for this town"

### CASE STUDIES

#### Early proof points in China's BESS market

One of the most important aspects of any growing market for industry is the successful collection of data from the work of early adopters and pioneers. Sungrow supplied equipment and knowledge to several examples of advanced energy storage projects in China between 2011 and 2013. As early as 2006, Sungrow's storage specific inverters had been used in Japanese projects.

**2011:** Yangshan Harbor, Shanghai  
Sungrow installed a 3MW ESS with supercapacitor, harmonic suppression control and frequency and voltage adjustment, improving and making reliable quality of power supply.

**2013:** Duanguang, Gansu  
Sungrow supplied technology to a 9MW system, the first PV ESS in north-western China. The local utility grid had a feed-in limitation and the ESS was used to improve power supply and increase economic benefits of the PV system.

**2013:** Zhiduo, Qinghai  
Sungrow worked on a microgrid site

at 4,300 metres above sea level. With 15MWh of battery capacity, and power conversion capacity of 2.4MW, Sungrow supplied the complete EMS to this project as well as two models of storage inverters, SC500TL and SG500MX

### Maximising profit from solar energy

PV + DC STORAGE

Odate, Akita Prefecture, Japan

Solar PV capacity: 350kWp

Battery technology: NCM (nickel cobalt manganese) Lithium-ion

Battery capacity: 49.5kW / 1.3MWh

A solar farm in Japan had a high FIT rate but a limited capability to sell the energy into the grid. AC connection to the local electricity grid is limited to just 49.5kW, but the solar power plant is capable of generating 350kWp. On the DC side is a Sungrow-Samsung SDI lithium-ion energy storage system which allows power to be fed into the grid 24 hours a day. This maximises profits generated from the plant and ensures the full usefulness and social benefit of solar PV is both demonstrated and enjoyed.

### System equipment and technology

The batteries are housed in a 20ft container and the power conversion system in a smaller, 10ft container.

The battery container houses ternary lithium-ion NCM batteries. These use a different combination of nickel, manganese and cobalt to the more common NMC batteries. Also in the container are integrated sort temperature controls (HVAC), and an automatic fire suppression system.

The power conversion system container houses DC converter, PV inverter, EMS and a cabin for power distribution and communications functions.

### How the system works

SCENARIO ONE: When PV generation exceeds the rated power of the connection inverter, the solar energy is fed into the grid, as well as stored in the system's batteries.

SCENARIO TWO: When PV generation is below the rated power of the connection inverter, the solar farm feeds straight into the grid, while the battery system also releases its stored energy into the grid.

SCENARIO THREE: At night, when there is no sunlight and therefore no solar, the battery services the connection.

- the system uses DC busbar coupling, eliminating conversion losses between transformer and storage inverter, and increasing efficiency;
- the battery smooths the power generated, so that it can be integrated into the grid more effectively;
- the containerised solution is easy to install, maintain, transport and commission, with fully integrated design features;
- the automatic fire suppression and HVAC make it safe and reliable;
- the design and execution of the project is flexible and was tailored and engineered to meet the customer's needs; and
- robust design and construction of the system makes it durable and weather-resistant.

### Coming soon: 30MWh in Hokkaido, Japan

A great example of the Sungrow-Samsung SDI JV in action is a 30MWh large-scale installation in Hokkaido, the most northern of Japan's main islands. That project is currently underway.

The region has seen prolific deployment of renewable energy over the past few years, but this has not been without

its challenges. Hokkaido only has old-fashioned undersea cables, expensive and not that efficient, to connect it with Honshu, the main land mass of Japan.

The Sungrow-Samsung SDI JV is supplying both inverters and lithium-ion batteries to that project. As with the rest of Japan, Hokkaido's local grid network is maintained and operated by a utility, Hokkaido Electric Power (HEPCO). Long-running issues of grid constraints, both perceived and real, led to some of the 10 regional utilities calling for a temporary halt to new solar farm approvals in 2014.

HEPCO has already installed a huge 60MWh flow battery in the region and has also added various technical requirements for renewable energy plant installations to obtain grid connections, including curtailing the offtake of power from solar or wind in times of overproduction, and requiring energy storage to mitigate the variable output of generators.

Sungrow is supplying a full turnkey energy storage system with 30MWh energy storage capacity and 23 containerised inverter solutions. Sungrow-Samsung SDI is providing the lithium nickel manganese cobalt oxide (NMC) batteries which have high energy density, long life cycle and deep charge and discharge capabilities.

While the customer wants to keep some of the project details private, Sungrow-Samsung SDI said the new storage system's proud new owner "highly appreciates Sungrow's system solution, which is designed against the power constrictions in the Japanese power market, by adding ESS to a PV plant and achieving 24 hours of continued power yield".

### UK 1MW/1.2MWh PV self-consumption project

This UK's first PV-plus-storage project is located in Swindon, in the south west. The project is built for maximum use of PV energy locally, thus improving the self-consumption. The energy storage system provided by Sungrow-Samsung SDI is 1MW/1.2MWh and is fitted into a 20ft container with all of the components integrated inside. This is possibly a good example for all similar chain stores with rooftop PV systems. The business model can be expanded for multiple sites offering a cookie cutter approach to clients with several locations. ■



20ft battery storage container with 10ft power conversion container in Akita, Japan.

# Sungrow makes global media splash over floating solar

Completion of the world's largest floating solar plant on land formerly used for coal mining generated a media frenzy last year. Sungrow technology was behind the innovation. Mark Osborne reports



In May 2017, a 40MW floating photovoltaic (FPV) power plant completed and grid connected on a former flooded coal mining region in Huainan, China, captured the global media's attention.

This was the world's largest FPV plant ever built. The transformation of an industrial wasteland into a sea of water, reused as a new form of renewable electricity on such a vast scale, proved irresistible to both the renewable trade press but also, importantly, to the global mainstream media.

Stories, videos, blogs and analysis all appeared in mainstream outlets such as the BBC, Bloomberg, Al Jazeera, RT News and the Huffington Post, among others. Indeed, such was the media attention

that, a year on from the announcement, the BBC has undertaken a follow-up story, highlighting the transformation of the coal mining region and the personal stories of former local coal miners employed to maintain the FPV power plant.

## Media frenzy

One company was responsible for the global coverage and one particular image used by countless media outlets: Sungrow Power Supply. The PV inverter manufacturer issued a press release on 18 May, headlined: "The World's Largest Floating PV Power Plant of 40MW Connected to the Grid Using Sungrow's Inverters." Leading global dedicated solar news and analysis

## New 150MW FPV plant in close proximity to the initial 40MW project

website, PV Tech immediately covered the story, followed by a large number of renewable energy news websites over the next few days. By the 28 May, the BBC covered the story as well as social media, in a frenzy that lasted well into June.

Indeed, the story never really went away, as PV Tech discovered at the end of 2017 that its initial story had been the top news story of the year and had continued to attract readers every day since.

John Parnell, head of content at Solar Media, the parent company of the PV Tech website said: "Any news story that achieves top story status on PV Tech in a given year stands out from the crowd as news traffic is very high, all of the time. As

the first to cover Sungrow's involvement in the remarkable project, many mainstream news channels linked or cited our story, while giving credibility to a project using a new technology and a company without a wider consumer brand name such as Tesla."

### Post splash impact

After Sungrow's announcement, floating solar has gone from being perceived as a niche application within the PV industry to a major new sub-segment market in its own right. Importantly, instead of being seen as a niche application in the sub-megawatt category, initially developed in Japan for small reservoirs, it has since been recognised as an important dual use technology.

Key recognition has come from a growing number of fresh water reservoir FPV project plans to reduce water evaporation and power water pumping requirements around the world, but also from utilities that have hydro-electric power plants. French state utility EDF has since announced a program to install FPV plants at dam reservoirs that reduce peak time water use for hydro. Grid connections are already installed on these plants, so there is little need for further infrastructure.

### Capitalising on success

Sungrow has since ridden the waves caused by the splash in Anhui. The company is already building a much bigger, 150MW FPV plant in close proximity to the initial 40MW project. Energy will be sold to utility State Grid Corporation of China (SGCC) once completed.

Sungrow has also supplied inverters to a 1.5MW FPV plant in Mitakabe, Japan, which provides power for Shikoku Electric Power Co. Sungrow supplied its SG2000MV turnkey station at the project, which features its 20-foot containerised design which integrates four SG500 central inverters, a transformer, and ring main unit, significantly saving the cost of commissioning and installation, as well as adding protection from extreme climatic conditions.

The combiner box used in the Mitakabe Pond plant, the SunBox PVS-8M/16M-W, was specifically customised for FPV plants and is able to work safely in wet and corrosive environments. "Our containerised turnkey solution has been proven to be the ideal choice in many similar plants and we are expecting to be asked for assistance even more in the future," said Renxian Cao, president of Sungrow.

## Anhui 40MW floating solar project

Sungrow Power Supply was a key supplier and engineering, procurement and construction (EPC) partner to the 40MW floating PV power plant on a former flooded coal mining region in Huainan, south Anhui province, China.

Sungrow's SG2500-MV central inverter was deployed at the floating plant that featured the integration of the inverter, the transformer and the switchgear, as a turnkey station. In addition, the SunBox PVS-8M/16M-W combiner box supplied by Sungrow was customised for floating power plant applications, enabling it to work in a stable condition in an environment with high levels of humidity and potentially corrosive spray.

Cleaning the plant will also be simplified by the proximity of water, although robotics will be used for much of the cleaning process.

### Customised technology

Major solar module manufacturer JA Solar supplied its monocrystalline double-glass modules to the project, which are designed for greater protection against moisture ingress and high anti-potential induced degradation performance and resistance against corrosion.

Moreover, the 12-year warranty on materials and workmanship and the 30-year linear power warranty for the double-glass modules ensure that customers will enjoy a steady financial return.

Sungrow engineers provided further insight into the world's largest FPV plant:

#### Q: What challenges were expected in completing the first phase of the project?

At that stage, the major challenges were of a practical nature, [achieving] reliability [through] creativity.

#### Q: What challenges actually occurred and how were these overcome?

The challenges encountered during the actual construction process were largely expected. While PV plants are developing rapidly, the practical requirements of building a plant have become more and more strict. These practical concerns cannot be ignored when looking at the overall success of the whole project. Therefore, carrying out a full and detailed study of the logistical requirements is an important exercise. This rationality is an important technical measurement to both control engineering costs and also to provide specific guidance and direction towards the ultimate implementation of the plant. During the actual construction process, the practical considerations of a specific project at the initial decision making stage naturally start with selecting a preferred location and deciding on the project's size. The design stage incorporates defining the overall PV system solution, the generation units, calculation of energy to be generated, analysis of system efficiency and, clearly, construction design. The subsequent stage covers project implementation, organisation of construction, operation and maintenance solution designs and establishing a comprehensive solution for water surface utilization.

Adhering to these practical principles contributes to the economic success, safety and applicability of the plant development. Looking closely at the current PV plant construction situation in China, the speed and number of domestic developments have gained world-wide recognition and China is certainly enjoying a 'boom' period.

However, PV plants are sometimes lacking in innovation, as well as the element of practical study outlined above. In the actual construction process of a PV plant, it is always possible to come up with innovative ideas, though these are often more of a one dimensional type and to a large extent are only innovative at the idea level, ignoring the functionality, economic aspect and efficiency of the plant construction itself. This reflects a basic misunderstanding by constructors of the concept of innovation and, further, a poor understanding of internal mechanisms and logistics, ultimately leading to an unsatisfactory end result.

To achieve innovation on floating PV plants, one needs to harness efficient integration, digital and smart applications, grid support and creative system design, basically linking a floating plant with its natural environment and applying the principles of people-oriented construction concepts.

The reliability element of a PV plant's construction additionally includes safety, adaptability and durability. The percentage scale of reliability is generally defined as the possibility of completing a predetermined function within a specific timeframe and under specific conditions.

Simulation analysis on a floating array's reliability is based on the array's ability to function under a set of extreme natural climatic conditions set by regulators, covering normal construction and operational conditions, while still maintaining necessary levels of safety. Highly reliable designs for floating units can ensure their service lifespan and satisfy durability requirements, both microscopically and macroscopically, from both the material and structural standpoints. Special water surface junction boxes, highly reliable integrated containers and voltage step-up inverter platforms are all designed specifically for the water surface deployment



Anhui 40MW floating solar project

environment of a floating plant and all provide great adaptability to meet the requirements of innovative equipment to perform all expected functions during its projected service life.

**Q: Could you provide an update on the status of the project and what new milestones in the build-out have or are expected to be achieved?**

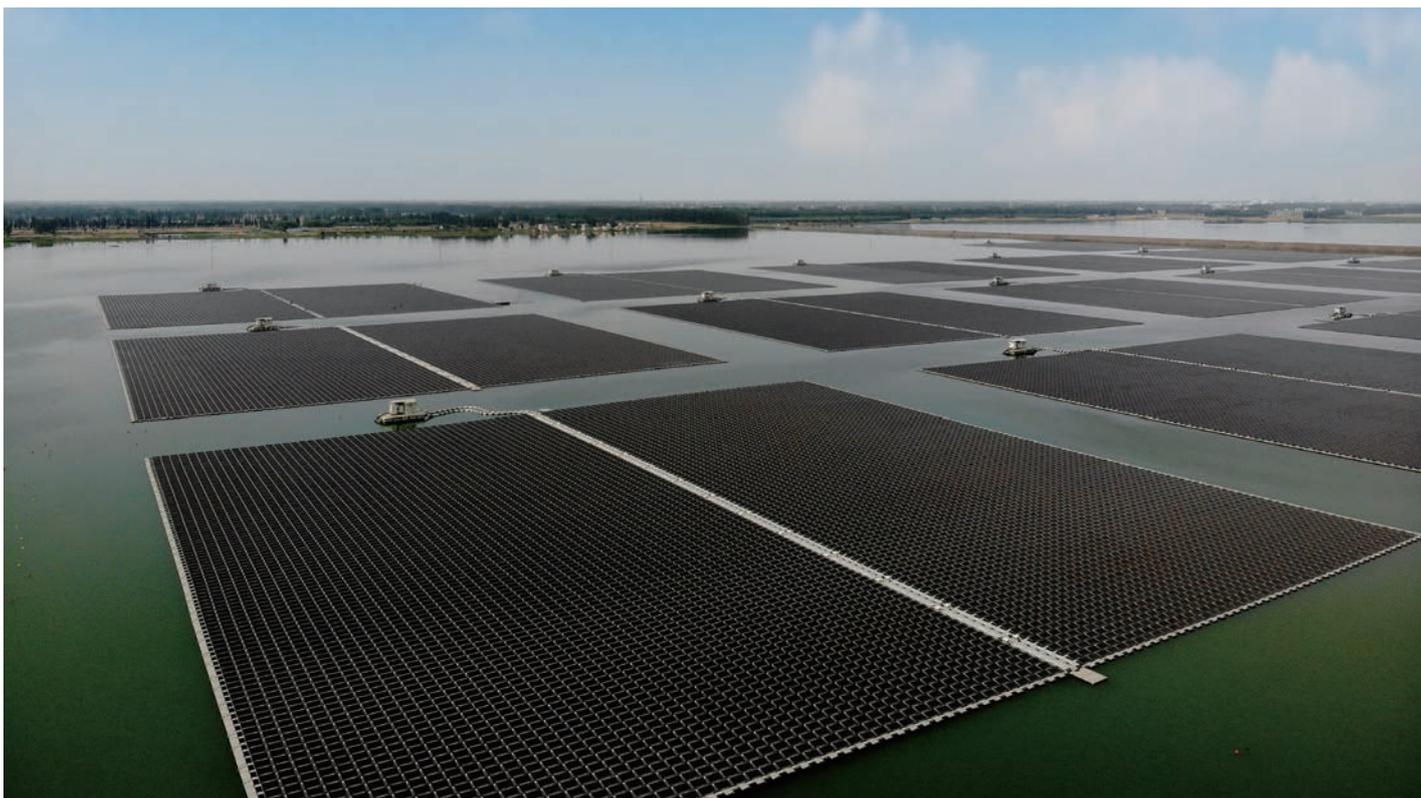
The project has now been connected for more than a year and is in good operating condition. From the actual generation point of view, floating plants have great advantages over ground-mounted plants. Due to the cooling effects from the water surface, light reflection for the floating parts and less dust, a floating system can achieve a generation gain of over 10% when compared with its ground-mounted counterpart. This project was the world's largest single-body floating plant at the time and has created enormous PR for floating PV plants as a major plant deployment type. From the project's role in demonstrating the feasibility of the concept, there is now massive momentum for developing floating plants all over the world.

**Q: Will FPV projects use 1500V? Are LCOE requirements driving the use of 1500V?**

Yes, using 1500V will be the future trend. Going forward, we will be one of the first to use 1500V products. A 1500V system could certainly greatly reduce the quantity of electrical equipment required, which would be an obvious benefit to a floating project; junction boxes and inverters could be even smaller, providing an advantage for water surface on-site voltage step up. There are actual effects of 1500V systems in reducing loss and saving costs, therefore their deployment is inevitable.

**Q: What PV modules are being used and why?**

Double glass modules are currently used in the projects. Since the permeability of the glass is close to zero, there is no need to worry about the problem of ethylene vinyl acetate (EVA) film hydrolysis induced by water vapour entering the modules. Back sheets in conventional c-si solar modules have a certain level of permeable rate, resulting in chemical erosion occurring inside the modules, with the increased possibility of PID and snail trails. The advantage of the double glass products makes them especially suitable for floating PV plants in both waterside and high density areas.



Japan is known for the scarcity and cost of its open land and has seen the growing use of water ponds for solar plants in recent years.

**Multiple benefits**

Floating solar power plants are becoming increasingly popular across the globe due to their ability to reduce water evaporation in many applications, while the cooler ambient air, due to the water location, notably in hot and humid environments, limits the solar panel's exposure to the temperature coefficient, which leads to degradation of performance as ambient temperatures increase.

Studies indicate that the evaporative cooling effect from water on solar FPV modules in hot and humid environments has the potential to increase the annual energy yield from 10% to 25%, compared to land-based PV systems. A side benefit is that they preserve water by cutting evaporation and preventing algae growth.

FPV power plants also address issues over land availability and landscape impacts that large-scale land-based PV power plant projects continue to come up against. The conservation of agricultural land can be complemented with FPV by converting unused or secondary irrigation ponds to new forms of revenue generation, while retaining their existing agricultural function.

**New 150MW FPV plant in close proximity to the initial 40MW project**

FPV could also provide significant financial benefits to hydropower plants in any part of the world due to existing grid connections and the ability to work PV in tandem with the hydro power as well as prolong hydro power seasonal operations especially in regions that encounter dry and wet seasons.

FPV is also expected to drive the adoption of new technologies that will lower the LCOE and provide greater ROI. Solar module tracker systems designed specifically for FPV have already been tested and glass/glass bifacial modules could become widely adopted. This would lead to further inverter innovations to harness the performance and system characteristics as well as the adoption of 1500VDC systems.

**FPV market trends**

According to market research firm IHS Markit, China, Japan, and South Korea have installed the majority of FPV power plant projects, which total more than 450MW capacity. China is expected to consolidate its position as the world leader in 2018, having already completed the world's largest floating PV system of 40MW, alongside plans to continue with 70MW and 150MW projects during the first quarter of 2018.

While China is set to stay at the forefront, new potential markets are also emerging, such as India with a 10GW tender, and the Netherlands with a plan to install 2.3GW by 2023. Japan is expected to continue to adopt FPV, and a growing list of new projects continues to gain momentum in France, Latin America and across South East Asia. ■



# Remote monitoring and O&M: The inverter-led approach

As the solar industry has developed, real-time monitoring to maximise yield, uptime and the efficiency of O&M efforts on the ground has become a must. Here we explore the benefits of an inverter vendor-led system for delivering maximum yield with minimum cost

The iSolarCloud is Sungrow's remote monitoring and O&M platform.

The cloud-based monitoring platform allows plant owners to monitor and manage all their PV plants worldwide from string level to system level. It features concise presentation options that can be accessed from anywhere in the world via the internet.

The platform gives plant owners access to their plant performance data to ensure round-the-clock monitoring. Plant owners have the convenience and ease to remotely monitor all the PV plants from one central platform.

## 1. Centralized PV plant management

Sungrow provides remote monitoring and an O&M platform with all PV plants managed within a central platform. The monitoring data of each PV plant can be acquired and displayed in the platform, which monitors the running status of photovoltaic modules, inverters, transformers and other related equipment in the PV system. It also monitors real-time data such as weather conditions, power generation etc.

By contrasting and analysing the device data in multiple aspects, more granular monitoring information can be obtained.

This means locating, analysing and resolving faults in real time, while also enabling the central operation and maintenance of the plants to continue.

Users can remotely control operation and maintenance, view module-level performance via the platform and receive automatic emails when performance is affected.

iSolarCloud is available for remote monitoring and centralized management of all your PV plants. It also provides PV plant owners with powerful insight. The web portal gives plant owners access to their plant's performance data to ensure the desired ROI (Return On Investment) is realised. The platform proactively suggests actions for better system performance. Remote management can be controlled through a single login access.

## Remote O&M assistance

With the use of the O&M platform, strong customer relationships can be built online and offline, providing comprehensive operation and maintenance services based on each customer's requirements.

The users can display their system overviews in list form, the "data analysis" page displaying the current monitoring data and data curves, and the plant map helping to pinpoint the location of the fault. With the online web portal, it is easier for an expert team to monitor, troubleshoot and solve issues. Furthermore, the O&M platform automatically analyses the monitoring data and provides an accurate fault location.

The O&M Platform is capable of performing full lifecycle management of photovoltaic power plants, supporting operations such as power station inspections, fault alarms, and device maintenance.

Customers are increasingly looking for highly-integrated PV solutions. With the rapid development of technology, such as big data, cloud computing and remote O&M, these applications are becoming increasingly ubiquitous.

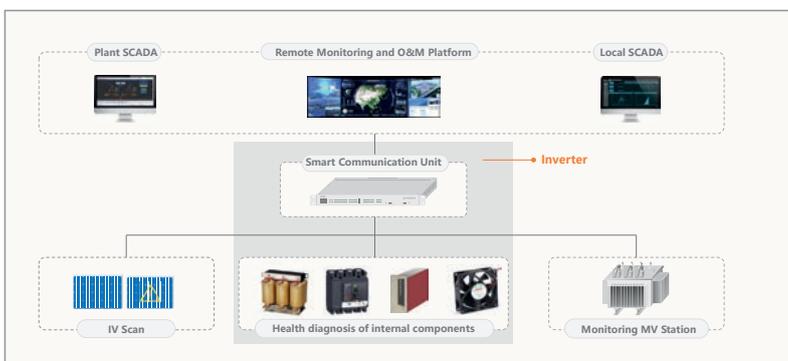


Fig.-1 System Diagram



Fig.-2 Remote Monitoring and O&M Platform

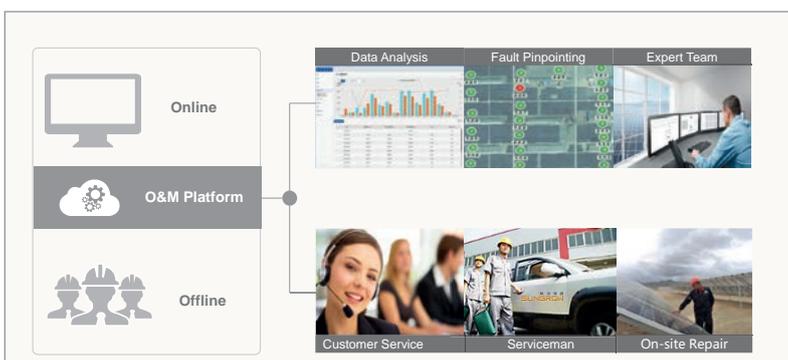


Fig.-3 Remote O&M Assistance

With over 21 years of experience, Sungrow has a comprehensive understanding of PV monitoring systems and knows how to optimise customers' return on PV investment.

iSolarCloud processes a billion real-time events each day, in doing so managing the solar power of more than 10GW. iSolar-Cloud is also applicable to wind energy and energy storage systems.

Remote monitoring and the O&M

platform performs a professional job of data acquisition and analysis and also works as a "service tool" to help plant owners reduce the cost of O&M and greatly improve work efficiency.

#### Application case

Sungrow's remote monitoring and O&M platform have a wide range of applications globally.

"The remote monitoring and O&M platform provided by inverter manufacturers is easy to understand for both the plant owners and end users. Inverter-supplied monitoring solutions have features that let plant owners view multiple systems, fault alarm, remotely update inverters and commission systems," said one customer who has experienced this platform. ■

#### 200MW Utility-Scale PV Plant, China

##### Sungrow Solution:

- Central Inverter, SG630MX, SG2500
- Smart Communication Unit, Local SCADA
- Remote monitoring and O&M platform

##### Customer Value:

- User-defined performance views, full plant supervision via multi-dimensional analysis.
- Sungrow provides centralized management, guide operation and maintenance to cover all aspects of the renewable energy system.

#### 18.5MW Utility-Scale PV Plant, Malaysia

##### Sungrow Solution:

- Central Inverter, SG2500-MV
- Smart Communication Unit, Power Plant Controller, Local SCADA
- Remote monitoring and O&M platform

##### Customer Value:

- Sungrow provide the local SCADA and Power Plant Controller control as well as the remote monitoring and O&M platform as a package monitoring & control solution.
- User-defined performance views, full plant supervision via multi-dimensional analysis
- Real time fault analysis and report, quick trouble shooting

#### 1.6MW commercial PV Plant, Maldives

##### Sungrow Solution:

- String Inverter, SG20KTL
- Wireless module, Logger3000
- Remote monitoring and O&M platform

##### Customer Value:

- Remote monitoring and O&M platform manages all the rooftop plants from a central platform.
- Quickly create PV Station and view real-time alarm information via APP
- Without RS485 cable between neighbouring roof tops, cable routing and costs are reduced.



## The Sungrow inverters about to be teenagers

**While O&M and lifecycle yield are reliant on forecasting, Sungrow is in the unique position of being able to revisit a customer whose inverters have been operational for 12 years**

#### Project scale:

30kW

#### Project location:

Yangzhou, China

#### Project Setting:

It's a rooftop project for the community that can supply 1,700 households, and had generated 320000kWh by April, 2018

#### Specification:

Six Sungrow 5kW string inverters ; 196 modules; the project investment totaled RMB890,000 (US\$129,000)

#### When was the project construction finished?

September, 2006



#### What makes customers to choose Sungrow inverters?

Even in 2006, Sungrow was widely recognized for its reliability and high-efficiency. Mr. Yan, the installer of this historic project, said he chose Sungrow as the inverter supplier of his first rooftop project as per the market trend

#### What the customer says:

"There is an incredible demand for renewable energy in China, and we have seen through our efforts an intense desire by the people and the government to continue evolving in ways that will allow local institutions to sponsor more and even bigger solar projects in the future." Yan Zhengsong

Mr. Yan Zhengsong, the local installer in Yangzhou, continues to work in the renewable energy sector

# DESIGN MEETS DEMANDS



**SUNGROW**

**Sungrow Power Supply Co., Ltd.**

Add : No.1699 Xiyou Rd., New & High Tech Zone,  
Hefei, 230088, China.

Tel: +86 551 6532 7834

Email: info@sungrow.cn

Website: www.sungrowpower.com

**SG3400HV**

# Sungrow in the field



Seeing is believing and Sungrow's rich portfolio of reference projects demonstrates its comprehensive inverter portfolio in action.

A 5MW plant in Spain built in 2008

## ROOFTOP



An 11MW plant in India



A 7MW plant in Lupburg, Germany



A 12MW plant in Sardinia, Italy back in 2011



The 13MW Moss Grange Solar Farm in the UK



The 40MW floating PV plant in Huainan, China



A 40MW project in Thailand



A 75MW plant in Thailand



A 735kW plant in Japan

# Enerparc banks on trust and technical excellence

German EPC Enerparc explains how its relationship with Sungrow has blossomed during five years of collaboration



Stefan Müller, chief operations officer, Enerparc, Germany

Hamburg-based Enerparc has been building large-scale plants for almost ten years, and now not only develops and builds plants itself, but also operates them, and works as an external service provider for investors. It is also active in energy trading.

Sungrow has been working with the engineering, procurement and construction (EPC) company for four or five years, according to Stefan Müller, the company's chief operations officer. Enerparc is active in mainstream locations, such as the US and India, but also in more offbeat destinations such as Belarus, Israel and the Ukraine.

"We control all international markets from Hamburg. With each one, we ask ourselves: 'Does anyone there need Enerparc? And if the answer is 'yes,' then we'll do it, even if it's a difficult country,'" says Müller.

Enerparc prides itself on being flexible enough to respond quickly to new trends and markets. It does not always make sense to open an office in a new market, so it uses local partners. "We work very closely with

them, exclusively, including smaller markets such as Armenia or Jordan," Müller says.

When looking for inverter manufacturers, Enerparc likes to use well-respected brands. The bankability of a project has a lot to do with having high-quality high-tech components, which includes inverters, he says.

"There are certain customers who simply prefer certain brands, and if an inverter manufacturer is very strong in a country, it is automatically that people ask for that inverter manufacturer. That is inevitable and we must respond to it," Müller explains.

Trust is the most important characteristic of Enerparc's relationship with Sungrow, Müller says. He reports that, ten years ago, there was a barrier to buying Chinese inverters. However, since then, companies have realised that Sungrow and others belong in the global top ten, not just in China, and that they can cooperate very well internationally.

"Trust is the important thing," noting that price can of course have a role too. "But flexibility plays a big role, too, which has to do

"Trust is the important thing... But flexibility plays a big role, too, which has to do with delivery, but also with technical service."

with delivery, but also with technical service, and the Chinese inverter manufacturers have certainly learned a lot," he says. He gives the example of a residential customer having access to a helpline where they will be answered in German, and for commercial customers, having the mobile phone number of the technical manager who can be contacted after hours.

Müller says that Enerparc was the first EPC company to really speak to Chinese manufacturers. It collaborates with Sungrow on 90% of the 250MW it builds each year.

# How a factory tour cemented the deal for Swinerton

Having known little about Sungrow initially, US-based EPC Swinerton explains how a whistle-stop factory tour laid the foundations for partnership.



Scott Stites, director of procurement, Swinerton Renewable Energy, US

Swinerton Renewable Energy was formed in 2008 out of traditional property construction company Swinerton. Since then, the California-based company has delivered more than 3GW of renewable energy projects across the US. It also offers operations and maintenance services.

For Swinerton, price is the most important factor when choosing an inverter supplier. "The utility-scale market in the US is very price conscious. Fractions of pennies per watt win or lose projects. The first phone call is made to the inverter manufacturer that is the most cost competitive," Scott Stites says.

Sungrow is typically the most cost competitive inverter manufacturer that Swinerton uses, he says. "But that doesn't mean that they're not also the best in technology terms. They are one of the top inverter suppliers globally – their global footprint is proof that their performance is at least as good as other manufacturers like SMA."

Swinerton's relationship with Sungrow began in 2014 when it travelled on a

"whirlwind tour" of manufacturers. The company did not know anything about Sungrow before the visit, Stites admits. "But we left thoroughly impressed. They're very Westernised for a Chinese company, they understand our culture. The size and scale of their operations was massive, and their throughput is high," he says.

Stites has also been impressed with Sungrow's products. "The componentry looks just the same as that of ABB or Siemens, and they're as robust as any inverter we've come across. They're equally as good as any other option," he says.

Following the visit to Sungrow's factory, Swinerton used its central inverters on the 30MW Red Horse 3 solar project, 80 miles east of Tucson, Arizona. This partnership was a success, he reports: "Those inverters harvest energy as well as, or better than, any other inverter." Sungrow's customer support has been "very attentive" too, he says. The power generated by the project connects directly into the Tucson Electric Power grid.

Stites is positive about his company's

"We left thoroughly impressed. They're very Westernised for a Chinese company, they understand our culture. The size and scale of their operations was massive, and their throughput is high."

partnership with Sungrow in the future. "They've had challenges breaking into US markets, which we've tried to help them with. We're optimistic that we have hundreds of megawatts that could open up between us and Sungrow in the near future."

# Thriving in India's demanding climate

Developer Hero Future Energies explains how Sungrow's innovation and technical expertise has helped develop a product that delivers in the Indian climate



Sunil Jain, chief executive and executive director, Hero Future Energies, India

Independent power producers Hero Future Energies was established in 2012, focussing on clean energy, with projects employing wind, grid-connected solar PV and rooftop solar. The company has presence in several states including Rajasthan, Karnataka, Madhya Pradesh and Andhra Pradesh. It has installed capacity of more than 1.2GW, and is aiming to increase this to 3.5GW by 2022.

Hero Future Energies started using Sungrow in 2017, with an initial order of 20MW, which has been commissioned.

Jain reports a good experience with Sungrow: "A good thing I have observed about Sungrow is that they are evolving and innovating as they move forward.

"We had a 2MW inverter one year back and the new inverter model they have offered is 3.125MW, which is unique in its class, without increasing the size of the

inverter. That helps because land is always precious and you are putting inverters all over the place.

"Secondly, Sungrow's efficiency level is higher up to 35-40°C, so you can extract more alternating current energy compared to the competitors. Those extra notches always help you in a competitive environment," he adds

India's tough climatic conditions mean that developers need equipment that can handle very high temperatures.

"We have a tropical climate and, unfortunately, in the majority of the good resource states where people are putting up solar, the temperatures can go very high. Therefore, maintaining the efficiency of an inverter, especially an outdoor inverter, without degrading at high temperatures is very important," Jain said.

A guarantee of the level of service is also

"Sungrow's efficiency level is higher up to 35-40°C, so you can extract more alternating current energy compared to the competitors. Those extra notches always help you in a competitive environment"

crucial. "The service network must include the availability of spare parts across the country and the ability to respond within 24 hours of any breakdown."

# Design meets Aussie demand

Distributor OneStopWarehouse witnessed Sungrow snap up market share in the country as its R&D and product development paid dividends



Anson Zhang, co-founder and CEO at OneStopWarehouse, Australia

OneStopWarehouse, a wholesale supplier of solar equipment to the Australian market, was set up in 2013 with its first branch in Perth. It now has branches in five cities in Australia and a sixth branch in China, with a total of 85 employees. Anson Zhang, co-founder and chief executive at OneStopWarehouse discusses his company's relationship with Sungrow.

Following a period of declining growth, Australia is undergoing a PV boom due to a dramatic increase in the price of electricity and falling costs for solar. OneStopWarehouse has partnered with Sungrow for the past four years, in what Zhang describes as a "mutually beneficial relationship".

"Sungrow is a very good brand and before Sungrow came into the Australian market, we didn't have any Chinese brand

to trust. Before they entered the market, we actually tried quite a few other Chinese inverters, but they did not draw the quality reputation nor the necessary service levels.

"Once Sungrow came into Australia, they picked up market share very quickly with their service quality and new products from their research and development," he adds.

Sungrow's products suit conditions for rooftop PV in Australia, Zhang reports, with a main advantage being the company's centralised inverter, which is commonly supplied to big solar farms in China.

"They used this experience to move into rooftop, distributed inverters. The first version was not perfect, but they kept analysing the Australian weather and other conditions and adapting.

"Once Sungrow came into Australia, they picked up market share very quickly with their service quality and new products from their research and development."

"Australia is very hot, and temperatures can reach 45°C, so the inverter has to be able to cope with the higher temperature, and that's why Sungrow kept developing the new technology to apply to the country," Zhang observes.

# Meeting India's service challenges

With a huge geographic spread and often rural project locations, India poses special challenges for inverter manufacturers, says developer and Sungrow client, SunSource



Kushagra Nandan, managing director SunSource, India

The Indian solar market offers huge untapped potential but with that come an array of challenges. Pressure on power prices is intense but financing projects can be costly. Installations must be able to deliver maximum output all year round be they on a factory roof or a large-scale utility project carpeting the landscape.

The huge geographic scale of India requires on-the-ground commitment from any supplier if they are going to meet these criteria. With the inverter the beating heart of any solar power system, Kushagra Nandan, managing director of India-based EPC, SunSource Energy, says selecting the right partners is of the utmost importance.

Inverters are far from being static, fit-and-forget components. They are increasingly the brain of a modern solar array as well. Between their influence on uptime and their role in monitoring and flagging any problems, Nandan says the selection process has to include the after sales capabilities as well as the product. In India, depending on the vendor's own dedication to the market, this can vary greatly from one company to the next.

"We have seen a clear difference in the customer service between one manufacturer and another so now we have to factor

that in when we're choosing inverters." With Indian PV largely being developed without feed-in tariff support, time is money when it comes to correcting any faults.

"Keep in mind that a client building a C&I system with a factory could be located in smaller towns or far out from the metro areas so it is even more important that this after sales network is strong," points out Nandan who says SunSource now has an important, trust-based relationship with Sungrow.

"It's been a really interesting relationship with Sungrow since we started working with them a few years ago. We've recently used them for a large ground-mount project in the Philippines. There were a lot of technical challenges and we even had to customise a few technical components. Sungrow worked with us on that very closely to meet our client's expectations and requirements.

"That built a lot of trust from us in Sungrow's technical competence and we were able to deliver the project on time. We developed a lot of confidence and now we have developed a very deep relationship with them for projects in India as well. It's not just about that front-end aspect during construction of a project, it's also about their after sales service network," he

"If you're going to own a system on an independent power producer (IPP) basis, the inverter selection becomes even more important. Our technical team puts a lot of importance on the functionality and after sales of the inverter partners they choose."

emphasises adding that the two companies will continue collaborating this year.

"The inverter is surely half the system," he says. "If you're going to own a system on an independent power producer (IPP) basis, the inverter selection becomes even more important. Our technical team puts a lot of importance on the functionality and after sales of the inverter partners they choose," he adds.

# DESIGN MEETS DEMANDS



**SG125HV**

**SUNGROW**

**Sungrow Power Supply Co., Ltd.**

Add : No.1699 Xiyou Rd., New & High Tech Zone,  
Hefei, 230088, China.

Tel: +86 551 6532 7834

Email: info@sungrow.cn

Website: www.sungrowpower.com

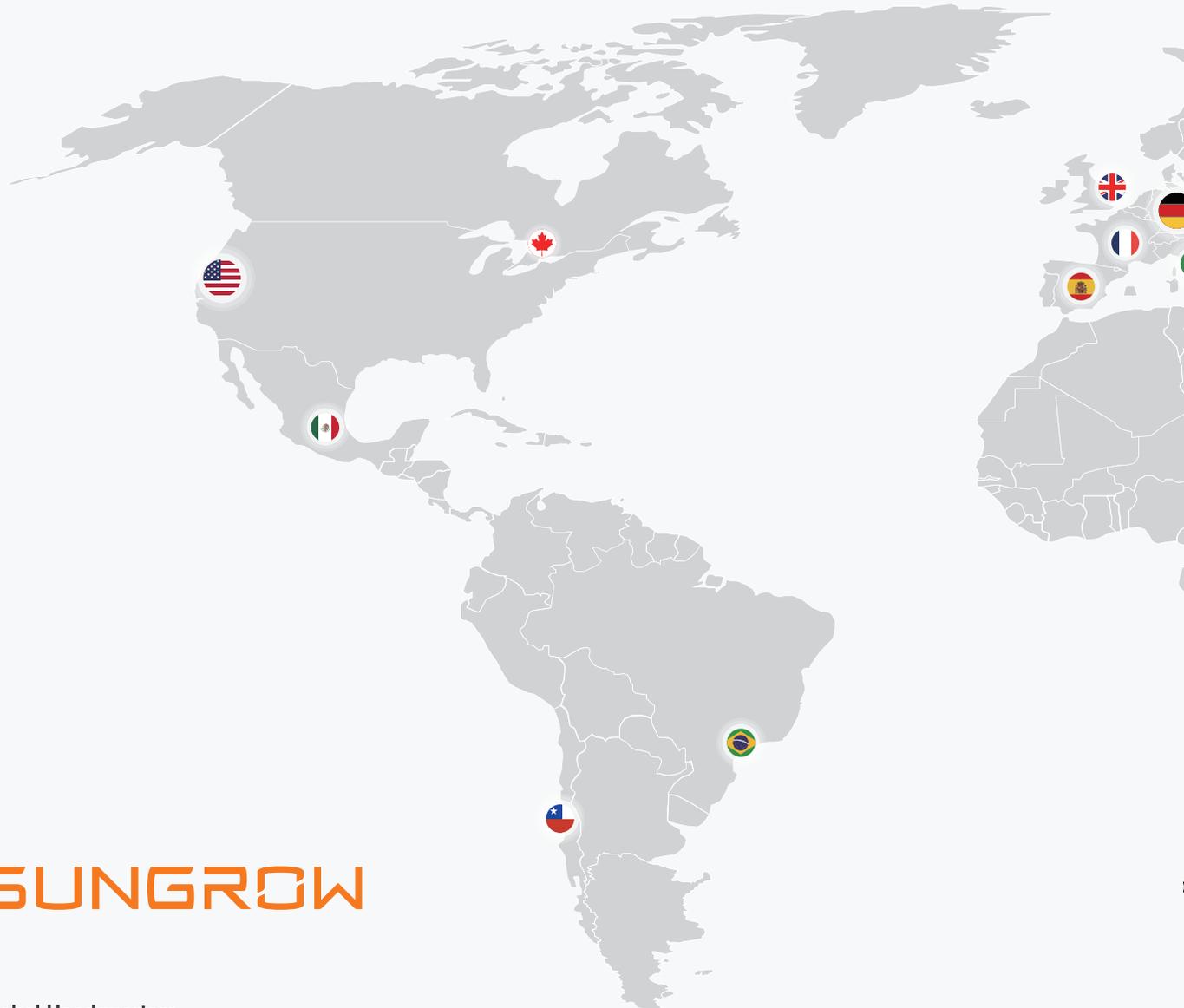
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 1400+ Patent Applications



# SUNGROW

## Global Headquarters Sungrow Power Supply Co., Ltd.

Add: No.1699 Xiyou Rd, New&High Technology Industrial Development Zone,  
230088, Hefei, P.R.China  
Tel: +86 551 6532 7834  
Email: info@sungrow.cn  
Website: www.sungrowpower.com

## Sungrow USA Corporation

Add: 426 17th St. #700 Oakland, CA 94612  
Tel: +1 510 656 1259  
Tech Support: +1 833 SGPOWER  
Email: sales@sungrow-na.com  
Service Email: service@sungrow.ca

## Sungrow Mexico S.A. de C.V.

Add: Av. Paseo de la Reforma 403-1306 México D.F. | 06500  
Tel: +52 (55) 5207 4520  
Email: mexico@sungrow-na.com

## Sungrow Deutschland GmbH

Add: Balanstrasse 59, 81541 Munchen  
Tel: +49 89 324 914 789  
Email: germany@sungrow.co  
Service Email: service.germany@sungrow.co

## Sungrow Power UK Ltd

Add: The Pinnacle Midsummer Boulevard, Milton Keynes, MK9 1BP  
Tel: +44 (0)1908 414126; +44 (0) 7934 738185; +44 (0)7909 757986  
Service: +44 (0)1908 414127; +44 (0)7480 853555  
Email: uk@sungrow.co  
Service Email: service.uk@sungrow.co

# THE GLOBAL LEADING INVERT



#### **Sungrow (India) Private Limited**

Add: 301 & 314, 3rd Floor, JMD Pacific Square, Sector - 15(II), Gurgaon, Haryana -122022, India  
Email: india@sungrow.cc  
Website: www.sungrowpower.com  
Dedicated service contacts:  
Mail: service@in.sungrowpower.com

#### **Sungrow Australia Group Pty.Ltd.**

Add: Suite 1703, 99 Mount Street, North Sydney, NSW 2060, Australia  
Tel: (toll free): 1800 SUNGROW (786 476); (Overseas): +612 9922 1522  
Sales Email: info@sungrowpower.com.au  
Service-Email: service@sungrowpower.com.au

#### **Sungrow SEA**

Add: B-02-26 Dataran Cascades. No 13A, Jln PJU 5/1 Kota Damansara 47810 pj Selangor, Malaysia  
Tel: Tel: +60 18 9879 756  
Email: luis.xu@sungrow.cn

#### **Sungrow Vietnam**

Add: Dreamplex building, 10 Floor, 195 Dien Bien Phu, Binh Thanh district, Ho Chi Minh city  
Email: thang.vu@cn.sungrowpower.com  
Tel: +84914187998

#### **Sungrow Japan K.K.**

Add: 5F, VORT Akihabara maxim, 1-7-9, Kandasudacho, Chiyoda-ku, Tokyo, Japan  
Tel: +81 3 6262 9917  
Fax: +81 3 6262 9918  
Email: Japan@sungrow.cc

#### **Sungrow Power Korea Limited**

Add: 10 floor, 5, Teheran-ro 33-gil, Gangnam-gu, Seoul, Republic of Korea  
Tel: +82-2-2051-1888  
Email: info@kr.sungrowpower.com

#### **Sungrow Thailand**

Add: 17th Fl, Unit 2,3,3A &4, Silom Complex Tower, 191 Silom Road, Silom, Bangrak, Bangkok, 10500, Thailand  
Tel: +00 66 945986455  
Email: sathian.k@th.sungrowpower.com

\* New offices opening soon in Dubai and South Africa.

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