



A new era of solar power

The challenges and opportunities
that power success in the growing
solar power industry

Introduction

It is an exciting and challenging time to be part of the solar energy revolution. The growth in demand for clean energy has reached unprecedented levels, and at a rate underestimated by many governments. Solar energy is the dynamic driver of this growth and decisions made now about how to tackle challenges and sustain innovation will shape the future success of the industry and the communities and nations that rely upon it.

While questions about scalability and grid stability along with distributed power generation have been largely answered, they are still a topic and many countries, especially those in the sunbelt, are capitalizing rapidly on their ability to generate clean energy sources.

Expansion of the industry is fueled by the changing nature of supply and demand, optimized through digitalization and smart home technology, and shifts in consumer expectations and behaviour. Their requirement is for greater choice and more comprehensive services that are seamless, intuitive and personalized.

In this white paper we'll investigate how understanding the rapidly shifting solar landscape will help you be prepared for the future and realize the opportunities for strong business growth

A new era

Energy from renewable sources now contributes to 12%¹ of the world's electricity supply. And the International Energy Agency (IEA) predicts continued growth; taking renewables' share of electricity generation from 24% in 2016 to 30% in 2022².

In 2017, annual installed solar capacity was 101.6 GW, almost double that of 2015. The pace of growth is forecast to slow over the next few years, but growth post-2020 will see the market increase to 144.6 GW in 2025³.

Solar is the fastest growing source of renewable energy and has overtaken the growth of all other forms of power generation. New solar capacity even outstripped the net growth in coal, and although coal is still the largest source of power generation, the IEA states that solar will continue to dominate future growth.

Energy from renewable sources now contributes 12% of the world's electricity supply

Renewables' share of electricity generation is predicted to increase to 30% in 2022

¹ World invested more in solar energy than coal, gas and nuclear combined in 2017, UN report

² Time to shine: Solar power is fastest-growing source of new energy

³ Global Solar Power Market, 2018 Update Solar Photovoltaic (PV) Gains Momentum as a Globally Irreversible Mainstream Energy Source

Market stage	Market revenue	Annual installed capacity	Market revenue for last year of study period	Annual installed capacity for last year of study period
Growth	\$121.49 billion (2017) ↑	101,620 MW (2017) ↑	139.03 billion (2025) ↑	144,590 MW (2025) ↑
Base year market growth rate for annual installed capacity	Compound annual growth rate for annual installed capacity	Base year market growth rate for revenue	Compound annual growth rate for revenue	Market concentration (per cent of market share held by top 3 companies)
32.8% (2017) ↑	4.5% (CAGR, 2017-2025)	10.8% (2017) ↓	1.7% (CAGR, 2017-2025)	24.0% ↓

↓ Decreasing ◻ Stable ↑ Increasing

Note: All figures are rounded. The base years is 2017. Source: Frost & Sullivan



Drivers of growth

The reasons behind market growth are interrelated.

- **Reduced cost of technology**
- **Government initiatives & policy**
- **Innovation in solar technology**

The key is cost. As a result of falling system costs, due largely to maturation of proven technologies, government policies have become more favourable. Their aim is to encourage the adoption of solar technology to meet national, industrial and residential demands. This is supported by increased PV plant efficiency, ongoing innovation and the environmental requirement for clean sustainable energy.

• **Core equipment costs have fallen faster than any other cost element that contributes to solar pricing. Thus PV modules account for 40-45% and inverters accounted for only 20-35% of total capital costs in 2017. Lower costs and the need to cut emissions will drive the market until 2025, according to a Frost and Sullivan report "Global Solar Power Market 2018. Project costs declined by 20% in 2017 alone.**

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The cost of solar modules has dropped by 40% between 2010 to 2016 ⁴. Driven by technology, economies of scale and an increasingly automated production process, costs are forecast to decline by a further 15%–20% between 2017 and 2025.

4. Frost & Sullivan



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The IEA suggests that renewables may become cheaper than fossil fuels over the next five years.

While large-scale projects will still need to meet ROI (Return on Investment) targets to attract future investment, the diminishing cost of building solar capacity is proving increasingly appealing to governments, utilities and investors.

Financing

The spread of new business models that promote the use of solar power by instigating new ways of financing has travelled beyond developed markets such as the United States and Europe and into Africa and Asia. Long-term contracts such as solar power leasing programs and power purchase agreements (PPA) provide investors with the opportunity of reducing cost and risk by using clean energy.



The use of feed-in tariffs is no longer widespread, but certain markets offer incentives and regulations to support solar power and the reduction of lifecycle costs will become increasingly significant. As solar power is a volume manufacturing business it is likely that consolidation of providers will continue. The opportunities for local niche players are diminishing except in a few relatively or fairly close domestic markets.

Environmental drivers

Awareness of the excessive pollution levels in the cities of China and India has persuaded these nations to lead the charge for pushing their capacity targets over the next 10 to 15 years.

The environmental benefits are compelling. The rise of digitalization and smart grid technology and additional storage could reduce curtailment of solar and wind across the EU from 7% to 1.6% by 2040 according to the IEA. This would in turn avoid 30 Mt of CO₂ emissions per annum.

The role of solar in today's societies

Smart cities

Solar powers a whole new way of thinking about how we live and interact with our environments. The rise of the smart city, one that uses information and communication technologies to improve the efficiency of urban systems, offers compelling answers to the problems of congestion, pollution and a creaking infrastructure. At the heart of the smart city lies digital connectivity and intelligent data management and a source of energy that is clean and sustainable.



Microgrids

The variability of solar as an energy source (even in the sunbelt, solar runs to nature's timetable) means that reliability is a key development. This is where the microgrid comes in. They provide lower cost, high-quality power to facilities like hospitals or data centers, where even brief outages can cost money or lives.

Operating as a distinct entity from the rest of the electricity grid they can disconnect from the main grid and rely on their own solar resources leveraging control software and digital connectivity to sense and respond to extreme weather conditions.





The rise of the prosumer

Also gaining momentum is the 'prosumer' (or producer and self-consumer) movement - those households that generate some or all of their own energy and use it when needed or feed it back into the national grid. The solar inverter acts as the 'brain', relying on digitalization to sit at the center of a complex network of communications that link the household's devices and appliances.

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Self consumers are at the moment early adopters, but will move rapidly into the mainstream.

This move will be enabled by the decreasing cost of solar panels and inverters, and government subsidies and policies that encourage uptake. Innovation in the market sector is keeping apace. Next generation solar power storage solutions such as ABB's REACT 2 are ensuring that the needs of these prosumers are met.

In the near future, it is likely that the smart building package will include solar as its core element. This will include building energy management systems, storage, EV charging and smart appliances.



Future trends and challenges

The rate of growth and innovation in the solar energy market brings unprecedented opportunities for not just installers but all solar companies along the value chain, to maximize market share and become an integral part of the evolution.

It is crucial to be aware of not only how the existing technologies will roll out into new markets and the mainstream, but also what the early adopters are likely to engage with next. This will help map the path that innovation will take.

The dawn of digitalization

Digitalization is already becoming an integral part of photovoltaic design specification and ongoing management of plant and installations. It will bring different benefits to different end users. For utilities, the support for greater stability and Demand Energy Response. For residential and commercial consumers, it will drive the future of smart technology and the appetite for greater connectivity and convenience.

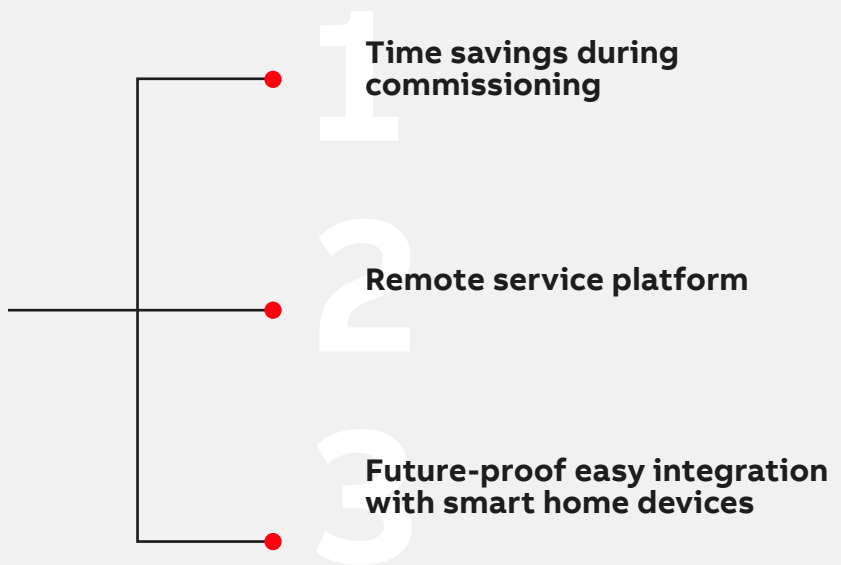


It is timely to consider how smart technology can integrate solar better into the grid and the benefits of doing so for all those involved in supply and consumption. The boost to revenues for renewables could be huge – analysts have estimated that €810 billion total renewable market revenue could be achieved by optimizing digital grids over the next 12 years.

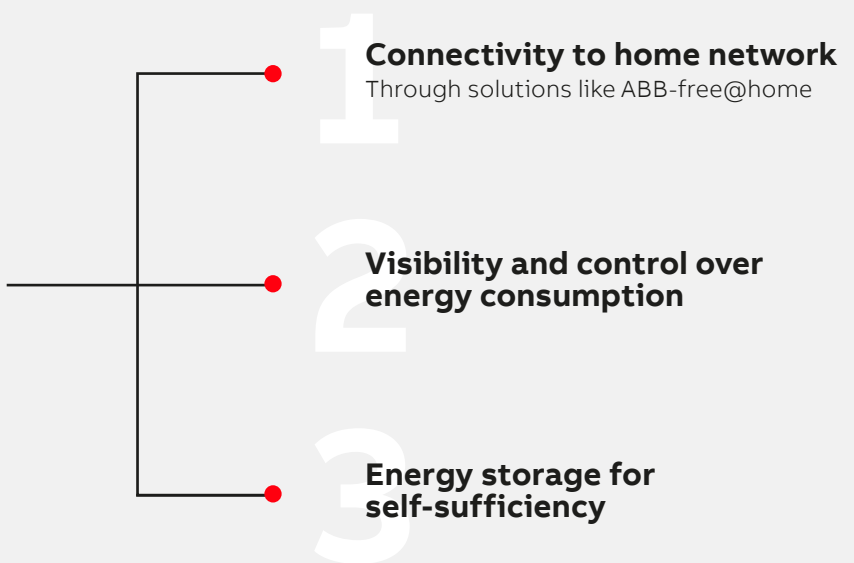
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Digitalization: Transformation and benefits for installers and residential users



Installer benefits



Consumer benefits



Enhanced digitalization can be achieved with advanced technologies such as the cloud, internet protocols and wireless communication. These enable the availability of big data with real-time analytics and remote monitoring. All of these will drive efficiency through more accurate predictions of grid load and better matching of supply and demand.

The cycle of supply and demand completes itself: as traditional energy costs increase and prosumers take control of their energy requirements, the development for Demand Energy Response and Virtual Power Plants are likely to determine increased uptake of digitalization and deliver greater need for solar power and storage.



Digitalization and new business models

As smart home technology broadens access to living a self-consumption lifestyle and improves feed in to the grid, so the profitability of the existing prosumer business model also increases. Extra value can be gained from other new areas made possible by digitalization such as Operations and Maintenance (O&M), residual power supply, finance, and aggregation. These can be sold by the installer as add ons to solar PV systems.

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Away from the residential environment, the benefits of using digital technology in large-scale operations such as utility ground-mounted solar are to reduce operational costs and increase asset performance.

Interconnecting microgrids to the main grid also offers an alternative business model, allowing them to feed into the main system, and allowing each to disconnect as necessary and operate as a standalone. As a result, the two major business opportunities for grid-connected microsites are where these benefits could be of critical value – industrial areas and municipalities.



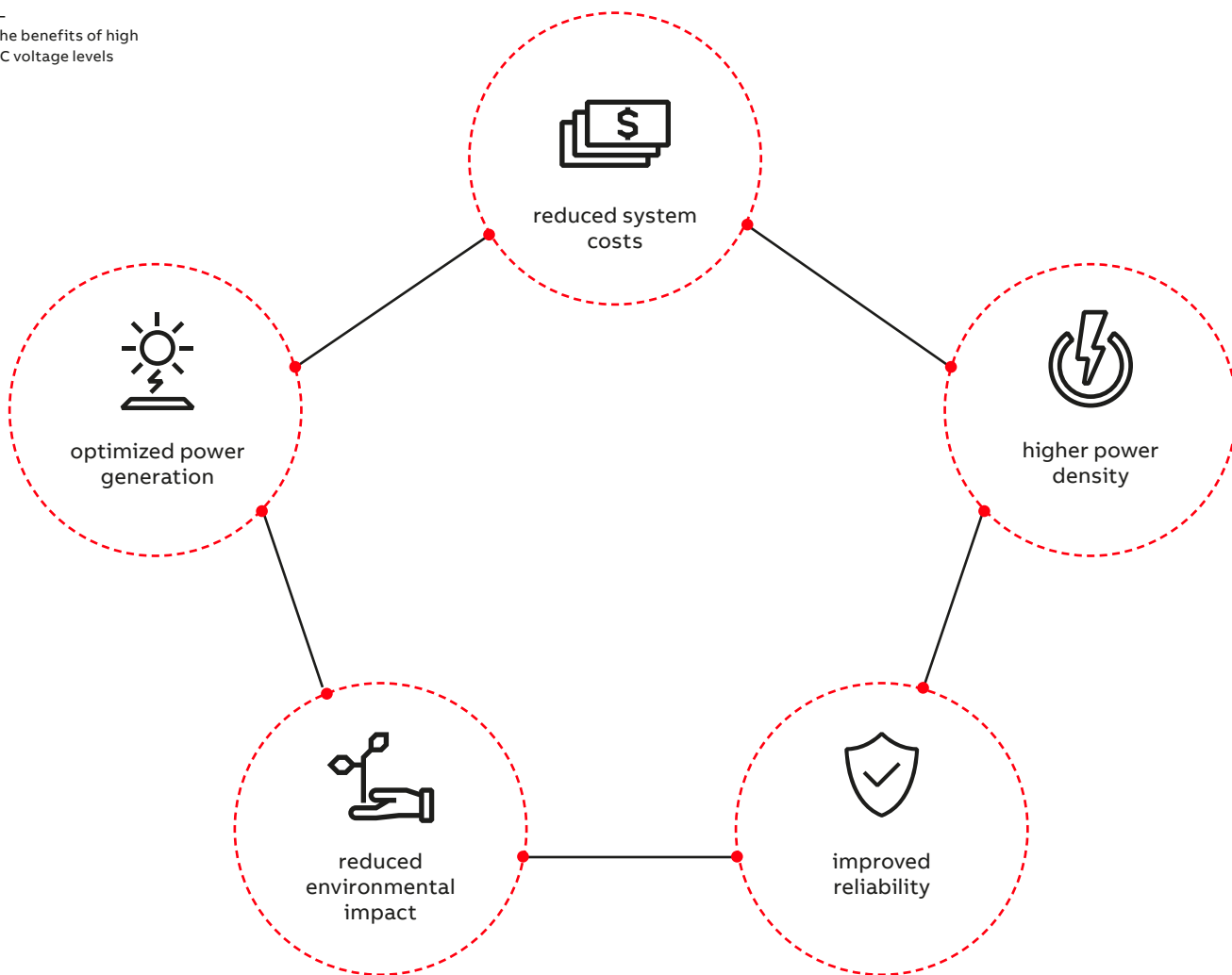
The move towards higher voltages

New cost-effective platforms meet market demand by offering extreme high-power string inverters with ratings of 100 and 120 kW, as opposed to traditional 50 to 60 kW. Higher voltage levels help optimize power generation through longer strings of PV panels with reduced system costs.

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Technology is also increasing AC voltage levels. This allows for higher power density, lower losses and more compact power blocks. Coupled with these benefits is reduced environmental impact and improved reliability.

The benefits of high AC voltage levels



Identify the influencers

To maximize on the opportunities afforded by this new and growing market, you must not only capitalize on existing technologies becoming widespread but also keep an eye on the developments and future demands of the influencers.

Rapid advances in innovation are allowing many prosumers to realize their plans for energy independence.



In Switzerland eight families are living in a completely energy self-sufficient 'house of the future' built by Umwelt Arena Spreitenbach in partnership with ABB.

Solar panels cover the roof and façade and generate direct current which is converted to alternating current by 26 ABB solar inverters. In one hour, the system harnesses enough energy to power the building for a full day, with the excess stored in batteries for later use.



Increased competition and the need for strong partnerships

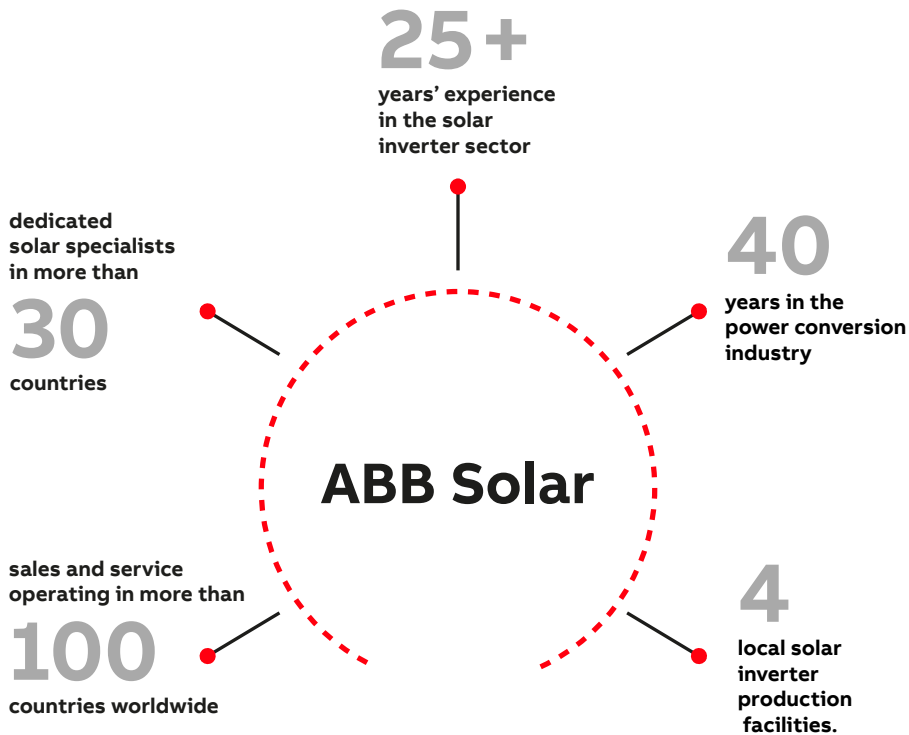
The growth of the solar market has seen competition between providers increase. Price is still highly significant as a competitive tool in utility scale markets, and only slightly lower in other segments. Greater value, however, is placed on providing strong partnerships, excellent service and a robust pipeline of innovation. For installers, specialization is the key to success, with a plethora of end users requiring specific expertise.

Building bedrock relationships with reliable partners will ensure that clients receive the right products for their projects, fully integrated with their requirements and invest in the more robust technologies available.

ABB – a partner you can rely on

“We know how important your work is, so count on us.”

ABB has over 25 years' experience in the solar inverter sector and over 40 years in power conversion, where we built our solid technical expertise and knowledge. Our reach is global, with sales and service operating in more than 100 countries worldwide, dedicated solar specialists in more than 30 countries and five local solar inverter production facilities.





From sun to socket

Our solar technology is a leading sustainable energy source for distributed power generation and building applications. The ABB portfolio includes everything from low-voltage DC components and medium-voltage AC turnkey solutions, from transformers and medium-voltage technology, to integration, solar and energy storage with our ABB free@home offering and EV charging solutions.

We design products and solutions that reduce cost over the whole system for solar installations. Increasing the output voltage capabilities, using larger PV clusters and higher power units can reduce the balance of system costs, bringing lower maintenance costs and improved overall performance efficiency.

This also impacts cables and component expenditure as well as cutting losses due to lower currents.

Our services

We offer a range of services from power consultancy, operation, maintenance and remote monitoring. Our clients count on us to give them the technological and professional edge that will usher in the next generation of solar power generation.

Delivering digitalization with ABB Ability™

ABB Ability is our unified, cross-industry digital capability.

It extends from device to edge to cloud, with devices, systems, solutions, services and a platform that connects our customers to the power of the industrial Internet of Things. We lend our expertise to turn data insights into the direct action that generates real value for customers.

Reasons to believe

Choice

Our one-stop-shop portfolio offers the widest choice in the industry. We keep ahead of the market, launching six new products and platforms in 2017 alone. We support this choice with a comprehensive package of communication, monitoring and control solutions that will help identify best fit for your client.

Since Taiwan's Bureau of Energy, Ministry of Economic Affairs, outlined its target for renewable energy installation of 20GW by 2025, we have been supporting solar installers and EPCs with our comprehensive range of excellent service, innovative products, compatible prices and tailored training.

A leading solar system integrator company in Taiwan, SunnyRich promote the use of our TRIO-50 inverters to increase the system reliability and efficiency of new plants and installations, supported by our training.

This partnership has enabled an innovative solar installation. In southern Taiwan, for example, SunnyRich built a solar powered greenhouse to grow healthy crops while the land recovered from one of the most severe typhoons in living memory.





Innovation

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We invest heavily in R&D and feel it's no longer about making the inverter more efficient, but using intelligent inverter technology to optimize the total system efficiency and levelize cost of energy of the solar plant.

An example of this is the hardware we provided for the world's largest floating PV test-bed located in Singapore. 'Floatovoltaics' uses floating solar PV platforms and mimics the photosynthesis of a lily pad on the water. The panels are designed to be cooled by the water, which increases their efficiency by more than 10%, compared to those on land.

Our TRIO-50 solar inverters convert the harvested solar energy into usable grid power. ABB low-voltage molded case and miniature circuit breakers protect the electrical circuits on the water and the entire platform has a peak capacity of 1 MW, enough to provide electricity for up to 1,000 households.

Reliability

Our extensive serial testing and R&D, decades of experience and comprehensive services give you reliability you can trust.

We've been technological leaders for 120 years and invest more than \$1.5b in R&D across the company every year.

A tech giant decided to power its data center in the Atacama region of Chile entirely by solar. The site is one of the driest places in the world and the scale of the requirement and the hostile environment combined to make this project a major logistical and technological challenge.

ACCIONA, the Spanish independent power producer appointed to meet this challenge needed to count on ABB for equipment that would be reliable even in these harsh desert conditions. We supplied an all-in-one inverter solution and the final result was the El Romero Solar plant, the largest photovoltaic plant of its kind in Latin America. It has a peak capacity of 246 MWp, able to generate 493 GWh of clean energy a year.

By saving the emission of 473,000 metric tons of CO₂ per year from coal-fired power stations, the El Romero plant is a flagship case for encouraging green energy on a global scale.





Efficiency

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Our commitment to economic efficiency gives you and your customers better value.

It also produces higher power output and optimized Levelized Costs of Electricity and plant productivity. Our conversion efficiencies are up to 98.8%.

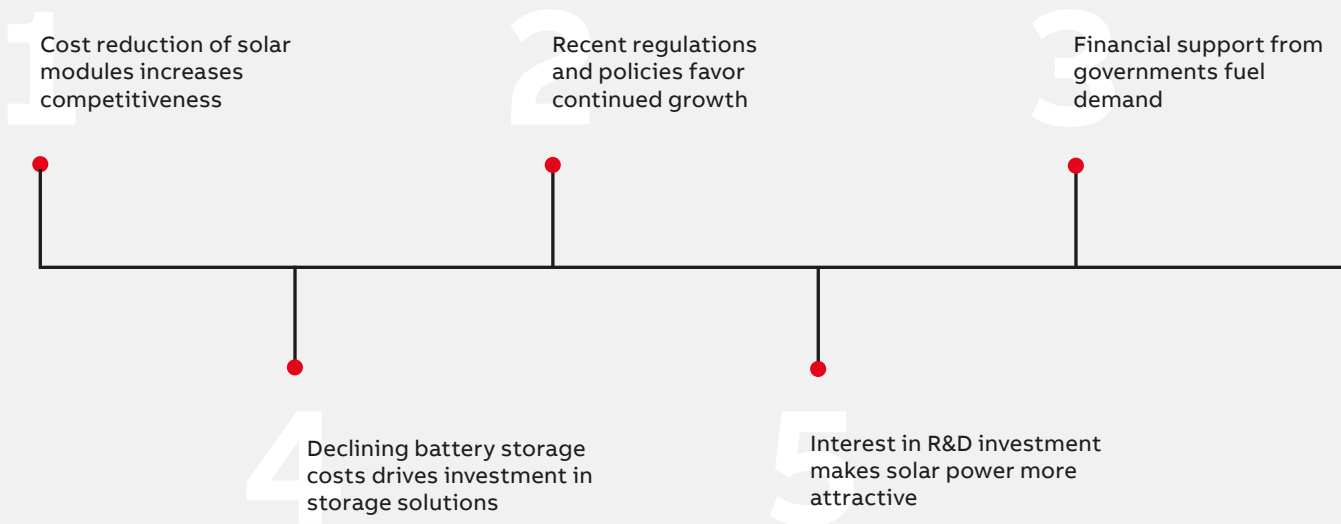
The United Arab Emirates announced plans to invest \$163 billion to generate almost half the country's power needs from renewable sources by 2050, and several projects have been commissioned in order to achieve this goal. One is the Hatta project – the installation of solar panels across 600 villas for all UAE nationals in the remote region of Hatta.

ABB supplied 600 UNO-DM PLUS solar inverters, featuring integrated digital connectivity. Given the scale, nature and location of the installation, the importance of remote monitoring combined with plug-and-play functionality was key. The benefit to installers and residents was the ability to maintain the installations without disturbance, and a 40% reduction in energy bills for villa owners.

Conclusion

Today, the solar industry should not only focus on how it can produce cleaner energy but on how it can be controlled, integrated and balanced through the Internet of Things and digitalization. The solar industry is poised to lead the charge on digitalization to create a more sustainable, consistent energy flow.

The important key drivers for the solar market.



Although a period of dynamism and challenge for professionals employed in the solar industry, the unprecedented growth in demand and supply of solar energy offers huge opportunities to grow support and installation businesses and align success.

With ABB's reliability, efficiency and innovation, and our huge portfolio of digitally enabled solutions, you can count on us to help overcome a wide array of project challenges.

To find out how ABB can help you be prepared for the future of solar, visit www.abb.com/solarinverters



References

1. "World invested more in solar energy than coal, gas and nuclear combined in 2017, UN report reveals", Josh Gabbatiss Science Correspondent, Thursday 5 April 2018. <https://www.independent.co.uk/environment/solar-energy-world-investment-higher-coal-gas-nuclear-combined-2017-un-report-a8290051.html>
2. "Time to shine: Solar power is fastest-growing source of new energy", Adam Vaughan Energy correspondent, Wednesday 4th October 2017. <https://www.theguardian.com/environment/2017/oct/04/solar-power-renewables-international-energy-agency>
3. "Global Solar Power Market, 2018 Update Solar Photovoltaic (PV) Gains Momentum as a Globally Irreversible Mainstream Energy Source", Global Energy and Environment Research Team at Frost & Sullivan, March 2018
4. Frost and Sullivan
5. "A bright spot for digitalisation", Leonardo Botti Global Head of Product Management – PG at ABB, The Energy Industry Times, January 2018
6. Digitalisation & Solar, Solar Power Europe, Published 4th October 2016, re-designed December 2017
7. "A complete range of sun to socket options", Leonardo Botti Global Head of Product Management – PG at ABB PES Solar
8. "The rise of the prosumers", Massimo Migiorini, ABB, rcimag.co.uk, September 2017



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