

Q CELLS Q. ANTUM TECHNOLOGY

Powering the world's best solar cells since 2007



THE Q.ANTUM PHILOSOPHY BE THE BEST, ONLY BETTER

Q CELLS provides affordable and smart energy solutions through technology and innovation to create a sustainable future for our planet

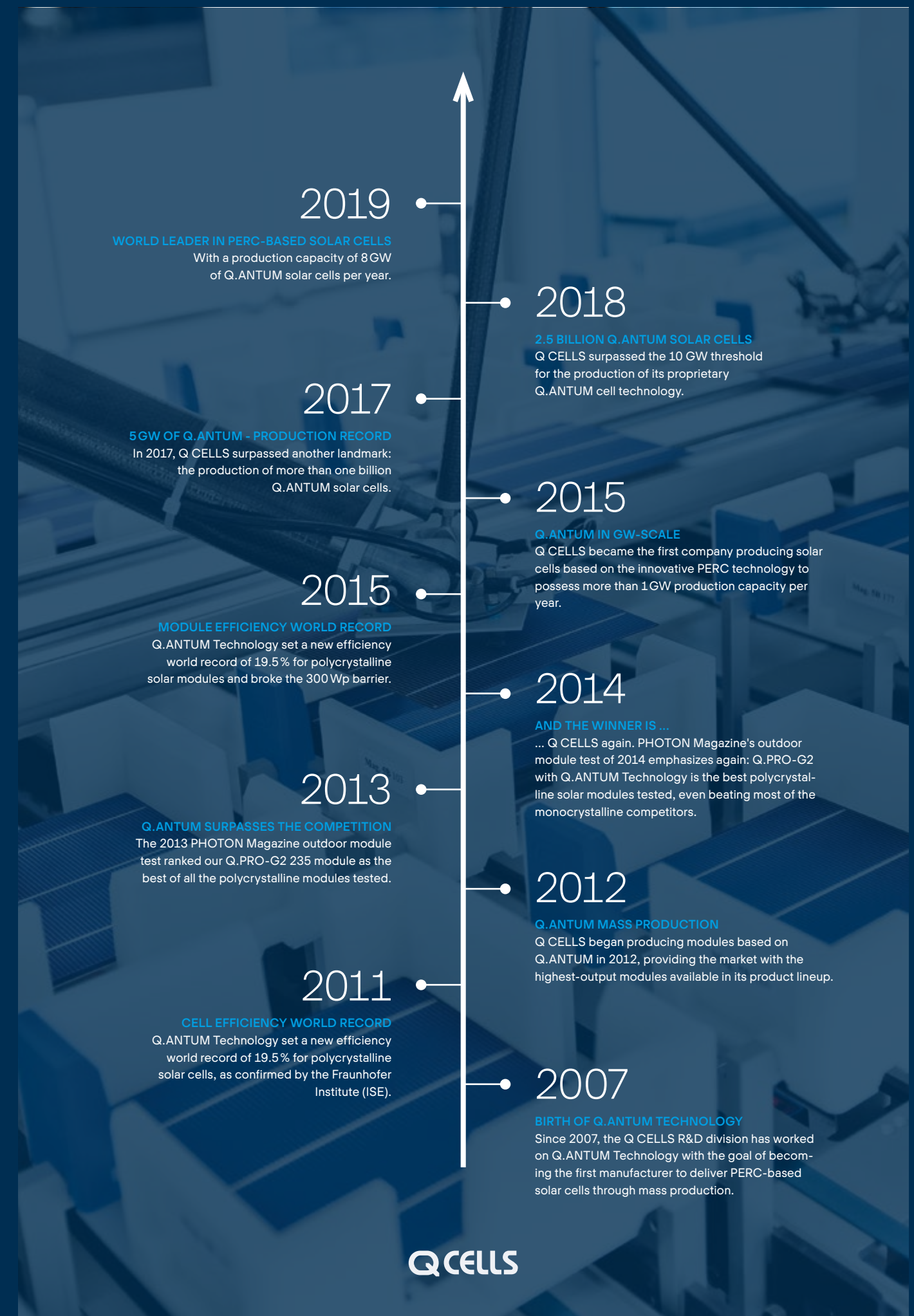
Q CELLS combines the best properties of all the foremost cell technologies to achieve high outputs at a lowest LCOE under one name - Q.ANTUM Technology. Q.ANTUM is the proprietary solar cell technology platform for Q CELLS solar modules. Though based on passivated emitter rear-side cell (PERC) technology, Q.ANTUM offers a number of additional benefits that differentiate the technology from conventional PERC products. These benefits include high module performance output and long-term reliability thanks to excellent Anti PID (potential induced degradation), Anti LID (light induced degradation) and Anti LeTID (light and elevated temperature induced degradation) performance. In addition to market-leading anti-degradation performance, Q CELLS provides for its Q.ANTUM cells and modules excellent performance warranties, Hot-Spot Protect and Tra.Q™ laser marking to ensure 100% traceability and a guarantee of our strict quality standards.



Dr. Daniel Jeong, CTO of Q CELLS:
"Our Q.ANTUM Technology has been a real game-changer - not just in underpinning the company's renowned Q.PEAK and Q.PLUS solar module series, but also in terms of raising standards in module performance and efficiency throughout the solar industry."

Q.ANTUM HISTORY BEING THE FIRST OF ITS KIND

High performance meets mass production: In 2011, Q.ANTUM Technology set a new world record for crystalline solar cells by achieving 19.5% efficiency. Q CELLS began producing modules based on Q.ANTUM in 2012, putting some of the highest output modules available in its product line-up. The 2013 and 2014 PHOTON module test ranked the Q.PRO-G2 235 Wp module at the top of all the polycrystalline modules tested. The current Q.PLUS BFR-G4.1 with Q.ANTUM Technology surpasses even this winning module in every performance and yield category. In 2015, Q CELLS for the first time crossed the 300 Wp line with a polycrystalline solar module, and doing so, already reached a module efficiency of 19.5% - another world record. Since 2017, Q CELLS has produced solar modules with 300 Wp in series for its clients, based on Q.ANTUM Technology.

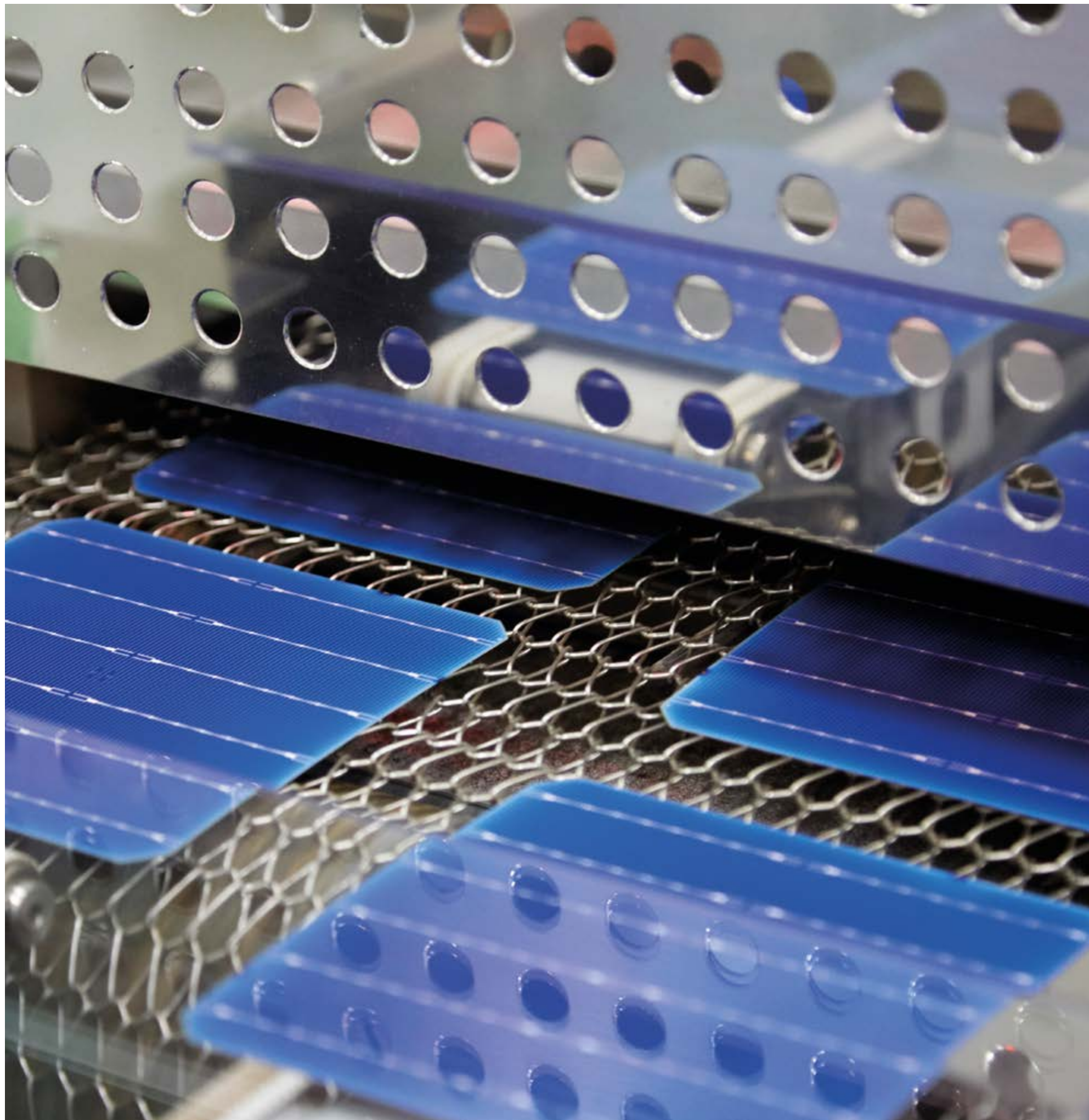




THE Q.ANTUM REVOLUTION MORE YIELD. MORE RETURN ON INVESTMENT.

In the end, it's all about your return on investment. How much electricity does your photovoltaic system produce in total over the course of an entire day or year — and at what cost? Q.ANTUM takes mature, cost-efficient crystalline silicon wafer technology and optimizes it to give you superior value for your money. It's a combination of high efficiency, high power ratings, and maximum yields at competitive prices that gives you one of the best solar deals under the sun.

Q.ANTUM Technology supercharges ordinary solar cells and modules to deliver exceptional performance under real-world conditions. We designed Q.ANTUM to generate more power when the sun is rising, setting, or even behind clouds. You'll also see higher yields in the middle of hot and sunny summers, and during clear fall and winter days, when the sun is not as high in the sky. We enhanced low-light performance, but also the output of our modules across a range of temperatures - all to bring you better returns.

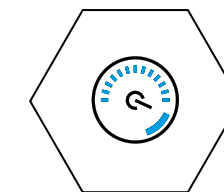
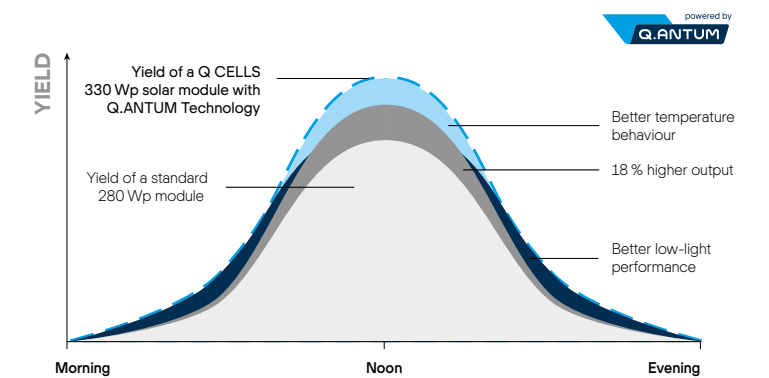


THE Q.ANTUM EFFECT LOWER LCOE AND HIGHER YIELDS

Q.ANTUM ADVANTAGE – MORE YIELD. MORE RETURN. MORE FOR YOU.

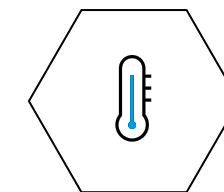
For PV systems only one thing counts: the total amount of produced electricity throughout the day and across the year – and how much it costs. The low-light performance of Q.ANTUM solar modules ensures outstanding electricity generation when the sun is rising, setting, or obscured by clouds. It doesn't matter if the sky is clear or cloudy, Q.ANTUM beats all the conventional cell technologies.

YIELD IN THE COURSE OF THE DAY WITH Q.ANTUM TECHNOLOGY



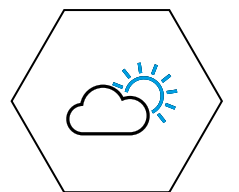
HIGHER PERFORMANCE CLASSES

Thanks to Q.ANTUM Technology, Q CELLS solar modules offer more power per surface area, resulting in higher yields at lower BOS costs.



TEMPERATURE COEFFICIENT

Even on hot days, Q CELLS solar modules produce reliable yields and lose less efficiency than standard solar modules.



LOW-LIGHT BEHAVIOUR

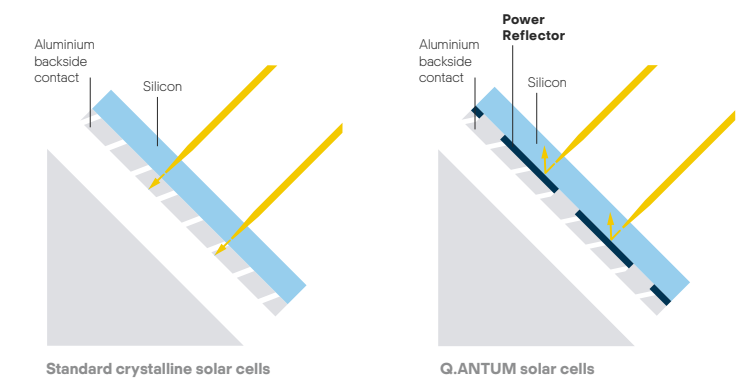
High yields with low radiation intensity, for example, during sunrise and sunset and on cloudy days, but also in autumn and winter when the sun is flat over the horizon.

WHAT IS PERC TECHNOLOGY?

In traditional BSF (Back Surface Field) solar cells some charge carriers and light are lost to the metalization at the rear of the cell. With PERC (Passivated Emitter Rear Cell) technology a passivation layer is added to the rear of the cell so that the otherwise lost charge carriers and light are reflected back into the silicon. In standard test conditions PERC cells are around 5% more efficient than traditional BSF cells.

Q.ANTUM CELL TECHNOLOGY

MORE LIGHT.
MORE PERFORMANCE.
MORE ELECTRICITY.



WHAT MAKES Q.ANTUM THE BETTER CHOICE?

Q CELLS has been developing its proprietary Q.ANTUM Technology since 2007 and while PERC techniques are a vital part of what makes Q.ANTUM special, it is just one of the many features that makes it stand out. Anti LID, Anti LeTID, Anti PID, Hot-Spot Protect, Tra.Q™ and Quality Tested all come together to form Q.ANTUM and provide the most powerful, long lasting, stable and secure solar modules. Q.ANTUM is the most mature PERC technology, with experience gained from more than 12 years of R&D, seven years of mass production and cumulative installation of over 10 GW globally.

Competitors clearly struggle to bring PERC technology to market, keep the technology stable in the field, and are mostly focused only on Mono PERC. One of the major reasons for this is potential for high initial degradation in PERC cells if not actively addressed. The primary causes of initial degradation are LID (Light Induced Degradation) and LeTID (Light and Elevated Temperature Induced Degradation). Q CELLS discovered degradation effects from an early stage and found ways to solve these issues before bringing products into mass production. Since there are different underlying causes, Q CELLS utilizes multiple proprietary processes to minimize initial degradation while competitors are yet to even understand the reasons.

THE Q.ANTUM TECHNOLOGY LEAD THE BEST PERC UNDER THE SUN



ANTI LID

CONQUER LIGHT INDUCED DEGRADATION

In the past, Mono modules have always suffered from higher LID than Poly modules. This is due to a higher concentration of Oxygen in the silicon wafers from which the cells were produced. This is an unavoidable side-effect of the Mono wafer production process. Oxygen forms complexes with the Boron added to make wafers "P-Type". During the initial exposure to light, these B-O complexes trap free electrons, permanently reducing the power of the module by up to 3%. Q.ANTUM's Anti LID Technology permanently deactivates these Boron-Oxygen complexes in the factory. Thus ensuring minimal LID in Q.ANTUM Mono cells.



ANTI PID

ELIMINATE POTENTIAL INDUCED DEGRADATION

PID (Potential Induced Degradation) comes from a difference in electric potential between the solar cells and the frame of the module. PID can reduce module performance by 80%. Q CELLS started analyzing the PID effect in 2008 and started to publish about the PID effect in 2011. Then in 2012, Anti PID Technology was introduced on all Q CELLS products since we understood the causes of PID in the field. Results from testing cells and modules as well as from sites around the world allow Q CELLS to accurately model the PID effect, ensuring secure yields in any environment.



ANTI LeTID

PREVENT LIGHT AND ELEVATED TEMPERATURE INDUCED DEGRADATION

LeTID (Light and elevated Temperature Induced Degradation) requires both light and high temperatures to occur and progress. It was thought that LeTID only affected Poly PERC, but as the availability of PERC products has increased, the industry has become aware that this degradation also affects the much more common Mono PERC modules. LeTID can cause degradation of 6% within the first three years of operation, depending on the climate of the installation site. It is recommended that anyone using PERC modules should test for LeTID. Testing using a climate chamber to maintain a temperature of 75°C along with current injection to the module of about 1 ampere (1A) for several days will reveal LeTID in PERC modules. Such testing needs to quickly become industry standard to protect investments. Q.ANTUM, as the most mature PERC technology, protects from degradation phenomena such as LID, LeTID and others like PID.

THE Q.ANTUM SAFETY LEAD PROTECTING YOUR YIELDS

HOT-SPOT PROTECT



PROTECT AGAINST HOT-SPOTS

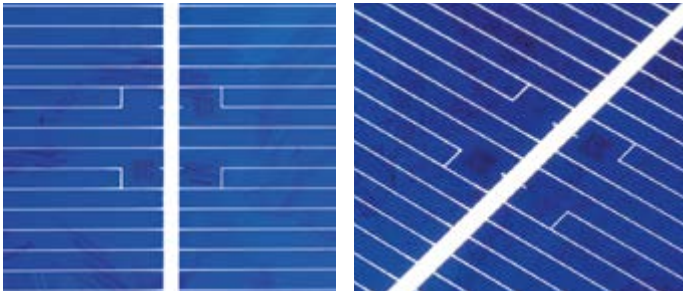
The processing of silicon wafers can cause imperfections which lead to Hot-Spots. Hot-Spots can lead to delamination and power degradation over time as the backsheet begins to degrade in high temperature, which can increase the likelihood of solar module fires: the worst-case scenario of every PV system owner. The industry standard is to use the cells' electrical parameters to identify Hot-Spots. However due to the low resolution of this process, most Hot-Spots are overlooked. Q CELLS uses IR cameras to test each and every cell for potential Hot-Spots. Spatial resolution of the IR camera allows for removal of 100% of affected cells during production.

Tra.Q™



AVOID PRODUCT PIRACY

At the heart of every Q.ANTUM solar cell is Traceable Quality (Tra.Q™). This unique laser engraved matrix barcode not only ensures original Q CELLS quality, but allows every cell produced to be traced back through its entire lifetime from wafer to field. Production information in this detail means Q CELLS can optimize production and raise quality using a level of detail not found elsewhere in the PV industry.



DON'T JUST TAKE OUR WORD FOR IT. INDEPENDENT TESTS, OUTSTANDING TEST RESULTS AND AWARDS

Many manufacturers promise excellence, but only Q CELLS can guarantee it. In addition to its own extremely strict quality criteria, in collaboration with independent test institutes such as the VDE or Fraunhofer Institute, Q CELLS has developed several test procedures that more accurately reflect everyday demands. These tests are far more challenging and tougher to pass than international standards such as the IEC. All our Q.ANTUM products undergo these tests to deliver long-term optimal results in all weather conditions.

2013 AND 2014 PHOTON MAGAZINE YIELD MEASUREMENT

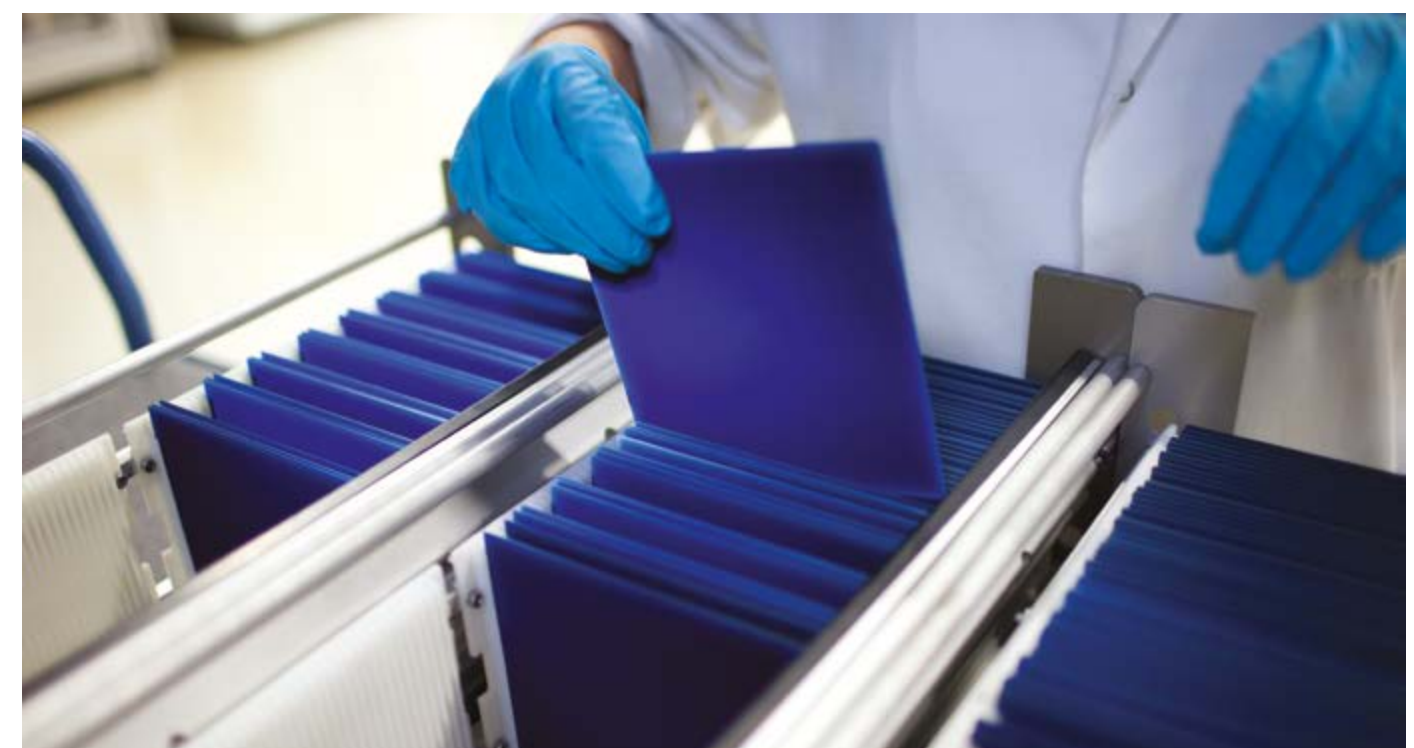
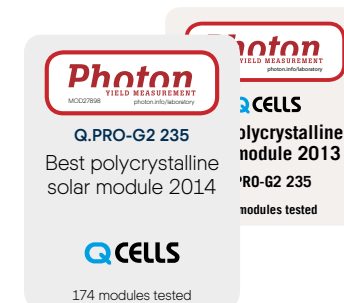
Based on Q.ANTUM Technology our Q.PRO-G2 solar module was the best polycrystalline solar module of 2013 and 2014 in the prestigious Photon Magazine's outdoor test.

2017 PV MAGAZINE TOP INNOVATION AWARD AND ARRAY CHANGING TECHNOLOGY AWARD

The Q.PEAK RSF L-G4.2 won the PV Magazine Award in the category "top innovation". Q CELLS' proprietary Q.ANTUM Technology and the reinforced steel frame design combine numerous advantages for higher yields and an improved system performance with lower installation cost and lower LCOE. These improvements in terms of performance, installation cost and LCOE make this solar module the ideal choice for utility-scale applications.

SOLAR INDUSTRY AWARD 2015

Q CELLS received the "Solar Industry Award 2015" for its Q.PLUS-G4 solar module based on Q.ANTUM Technology. The innovative solar module has been nominated and shortlisted by the award's panel of judges in order to credit the innovative Q.ANTUM Technology - a complex cell architecture for maximum energy yield under real conditions.



SOLAR POWER PORTAL AWARD 2017

The winner takes it all - so our Q.ANTUM Technology based Q.PEAK RSF L-G4.2 solar module won the Solar Power Portal Award for the best product innovation in 2017. Solar Power Portal is the online platform for the UK solar market which is operated by Solar Media, also internationally known for the pv-tech.org website and the Photovoltaics International magazine. The Solar Power Portal Awards were presented on October 4th, 2017 in 13 categories.

SOLAR + POWER AWARD 2017

Our Q.PEAK DUO-G5 solar module with Q.ANTUM DUO Technology won the Solar + Power Award 2017 for Excellence - Innovation. This award is presented by Solar + Power Management magazine each year and covers the entire value chain of photovoltaics. The jury is the industry itself. More than 4,800 experts from the solar industry selected their favorites in an online poll. Q CELLS had already won the award in 2015 and has now scooped up another award with the Q.PEAK DUO-G5. The organizers put particular emphasis on the fact that "Q.ANTUM Technology is continuing to improve conventional PERC processes and controls degradation effects, such as LID and LeTID, in order to achieve even greater efficiency and quality".

INTERSOLAR AWARD 2017 AND 2018

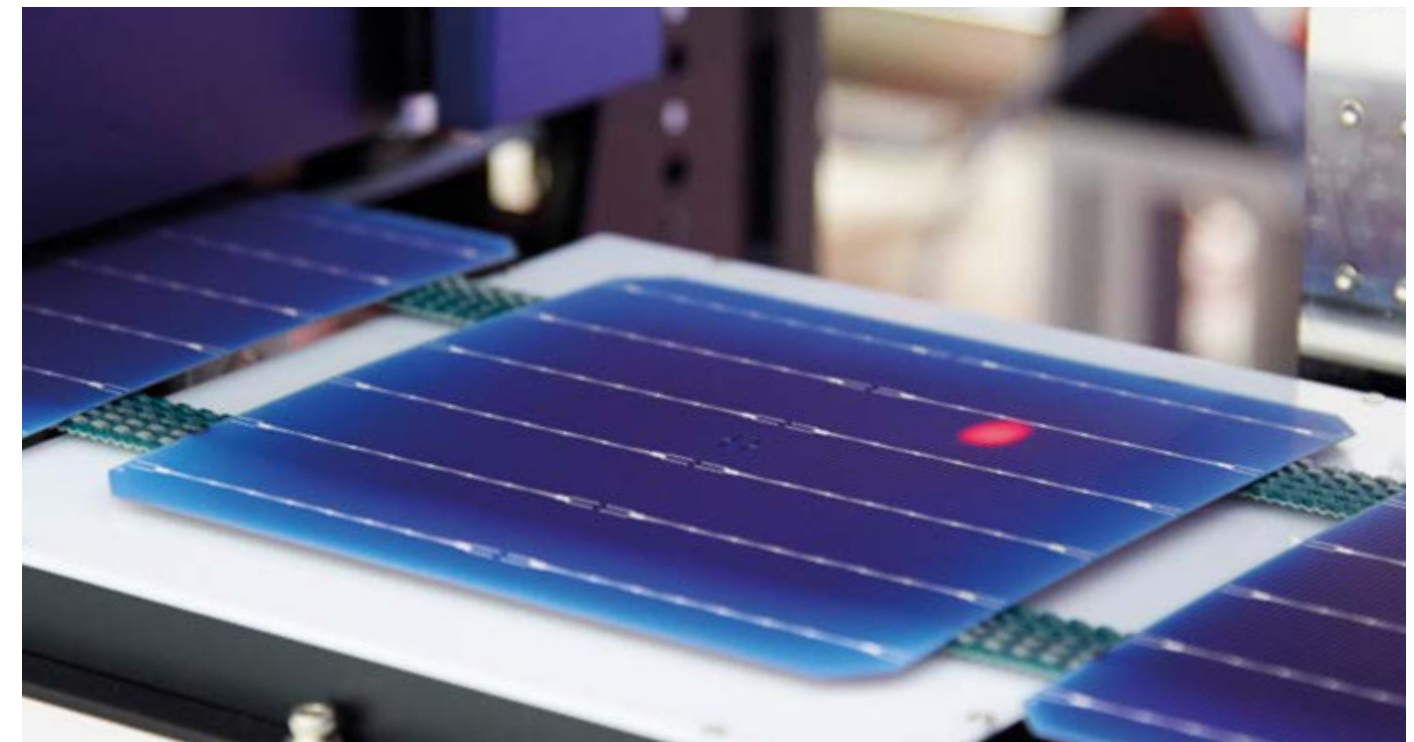
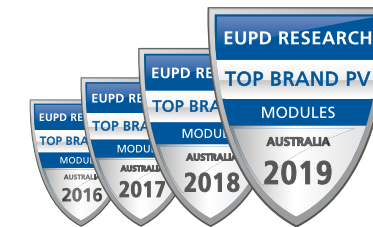
Q CELLS obtained the Intersolar Award for the second consecutive year with its innovative Q.PEAK DUO-G5 solar module based on Q.ANTUM Technology. Having triumphed in 2017 with the innovative Q.ANTUM solar module Q.PEAK RSF L-G4.2, we secured another achievement in the Intersolar Award 2018 Photovoltaics category with our Q.PEAK DUO-G5 solar module. It is equipped with next generation Q.ANTUM DUO Technology combining half-cut cells, six bus bar design, and novel interconnection technology based on round wires, setting the standard in power, energy yield, and LCOE. As a result, Q.PEAK DUO-G5 was selected as one of the most innovative out of ten entries shortlisted from 51 total applications.

TESTED IN AUSTRALIA FOR AUSTRALIAN CONDITIONS

Our products are specifically designed and tested for Australian conditions to ensure optimal performance - and we undergo the testing to prove it. Since 2012, Q CELLS modules have been installed at The Desert Knowledge Australia Solar Centre (DKASC). Q CELLS has been a consistent top performer year after year where it sits in a field with other PV brands. Daily, weekly, and yearly generation information is publicly available to anyone in the world. At James Cook University's Cyclone Testing Station, our panels survived the phenomenal pressures of a 1 in 500-year cyclone, ensuring that a solar system using Q CELLS' modules and installed on a conventional roof-top mounting structures will survive category C cyclones, the most severe category for all major cities in Australia.

EUPD RESEARCH TOP BRAND 2016-2019

Because of our innovative products and great local support, Q CELLS is one of the most popular and well-known module brands in the photovoltaic industry in Europe, USA, and Australia. In 2019, Hanwha Q CELLS Australia Pty was awarded the title of Australia's Top Brand PV by internationally recognized research institute EuPD for the fourth consecutive year.



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