REC N-Peak Technology:
How REC uses award-winning technology on an n-type mono platform to provide long term power for lasting performance

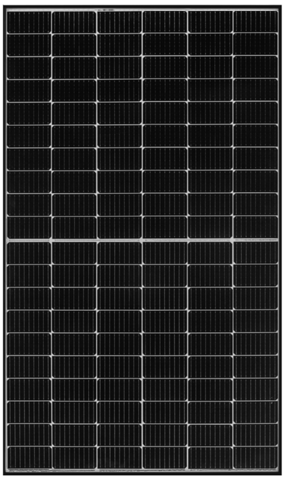
The REC N-Peak 2 is an advanced, highly efficient solar module that builds on award-winning technology enablers and features an innovative design with impressive power output. With its n-type monocrystalline platform, the REC N-Peak 2 is available in watt classes of up to 375 Wp and offers customers a product that marries high power levels with the highest product quality in the market.

What is the REC N-Peak 2?

The REC N-Peak 2 is a solar module that builds on REC's multiple award-winning technology enablers and features innovative, high efficiency cell technology for the highest power output. Based on n-type monocrystalline silicon cells, the 60-cell REC N-Peak 2 Series achieves watt classes of up to 375 Wp.

The major characteristic that sets the REC N-Peak 2 apart from comparable mono p-type products is the cell type. The cells in the REC N-Peak 2 are based on M6 sized n-type mono wafers that have been cut into two equally sized pieces through our half-cut technology, to give 120 separate cells in total.

Fig 1: The REC N-Peak 2 module, with mono cells and 'twin' cell layout design



At module level, these 120 cells are then laid out in two halves of 60 cells, each with three 20 cell strings and the two halves then connected in parallel. This iconic layout first pioneered by REC in 2014 is then supplemented by a collection of other enablers:

- Nine bus bars
- TOPcon (tunnel oxide passivated contact)
- A split junction box

The REC N-Peak 2 also features REC's innovative frame design which offers a thinner frame height to increase easy handling of the module, but with support bars on the rear to ensure the module retains its durability, stability and increased load bearing capability.

What makes a mono cell different to a multi cell?

As the name suggests, multicrystalline (multi) ingots are formed from multiple separate crystals, whereas monosilicon is grown from a single one. This means that, after slicing, a mono wafer (and therefore the cell) has a higher level of silicon purity, giving it a higher absorption efficiency, no visible cell structure and a uniformly dark color. These differences have a decisive effect on cell performance, giving a lower cell temperature coefficient, which improves energy yield, especially in warmer weather.

The manufacturing process of a mono wafer differs from that used for multi and it is this that creates the distinctive rounded corners seen on a mono cell. The reason for this is that mono wafers are grown as cylinders, rather than square or rectangular crucibles, before being sliced and cut to make best use of the space available in the module.

What is n-type technology and what benefits does it offer?

Previous generations of REC modules have been based on p-type multi wafer technology. The market however, demands ever higher power and efficiency modules and a mono wafer platform allows REC to address this demand. The P in p-type stands for positive where the cell bulk is doped with boron, which has one less electron than silicon creating a positive electron imbalance and creating an electrical field.

N-type on the other hand, sees the cell bulk doped with phosphorus, which has one more electron than silicon, creating a negative charge and stimulating the flow of electricity. As mono cells are generally more efficient than their multi counterparts, n-type technology has so far been used exclusively on mono to make best use of its high efficiency properties and reach ever higher watt classes.

More importantly however, such a construction avoids the coming together of boron and oxygen in the bulk. This combination is the main cause of light induced degradation (LID) in the cell, and the non-occurrence of this in n-type cells means they are free from any permanent loss of power upon first exposure to sunlight.

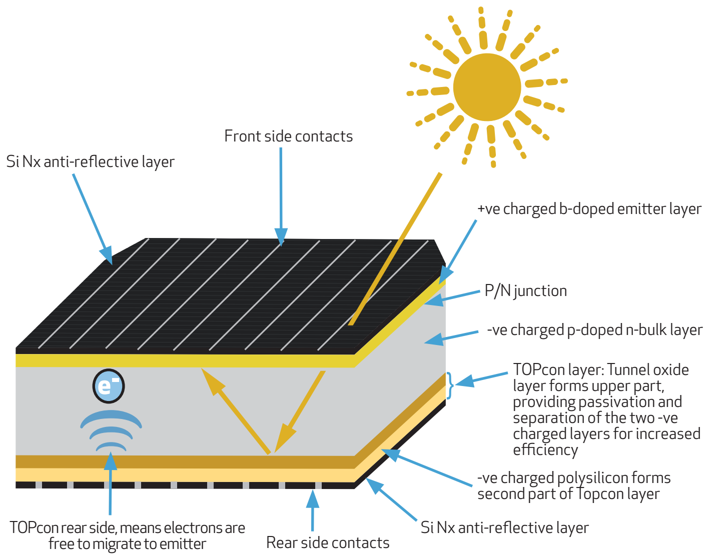


Fig 2: Cross-section of an REC N-Peak cell showing negatively charged bulk and TOPcon layer

Market studies have shown that high power n-type products are expected to grow to around 25% of capacity over the next decade and this is why REC's move into n-type technology is a critical step. It is however noted that multi technology is expected to remain at around 50% of the market up until the mid 2020s and therefore stay a major industry section.[1]

What has REC put in place to achieve mono n-type production?

In 2018, REC built a new state of the art n-type mono cell production plant at its integrated module manufacturing facility in Singapore for the n-type cells. Using all its experience in half-cut cell technology and rearside cell passivation, REC has invested heavily in ensuring n-type mono production comes under its own quality control processes.

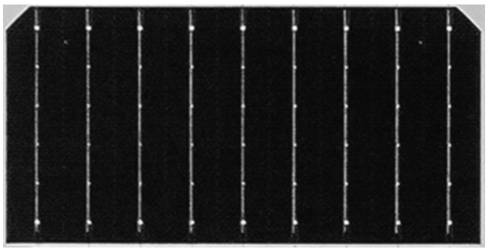
1 ITRPV Ninth Edition 2018, International Technology Roadmap for Photovoltaic Results 2018, www.itrpv.net/Reports/Downloads/

What advantages do half-cut cells offer?

As can be seen in fig. 3, the mono cells of REC N-Peak modules are cut into two rectangular pieces. This reduces internal current by 50%, which cuts resistance and therefore also power loss. As power loss is proportional to the square of the current, the power loss in the complete module is reduced by a factor of four.[2]

Reducing power loss in a half-cut cell produces a higher fill factor - an indicator of cell quality. Modules with a higher fill factor have a lower series resistance meaning reduced loss of current. In turn, this produces higher cell efficiency, especially at times of high irradiance.

Fig 3: An REC N-Peak 2, n-type mono, half-cut cell, showing its multi-busbar connection technology and the darker aesthetic of mono cells



What benefits does multi-busbar connections offer?

The more bus bars there are on a cell, the more the greater the reduction in distance an electron has to travel to reach the ribbon. this decreases internal stress as there is less congestion along the electron's path, improving flow and overall reliability of the module. With this, resistance in the cell is lowered, so current increases.

Stringent accelerated testing has been carried out on N-Peak cells which have demonstrated a major improvement in the thermal cycling performance with multi-busbars, meaning that the cells are less stressed by heat and therefore more efficient and durable.

What are the advantages of TOPcon technology?

In 2015, REC was the first module manufacturer to introduce Passivated Emitter Rear Cell technology (PERC) to mass production on multisilicon cells. PERC is fundamentally an additional layer at the rear of the cell with many tiny holes punched into it to allow an electrical connection between the bulk and the back side. This reduces electron recombination and also reflects certain wavelengths back through the cell to give a second chance at being captured. Equally, the reduction in metalization on the rear side of the cell enhanced the operating temperature of the cell, keeping it lower for higher efficiency.

Using its vast experience and know-how in the use of rearside cell passivation with PERC, REC was able to develop this technology for n-type mono cells, where the rear of the cell is now totally diffused, i.e., it has no tiny holes. This passivation layer is known as tunnel oxide passivated contact (TOPcon) and acts like a barrier across the complete area of the cell, separating the two negatively charged layers, preventing recombination of electrons at the rear (passivation), keeping heat generation low and allowing the cell to operate more efficiently while giving high and stabilized conversion efficiencies.

To back this up, third party testing has shown REC N-Peak panels to have an NMOT value (Normal Module Operating Temperature) of a market-leading 44°C and a temperature coefficient, the % by which a module loses power generation capacity for every 1°C rise in temperature, is also reduced to an impressive -0.34%/°C.

What advantages does a split junction box offer?

The use of a three-part split junction box is key to enabling the 'twin' section cell layout seen in REC N-Peak 2 modules. Splitting the junction box into smaller parts uses less metallization, again reducing resistance in the module and saving space. In turn, this then allows a slightly larger gap between cells increasing the internal reflection of light that does not land directly on a cell and therefore the likelihood that it is captured and can contribute to energy generation.

With three smaller boxes used, there is a reduction of between 15 and 20°C in heat build up at the rear of the cells compared to a standard module. This keeps the cells cooler, increasing absorption efficiency, module reliability and overall output.

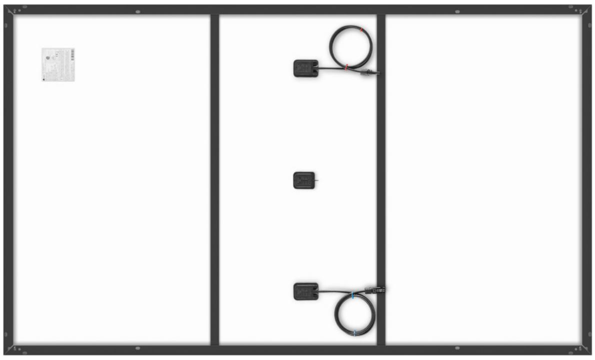
2 Power loss = R x I², where R is the resistance and I is the current

The use of the split junction box on the rear (fig. 4) is also the key factor which enables the module to be split into two 'twin cell sections' of 60 half-cut cells connected in parallel (fig. 1). With this layout design, the module can continue to produce energy, even when one part of the module, or the string, is shaded. What this means, is that rather than the shading causing a bypass diode to be activated and a cell string the complete length of the module being circumvented, bringing the complete string capacity down with it, instead only half the length of a module is bypassed, enabling at least 50% to continue contributing to the module's higher overall energy yield.

What advantages does REC's frame design offer?

Although thinner in height at only 30 mm, the frame structure of the REC N-Peak 2 in fact offers more strength and robustness than comparative products. A three year development project enabled the use of two support bars on the rear to dramatically increase the module's load-bearing strength.

Fig 4: Rear view of the REC N-Peak 2 module with support bars and split junction box



The two support bars across the rear prevent the glass and laminate from bending as far under heavy load. The reduced deflection makes the cells less susceptible to damage, increasing their long-term reliability as the chance of breakage and deformation is greatly reduced. Testing has shown that the support bars truly limit module deflection and deformation, with less than 1% power degradation after mechanical load testing. Indeed, the support bars add so much extra strength that the module can withstand downward loads of up to 7000 Pa.

Conclusion:

The mono n-type technology in the REC N-Peak 2 pushes module power, efficiency, and watt classes, ever higher. With their higher purity levels, mono cells are more efficient at turning sunlight into energy with the subsequent addition of n-type technology boosting cell efficiency even more. An improved temperature performance due to TOPcon helps protects the cells from overheating helping achieve even higher efficiency and with no boron present in the cell bulk, there is no occurrence of LID; the benefit for customers being no immediate power drop upon first exposure to sunlight. The result of all of this is higher energy yield for customers.

However, the initial power level of a solar module is not the only critical feature, but also the performance over its entire lifetime. It is here that the REC N-Peak 2 excels as the 30 mm frame design provides additional robustness, affording increased protection to the high performance cells over a longer period of time.

With cell level technology enabling increased energy generation and the stronger frame design ensuring that power is preserved over decades, the REC N-Peak 2 is supported by a warranty of maximum 2% degradation in year one and 0.25% degradation in years 2-25, leading to a final value of 92% after 25 years, making it a leading choice of solar module for high energy generation over its entire working lifetime.