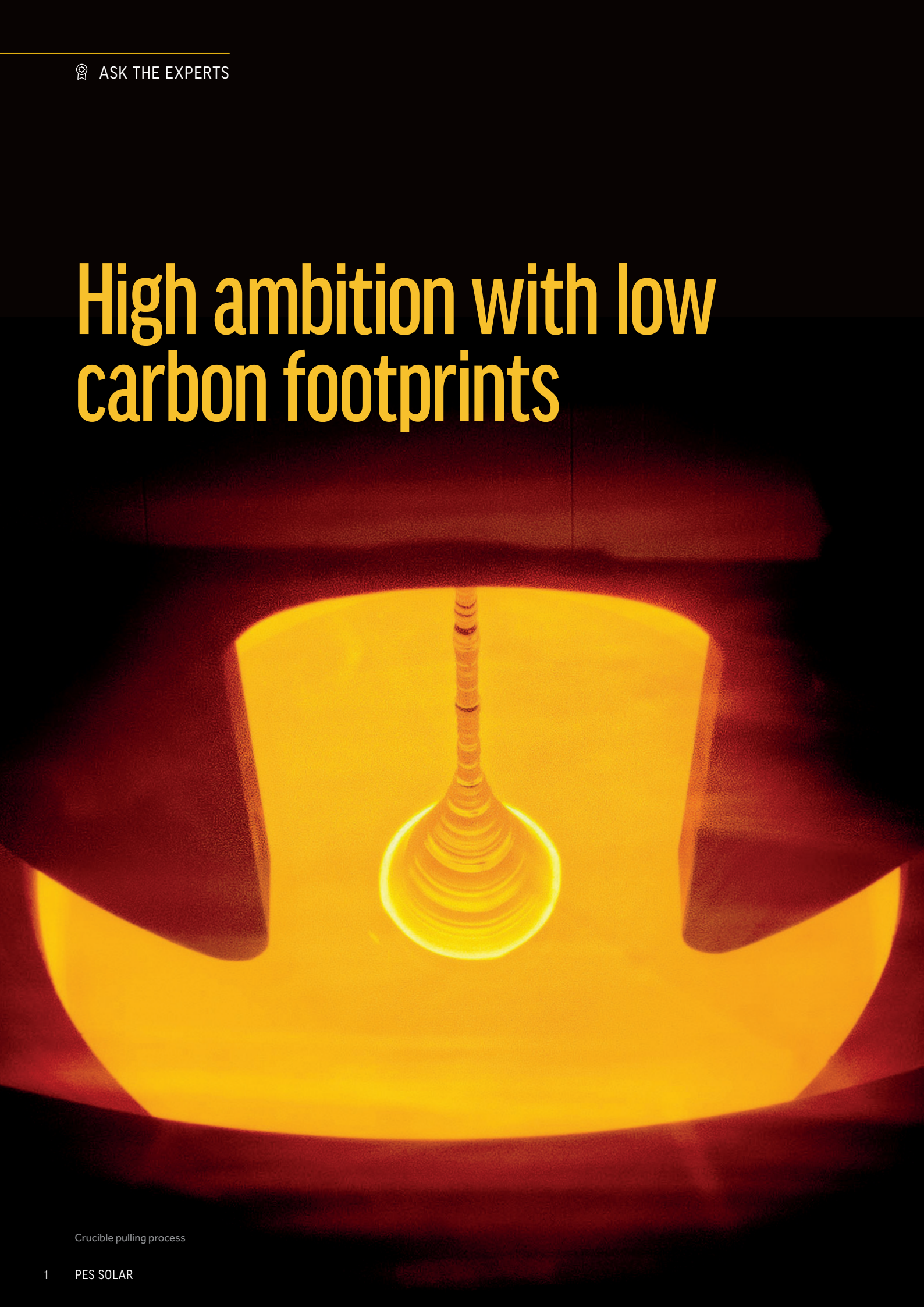
High ambition with low carbon footprints



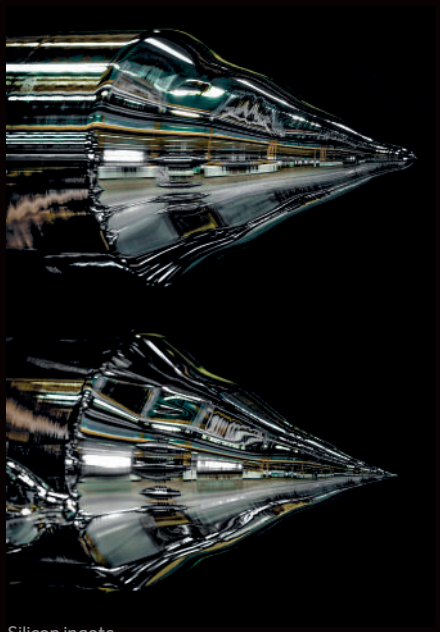
Crucible pulling process

PES is thrilled to introduce both Norwegian Crystals AS, a new contributor to the solar value chain and Gøran Bye, a familiar name and the company's CEO. With over 20 years of executive management and leadership experience within the PV industry in Europe, Asia, the US and the Middle East, he has now moved back home to Norway, to take the reins of a re-emerging monocrystalline ingot manufacturer. Gøran and his team have high ambitions for Norwegian Crystals.

PES: Welcome to PES Solar Gøran, it's wonderful to have you with us and to have the opportunity to learn more about Norwegian Crystals. With that in mind, perhaps you would like to begin with a brief introduction to the company, for those less familiar with it?

Gøran Bye: Certainly! Norwegian Crystal AS (NCR) has operations located in Northern Norway, a region that has access to clean hydropower, a skilled workforce and a rich tradition rooted in the solar industry. It is there where we specialize in making high quality and cost-efficient monocrystalline silicon products with an ultra-low carbon footprint. We have gone so far as to trademark that as ULCF-Si.

There has been monocrystalline silicon production in the town of Glomfjord, where we are located, for the last 25 years. Simply put, there is a lot of knowledge and competency in the area. With this extensive industry experience, we have navigated the company through significant changes and successfully prepared the company to become one of the most sought-after sources for monocrystalline silicon materials, worldwide.



Silicon ingots

In addition to the global interest in our products we see a general growth in the PV industry and a re-emergence of the solar value chain in Europe. The growing demand for our ingots and wafers and the increased interest from the industry have prompted us to accelerate our significant expansions.

PES: Can you briefly explain where Norwegian Crystals is situated in the solar supply chain?

GB: Our position is squarely in the middle... no pun intended. We consume virgin polysilicon and use that to produce perfect silicon crystals, specifically monocrystalline silicon.

Then we process those cylindrical crystals (ingots) into rectangular bricks or if our customers so prefer, we will also provide wafers (sliced from the bricks) through certified contracting partners. These bricks (or wafers) are then delivered downstream and serve as the substrates for solar cells, which eventually become solar modules, which then find themselves installed on roof tops or as a part of a solar power facility. We strive to be completely customer focused and market driven.

PES: In what way are your company 'customer focused, and market driven'? Do you have any examples?

GB: We aim to disrupt conventional energy generation paradigms by leading the de-carbonization revolution, contributing to meet the less than 2°C climate target and paving the way towards a cleaner and more sustainable world, one ingot at a time. To do that, we must position our products to meet not only the needs of our customer, but our customer's customer, the end user. They are demanding low-carbon footprint solutions, and we are uniquely positioned to deliver on that promise.

Further, with that customer focus we respond and react based on our customers' requirements. If the customer requires a different form factor or different specifications or properties to improve their products, then we engage with them to deliver what they are looking for.

A specific example is that many of our

Gøran Bye

customers are now shifting to a larger form factor, called M6, and are introducing gallium dopant to change the electrical properties. Both of these shifts aim to enhance the financial returns over the lifetime of the solar panels thus creating better value for the end user but also increasing the sustainability profile of solar.

We believe that Norwegian Crystals is actively shaping the future of energy where solar, and specifically PV, is expected to supply over 50% of electricity consumption globally.

PES: How do your high purity silicon ingots contribute to ultra-low carbon solar cells and modules; can you give us a little detail on this?

GB: Our extreme focus on keeping the carbon footprint as low as possible in all aspects of the production is important for the total carbon footprint of solar panels.

We source our feed stock exclusively from producers who also have a certified low carbon footprint. We offer our customers a certified life-cycle analysis where they can see the low global warming potential of our products. They share this information with their customers located in the jurisdictions which have increased focus on a low carbon footprint in addition to high quality products.

Black ice glacier

PES: Where in particular is Norwegian Crystals seeing growing market interest in its ingots because of ultra-low carbon footprint silicon?

GB: Currently, there are two main markets, France and South Korea, which have specific demands, regulations and premiums when it comes to the carbon footprint of solar panels. We strongly believe that more markets will follow in the near future.

We see a generally growing concern worldwide around all traded goods (not just silicon) and its carbon footprint. We are, of course, benefiting from that current focus as we are known in the industry for having amongst the lowest carbon footprint ingots in the world.

That said, we are also well positioned because of the profile of our products. Monocrystalline Silicon (mono-Si) is the clear platform of choice to drive further PV growth. We don't see any near-term alternatives or logical replacements for mono-Si based PV.

PES: It is a very interesting concept, focusing on creating renewable energy using renewable energy, can you tell us a little bit about your production processes?

GB: Norway is eminently suited for energy intensive production, as we are leveraging the forces of nature available around us. Norwegian Crystals is using hydropower for our production and sourcing materials from carbon-efficient suppliers. That's how we keep our carbon footprint down. We are fortunate to be located next to one of the largest glaciers in Norway, The Black Ice Glacier, from where we get the natural cooling water and the hydropower.

The focus on keeping our energy consumption throughout the production process as low as possible, is non-stop, and we are always looking for improvement potential. We are currently looking at innovative energy control systems and emerging 'applied solar solutions' to help us further optimize our energy consumption.

Furthermore, we are participating in various programs to help us continuously improve energy consumption, chemical consumption and recycling. We are for example recycling the natural cooling water by sending it on to a local fish hatchery after we have warmed it up in our process. All of these focus areas are part of our sustainability DNA.

PES: What kind of priority do you place on ESG and particularly the context of sustainability?

GB: Well, in doing what we do best we are actively working to improve the quality of life for many by reducing carbon emissions. And hopefully improving energy system stability while contributing to increasing green electricity, energy independence and security.

Transition to a low carbon future has started and is inevitable. The critical climate change issues have gone beyond awareness to action. People, scientists, businesses, international agencies, local states and governments are progressively coming onboard and engaging in the dialogue.

Harnessing and transforming natural resources to improve the quality of peoples' lives and society overall are at the core of our heritage.

PES: It is no secret that Norwegian Crystals has also been going through an evolution. Can you tell us a bit about that journey?

GB: I have personally been part of the solar industry for many years, and it has never stopped fascinating me. It's gone through boom-and-bust cycles which have contributed to the industry's current position where half of the growth in electricity generating assets globally, is PV! I think many of my peers would agree, being a player in this industry has been extremely tough at times – often painful, but never boring.

Prices have gone down intensively. In 2018 alone, prices went down by over 40%. It actually dropped 30% in the scope of 6 weeks. That did, of course, affect the company. We

Long silicon ingot

had already cut our costs with over 70%, but even that wasn't enough to keep up with the price decline in the market.

The choices we faced was to give up or dig in and adapt to the new reality of the PV industry. We chose the latter and we have completely turned around the company since then. Our focus on chasing costs and efficiencies has enabled us to make Norwegian Crystals both profitable and competitive.

We have new owners on board who believe in us, and who are helping us expand our production capacity. We are also lucky to have devoted employees who have been standing by us through it all. It's thanks to them that we have a company today.

This journey of turning the company around is something that we have accomplished together, and there is a certain pride in that.

PES: The solar industry is fast-changing, but what further changes would you like to see happen in the next decade?

GB: I would like to see a more diversified geographical footprint of the PV manufacturing chain. It would be great to get more support and more growth capital for the manufacturing parts of the PV industry outside of China.

Don't misunderstand me, the industry must give a nod to the cost and efficiency improvements and progress made in China over the past decade. Their participation in the value chain has been crucial in the world's achievement of the magic cost level we call 'grid parity.' However, China produces about 95% of the solar products used globally – so we would like to see complements to and collaboration with the Chinese PV industry where it all started, in Europe and in the US.

In order for that to happen we need a system which is committed to investing and putting growth capital into the manufacturing process of solar panels, and not just into deploying and the use of solar panels.

PES: And finally, for the solar industry as a whole what would your predictions be for the next 12 months, as well as for the longer term?

GB: In the next 12 to 18 months, I think we will see an acceleration toward low-carbon manufacturing practices, continued PV market growth, and I hope we will see the evolution of what some call 'applied solar' which is the use of solar for specific applications like industrial power-consumption off-sets and EV support, and even better: off-grid cooling / refrigeration that can be deployed for instance to minimize the waste of produce at point of harvest or to enable in-field clinics to preserve medicines needed to alleviate pain and suffering.

We are riding the next PV wave ... and it is an exciting time to be a part of the industry.

www.crystals.no

NCR in Glomfjord