

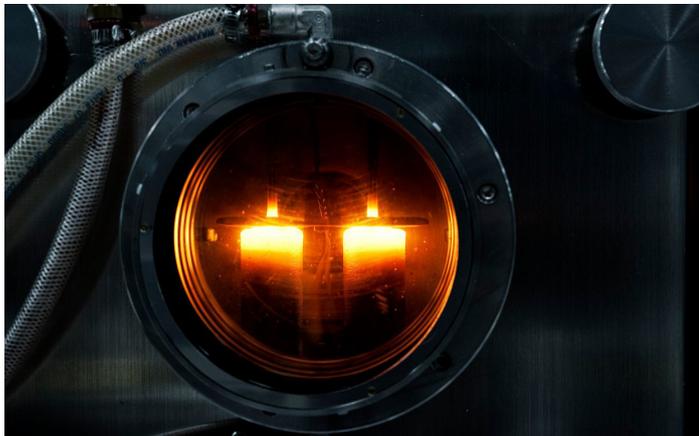
REC leaves a lasting impression: How REC achieves a class-leading carbon footprint

Energy is needed for all types of process, even when making the components of an environmentally-friendly electricity generation system such as a solar panel. So, if it takes energy to make energy, when considering the values of a product, it is always worth assessing what has gone into it and its contribution to the harmful gases that lead to climate change and measuring the actual ecological impact made of the manufacturing process.

Energy is needed for all types of processes, even when making the components of an environmentally-friendly electricity generation system such as a solar panel. As a source of primary energy is needed to power this production chain, when considering the values of a product, it is always worthwhile assessing its actual contribution to the harmful gases that lead to climate change and measuring the actual ecological impact made of the manufacturing process.

What is a Carbon Footprint?

The term carbon footprint is now regularly seen and discussed across all types of media when discussing the impact an activity has on the environment. What this actually means however, is often falsely used and misunderstood. So, what is a carbon footprint? Image walking along wet sand, and the footprints left behind vary in depth and size according to how hard you put each foot down, i.e., the impact of each step. When referring to issues such as climate change, the term carbon footprint is similar in that it refers to the full environmental impact of the activity in question, where carbon is a concise and relateable way of referring to all the harmful greenhouse gas emissions that are released during manufacturing, and the word footprint is a metaphor for the total traceable imprint left behind by the action in question.



Img. 1: Industrial production of solar silicon in a Siemens reactor, showing the intense levels of heating required.

Man-made climate change is generally accepted to be caused by the release of certain types of harmful gas into the atmosphere. The most dominant of these is carbon dioxide (CO₂), a gas which is emitted when fossil fuels are burnt in homes, factories or power stations. Other types of gas also make a significant contribution, for example, methane (CH₄) which is mainly produced by agriculture and landfill sites, and is 25 times more potent per kilogram than CO₂. More toxic, but emitted in smaller quantities is nitrous oxide (N₂O), which is around 300 times more potent than CO₂ and comes mainly from industrial processes and farming. Then there are also refrigerant gases, which are typically several thousand times more potent than CO₂.¹

Taking the example of the United Kingdom as a representative country in the industrialized world, the country's total greenhouse gas emissions breaks down as follows: carbon dioxide (86%), methane (7%), nitrous

oxide (6%) and refrigerant gases (1%).² As any single activity or action can produce different levels and quantities of gas emissions, the detailed calculation of a carbon footprint can get overly complicated. To achieve an understandable and relateable value, the amount of CO₂ is by far the largest emission of gas, so a carbon footprint is expressed as the amount of carbon dioxide equivalent or CO₂e. This means the combined total effect of all greenhouse gas emissions is expressed as the amount of carbon dioxide that would have the same impact.

Why is a Carbon Footprint important to the solar industry?

Solar is one of the key technologies for producing clean energy in the whole renewable energy sector, but for an industry seen as central to cutting the burning of carbon fuels across the globe, it would be illogical for the energy consumed in manufacturing to have a high environmental impact rendering the use of a solar panel potentially more damaging than it should be. By cutting their carbon footprints to minimal levels, solar companies can extol the environmentally-friendly virtues of their product and help to reduce global warming and climate change, meaning that the overall benefit of clean solar energy is felt by everyone across the world.

Where are the harmful greenhouse gases produced in the manufacturing of a solar panel?

Energy is needed to make a solar panel. This energy is used to run machines for the extraction of silicon, the purification and handling of the raw material, the melting and cutting into useable wafers, cells and the combination and transformation into a final solar panel. In fact, around 80% of the energy usage in a standard silicon production chain comes at the early silicon handling stage where it is heated to over 1500°C over a period of time in order to purify it.³ The crucial matter here however is how this initial energy is generated. For example, a factory in a region with a primarily coal-based electricity mix will burn more carbon and release more greenhouse gases than an area that uses more natural gas or renewables in its energy mix. To summarize, the higher the carbon content of the primary energy, the higher the carbon footprint.

How high is REC's carbon footprint?

Over its entire production history REC has made rigorous efforts to keep its environmental impact and carbon footprint low. Indeed, REC's has shown great success in achieving a low carbon footprint. This can mainly be attributed to its low carbon energy mix in the silicon production process.

The silicon used by REC comes from its subsidiary company REC Solar Norway (previously known as Elkem Solar), which extracts and produces its silicon in Norway. Among all International Energy Agency member countries, Norway has the fifth-lowest share of fossil fuels and the second highest share of renewable energy sources. Large hydropower resources enable Norway to have low levels of fossil fuel consumption, where roughly 96% of Norway's electricity comes from hydroelectric sources.⁴ Furthermore, in its silicon production, REC Solar Norway uses a proprietary process that has reduced the energy usage in the purification stage to 11 kWh/kg; well below that used in the standard Siemens production process which consumes up to

² UK Environmental Accounts, (2009), Office for National Statistics, www.ons.gov.uk

³ REC internal data from 2011 usage of Siemens reactor process

⁴ IEA, (2017) Energy Policies of IEA Countries, 2017 Review Norway, www.iea.org/publications

¹ Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2008, (April 2010), U.S. EPA #430-R-10-006, www.epa.gov/climatechange/emissions/usinventoryreport.html

200 kWh/kg.⁵ With such an energy efficient production process, and with the predominance of hydroelectric in Norway's energy mix, the burning of fossil fuels and the release of harmful greenhouse gases can be reduced to close to zero.



Img. 1: REC Solar Norway's production plant in Kristiansand, Norway.

The most recent study into REC's energy usage and carbon footprint was carried out by Deloitte & Touche Enterprise Risk Services Pte. Ltd. South East Asia in 2016 and looked at the production of a 285 Wp REC TwinPeak module using ISO/DIS 14067. Included in the analysis was raw material extraction, transportation, manufacturing and facilities, on site emissions and both on-site and off-site waste treatment. The report assessed a full carbon footprint throughout the complete production process of only 385 kg CO₂e/kWp – a value critically reviewed and certified by LCA consultants in Denmark. If this value is divided by the amount of years the panel is in service for, for example the duration of the 25-year performance warranty offered by REC, the carbon footprint comes down to a value of 15 kg CO₂e/kWp per year of use. Similarly, if a moderate annual energy production of 1 kWh/Wp is assumed, and this value taken over the same 25 years, then the carbon footprint of an REC module is only 15.4 g CO₂e/kWh.

**LOWEST
CARBON FOOTPRINT**

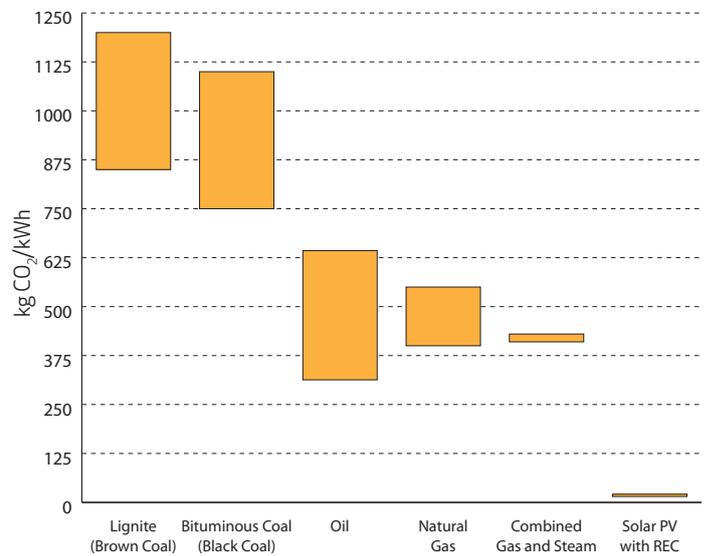


Img. 3: REC's imagery used on product documentation to identify its class-leading carbon footprint.

How the carbon footprint of solar compares to other energy generation processes:

The carbon footprint value that REC can demonstrate leads the way in the solar photovoltaic industry, as well as versus fossil fuel based energy sources as shown in the following graph. As the different carbon footprints of the various energy generation sources can be compared, it is clear that solar PV in general has a much lower carbon footprint than fossil fuel burning sources. What is more, the clean primary energy mix in Norway makes it possible for REC to achieve a carbon footprint well below the values shown by fossil fuel burning energy sources and likewise, well below that of the standard solar industry values.

⁵ A. Waernes, (2006), Solar grade silicon by direct metallurgical process, SINTEF/ECN/SCANARC/SUNERGY, Silicon for the chemical industry VIII.



Img. 3: Comparison of the maximum and minimum CO₂ emissions of major energy generating sources.⁶

What difference does a low carbon footprint make?

Being able to demonstrate a low carbon footprint gives REC an ecological advantage over its competitors as shown in the graph above. Environmentally-minded customers are able to use this data and base their buying choice on which module makes the biggest contribution to a greener world.

Equally, the consideration of a product's carbon footprint is becoming an ever more important consideration in purchasing decisions. Indeed, in France, the ability to provide a low carbon footprint value is one of the critical areas in which a 'score' is given to tender applications. REC's carbon footprint has been researched by Greenscans from the Netherlands, validated by ADEME, the French Environment and Energy Agency, and certified by Certisolis, an accredited and independent French institute.

Conclusion:

Through being able to demonstrate a class-leading carbon footprint and by having one of the lowest overall impacts on the environment in the industry, REC has once again shown its leadership in the solar module production process. As the entire energy sector has a key role to play in reducing the amount of harmful gases released into the atmosphere, such advancements with low environmental impact are the solution to creating a better world for future generations. Of course, as the growth of solar power deployment continues alongside other renewables, the industry will see carbon footprints continue to fall and the impact of the manufacturing process head towards being a truly ecological method of energy generation.

⁶ CO₂-Bilanzen verschiedener Energieträger im Vergleich, (2007), Deutscher Bundestag, WD 8 - 056/2007, REC values from analysis performed by Deloitte & Touche Enterprise Risk Services Pte. Ltd., (2016), Carbon Footprint Assessment, For the Production of Photovoltaic Modules used in Photovoltaic Power Systems for Electricity Generation