

Lightning in a bottle? Solar power in a chip Silicon purification process “under control” by ABB



The country known as Land of the Midnight Sun and the Land of the Northern Light is leading the way in creating technologies that aid in harnessing the power of the sun.

In its US\$600-million (4.2 billion kroner) facility, Norwegian company Elkem Solar has embarked on industrializing the production of solar-grade silicon to be used in solar power cells capable of generating renewable energy for more than 30 years.

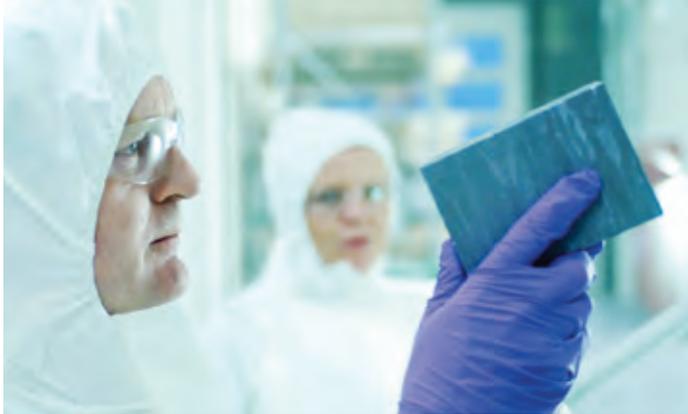
ABB delivered electrical high/ low voltage solutions to the total plant, including the System 800xA control solution.

While the world's energy needs are growing, energy production must turn renewable, to avoid global warming. Reducing carbon dioxide emissions and doing so by using energy more efficiently are the two key elements in an energy policy for the 21st century.

Solar panels made from silicon are increasingly transforming solar rays into energy for people all over the world. Indeed, harnessing even 0.3% of the solar energy falling in the Sahara and Middle Eastern deserts is enough to meet the energy needs of the continents of Europe, North Africa and Middle East. Making solar power a more competitive energy source is an important step towards creating a sustainable world.

The most critical component in solar cells is highly purified silicon. Elkem Solar has been the world's leading producer of silicon since 1970. It has again shown Norwegian metallurgical expertise with its new plant in Kristiansand.

In this new factory, energy consumption is 75% lower than in a similar factory with traditional technology.



Breakthrough technology

High-purity silicon is needed in making photovoltaic and solar cells. However, the solar market has seen a limited supply of such silicon. Elkem Solar addressed this need by building a new facility in Kristiansand to produce 6,000 metric tons of high-purity silicon for solar cell panels a year. The plant became operational in July 2009.

In this new factory, energy consumption is 75% lower than in a similar factory with traditional technology. It accomplishes this by using ABB's compressive automation and power solution, integrated on the common System 800xA platform.



The new plant utilizes a new and energy saving metallurgical process for producing solar-grade silicon, Elkem Solar Silicon®, a future-oriented product that helps contribute to lower global CO₂ levels.

The new production line consists of five independent process steps for purifying silicon. System 800xA provides precise control of two of the processes, while ensuring safe and reliable operations and optimizing production and energy efficiency.

ABB control and safety solutions for energy efficiency

By integrating power and process systems on the common 800xA platform, ABB optimizes the design and performance of Elkem's electrical and automation systems, overall energy efficiency. Plus, there are the additional benefits of reduced maintenance, engineering and overall lifecycle costs.

Silicon – one of the most abundant resources on Earth – puts the silicon solar cell in a prominent position among various solar cells.



The System 800xA solution consists of several operator workplaces, five AC 800M controllers and one AC 800M high integrity (HI) integrity controller for approximately 3,000 I/Os. The solution is comprised of Foundation Fieldbus which is used to communicate with the various types of process equipment throughout the plant.

Scope of the project

- IO Check out
- FFB implementation and configuration
- FFB SW interfacing
- FFB Instruments parametrisation
- Profibus setup + SW for data mapping
- Commissioning assistance
- 800xA support
- Application SW modifications
- Platforms:
 - 800xA version 5.0 SP1
 - Profibus
 - Foundation Fieldbus

Integrated process automation maximizes Elkem's capacity and energy efficiency

The realization of high-efficiency solar cells with low process cost is currently the most important technical issue for the major solar cell manufacturers, including Elkem.

To this end, Elkem developed the five-step process for purifying the silicon produced, with ABB control solutions including System 800xA controlling Steps 1 and 3 of the process line.

Elkem Solar Silicon production process

Step 1: Smelter (metallurgical silicon)

Quartz is reduced to silicon using carbon

Step 2: Slag treatment and crushing

This is the first of three sequential purification steps to reduce impurity levels and remove boron. This involves a pyrometallurgical slag treatment where liquid silicon is transferred from the arc furnace and then solidified and crushed after treatment. The slag-treated metal is then crushed before being sent to Leaching.

Step 3: Leaching

The hydrometallurgical cleaning process is where crushed silicon is cleaned with acids to reduce the level of phosphorus and other metallic impurities. Despite having one production line performing these energy-intensive and critical steps, Elkem is assured of complete control, safety and efficiency with System 800xA technology.

Steps 4 and 5: Direct solidification and post-treatment

For Step 4, the main purpose is to further reduce the levels of phosphorus and other metallic impurities. The process is similar to solar ingot production. Post-treatment involves cutting the solidified ingot into 10 kg bricks and cleaning them with acids. Parts of the ingot with an excessive concentration of impurities are cut off.

Lower production costs, equivalent product quality and less energy consumption – this is the picture Elkem foresees for the solar industry. ABB shares this vision. And together, we are one step closer to making this a reality.

Elkem Solar Silicon[®] production process



Step 1



Step 2



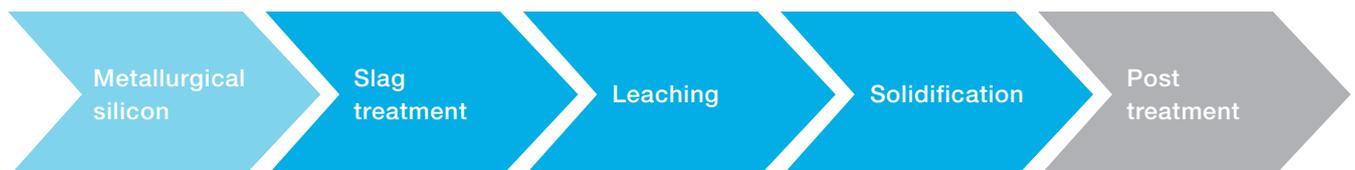
Step 3



Step 4



Step 5



- In-house production only
- Based on Elkem's core competence

- Three sequential purification steps to reduce impurity levels
- Elkem's core competencies are high temperature processes, and process- and equipment design

- Ingots cleaned and cut into brick of ~10 kg
- Quality control

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