SOLAR FRONTIER

Corporate Profile

Solar Frontier K.K.

Solar Frontier is:

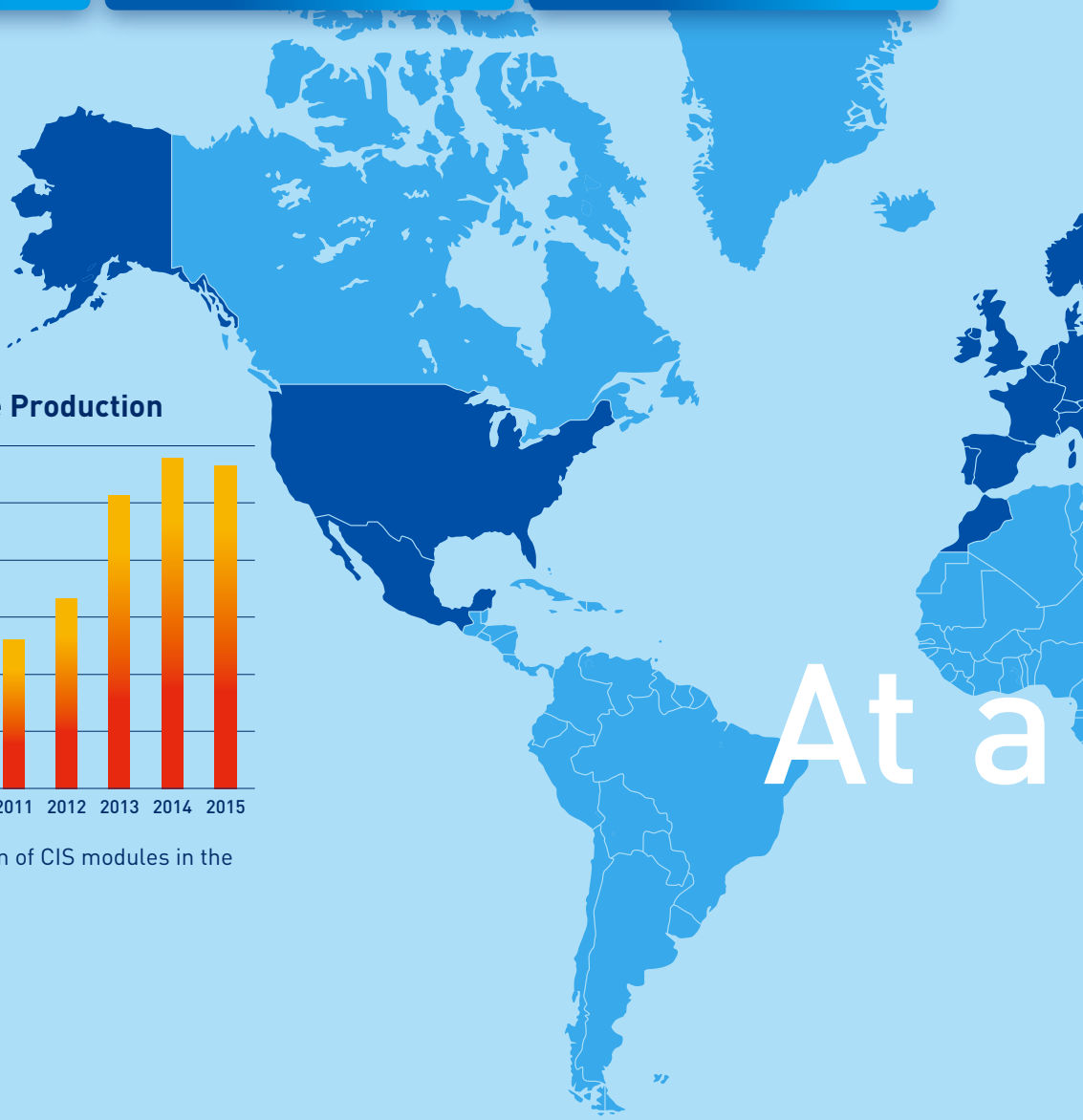
A global solar energy solutions company

We aim to:

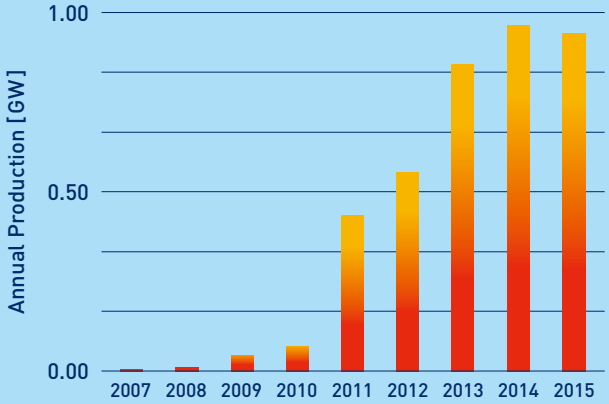
Harness the power of the sun to provide a cleaner, more comfortable lifestyle for everyone

We are:

From Japan and active in all time zones



GW-Scale Production



Leading the production of CIS modules in the solar energy industry

At a

We specialize in:

CIS thin-film technology

We distinguish CIS solutions by:

- **Higher electricity yield vs. crystalline silicon installations**
- **Quality manufacturing in Japan**
- **Ecological leadership**
- **Refined aesthetics**

We have:

The largest CIS production capacity in the world: GW-scale

We are led by:

A team of award-winning solar pioneers and energy industry specialists

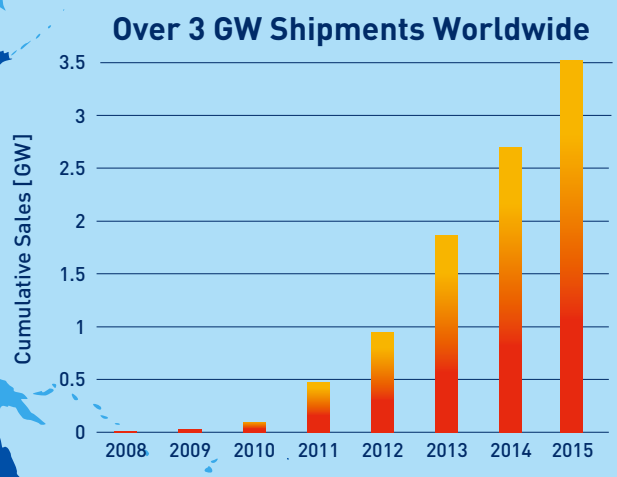
We build on:

Over 35 years of experience in solar photovoltaics

We do:

- **R&D and innovation**
- **Precision module manufacturing**
- **Solar energy system solutions for homes, commercial applications and power plants**

glance



Solar Frontier has directly shipped to 50 countries with installations in more

We inspire trust through:

- **Financial strength**
- **Technological reliability**
- **Track record of debt-financed projects worldwide**

We support and serve:

All customer segments [residential, commercial and utility], installers, distributors, EPCs and financiers

You can find our hubs in:

- **Tokyo, Japan**
- **San Jose, USA**
- **Munich, Germany**
- **Al Khobar, Saudi Arabia**

A Global Provider of Solar Energy Solutions

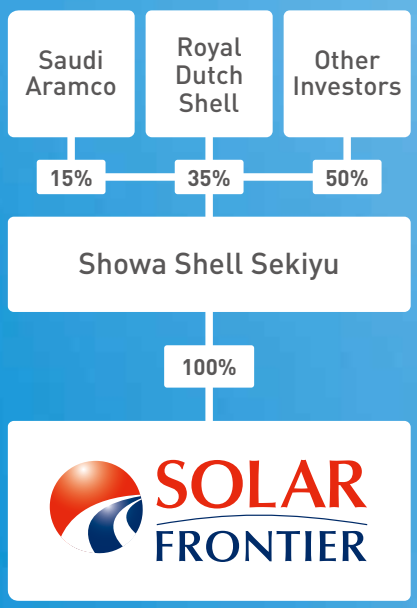
Solar Frontier is a leading CIS thin-film solar energy company by production, sales and technology. We are headquartered in Tokyo, Japan, and come from a background of global energy companies. Envisioning solar for all, we provide CIS thin-film modules and integrated system solutions worldwide.

In technology, our CIS modules excel. They are distinguished through higher electricity yield in actual operating conditions, precision manufacturing in Japan and ecological leadership.

In solutions, our products and services are customer-focused. From home energy systems to power plant development, we optimize IRR, minimize risk and provide comprehensive support before and after sales.

Solar Frontier operates offices in Japan, the United States, Germany and Saudi Arabia. We number 1,500 employees and are advancing solar across the value chain – from R&D to manufacturing and system solutions.

From a Background of Global Energy Companies



Over 100 years ago
Parent company's roots in energy industry

1970s
Began R&D in solar technologies

1993
Focused on CIS for technological advantages

2006
Founded company and committed to commercialization

2007
Commenced production in Japan

2009
Established state-of-the-art R&D facility and production plant

Our Past: Over 35 Years in Solar

Our story begins with the oil crisis of the 1970s. In search of a sustainable energy future, our parent company began developing solar energy technologies with the Japanese government, academia and early industry leaders. This included crystalline silicon and amorphous silicon. We soon uncovered the advantages of our CIS technology and committed to it from 1993. Under the name Showa Shell Solar, we commenced commercial production in 2007.

On the back of this success, the Atsugi Research Center – a world-record-setting R&D facility – and a new production plant followed in 2009. These set the stage for technological leadership and global growth. By early 2011, we had constructed the world's first gigawatt-scale CIS production facility and were active in key global markets. Solar Frontier has since become a global provider of solar energy solutions.

2010
Established international businesses

2011
Became world's biggest CIS manufacturer [GW-scale]

2012
Selected for world's largest CIS project [82.5 MW - U.S.]

2013
Introduced comprehensive solutions for homeowners, businesses and utilities

2014
Started construction of technologically advanced Tohoku Plant

2015
Surpassed 3 GW global shipment milestone

Our Future: A Strategy to Advance Solar PV Worldwide

We focus on solutions that increase the economic returns of solar energy while reducing its ecological cost. We are achieving this on three pillars of growth:

CIS Technology

CIS modules yield more energy in real-world conditions and require less energy to manufacture compared to crystalline silicon modules. We are now accelerating the capabilities of CIS in R&D - from achieving higher efficiency to developing new types of products.

Production

We manufacture among the highest wattages available in thin-film at globally competitive cost. The new Tohoku Plant, harnessing our latest production technology, serves as a model plant for future factories that will be based overseas.

Solar Energy Solutions

We provide solutions for the residential, commercial and utility segments. This includes home energy management systems and project development services. We do so with global partners, enabling us to capture additional value in each of our solutions.

R&D To Achieve Our Strategic Goals

The Atsugi Research Center [ARC] is located west of Tokyo in Kanagawa Prefecture, Japan. This is the base for 200 scientists, engineers and product managers – including award-winning pioneers of CIS – working in pursuit of our global growth strategy.

Their mission is to extend the boundaries of CIS conversion efficiencies on large substrates, develop mass production machinery, reduce total system costs and create new products and solutions.

Atsugi Research Center

ARC researcher testing module sample

Advancing CIS Conversion Efficiencies

ARC has broken world records. In 2015, it achieved 22.3% conversion efficiency on a 0.5cm^2 cell cut from a 30cm x 30cm CIS substrate. We are applying our record efficiency achievements into mass production in shorter periods as part of our customer-focused approach.

Driving Down Production Costs

Our scientists are working closely with our factory engineers to implement our latest production line technology in the new Tohoku Plant. These lines are faster, more compact and more efficient, enabling best-in-class production cost. They will serve as a blueprint for future production lines.

Reducing Total System Costs

New modules to be manufactured at the Tohoku Plant feature lower voltage, enabling lower system cost and more freedom in system design. Our Cross-One mounting rack for residential rooftops, which reduces installation time and helps maintain the integrity of the roof, is an example of our work on advancing system component design.

New Products to Open New Markets

We continue to innovate – Solacis Neo is a lightweight CIS module that is thinner than a smartphone, enabling installation on a wider range of rooftops. We are now researching future products such as bendable and ultralight modules. And on the solutions front, we are are working with pioneering companies to develop comprehensive systems, including Home Energy Management Systems.

Kunitomi Plant production lines in operation

World-Class Production

Located in southern Japan, our 900 MW Kunitomi Plant produces CIS modules with among the highest level of wattages available in thin-film. It does so at industry competitive cost. The Kunitomi Plant is today one of the largest module plants worldwide, manufacturing 15,000 modules per day.

Our production process is key to our bankability. Through high automation and precision engineering, we bring everything from raw materials to finished modules under one roof. No hands touch our modules until the final quality check, with multiple computerized and manned quality monitoring stations throughout. This ensures lower production costs and maximum quality and throughput.

In line with our growth strategy, we are now verifying our latest production technology at the Tohoku Plant. This technology is designed to be modular, enabling efficient and faster replication in future production plants.

Production Facilities

Miyazaki Plant

Capacity: 60 MW
Land: 50,000 m²
Building: 27,000 m²

Kunitomi Plant

Capacity: 900 MW
Land: 400,000 m²
Building: 158,000 m²

Tohoku Plant

Capacity: 150 MW
Land: 70,000 m²
Building: 15,000 m²

Bankability and Growth

Solar Frontier inspires trust in its corporate strength as the subsidiary of a robust energy company and as a technological leader.

Solar Frontier is today committed to sustainable growth in line with its global strategy. On top of continuous investment in R&D to ensure future technological leadership, new investments were made in the construction of the Tohoku Plant, a model for future production plants.

Solar Frontier and Showa Shell Sekiyu HQ

11.6 MW installation at Kansai International Airport

Trusted Technology

From Japan to Europe and the U.S., Solar Frontier has supplied and worked on large-scale projects that have achieved debt-financing from commercial and developmental financial institutions, equity-based large institutional investors and utilities. This is because our solutions generate excellent economic returns and because we minimize operational risk for our customers.

We ensure reliability and standardization in technology. Our CIS modules are manufactured using fully automated lines in Japan based on strict quality-control protocols. Our lines have also been tried and tested since we began production in 2007, and have been technically audited by independent third parties such as Black & Veatch. And at the module level, our technology has passed multiple additional durability tests, including for ammonia, salt-mist and anti-PID. [1]

[1] Potential Induced Degradation

CIS Advantages in the Field

Performance

CIS yields more electricity[2] in actual operating conditions compared to crystalline silicon, whether in humid conditions or desert extremes.

[2] kilowatt-hours per kilowatt-peak

Performance in Heat

Lower heat sensitivity due to a lower temperature coefficient.

Light-Soaking Effect

Exposure to light further increases power output due to a phenomenon known as the "light soaking effect".

Low-Light Behavior

Higher performance at lower irradiance levels.

Shadow Tolerance

Continues to generate electricity when partially shaded.

Reliability

On top of manufacturing excellence, Solar Frontier's CIS modules are certified to major international quality and safety standards. Solar Frontier performs in-house testing that goes beyond the requirements of many international standards.

Ecology

Lead- and cadmium-free, our modules are certified as compliant with the European Union's RoHS [3] Directive. CIS modules have a faster EPT [4] compared to crystalline silicon.

[3] Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive

[4] Energy Payback Time: the time required for a solar panel to generate the same amount of electricity spent in its production

Design

The black design is well-received by residential and commercial consumers.

Value-Added Solutions for All Segments

The following products and services are available based on region.

Residential

On top of CIS module advantages, we provide added value for homeowners. This includes specialized products such as our lightweight Solacis Neo module and our Home Energy Management System in Japan.

"Thanks to our rooftop system with Solar Frontier's CIS modules, we will be able to produce our own electricity in an independent, economically and ecologically attractive way. And it looks really great!"

Bettina Janka
Homeowner, Namibia


Schirra Solar Consulting, Germany


Homeowner, Japan


Risource Energy, U.S.


Ikaros, Belgium

Commercial

From office complexes and factories to farm buildings, harbor facilities and airport terminals, Solar Frontier is offering businesses an energy alternative. This includes pre-configured kits for commercial applications and consulting services.

"Solar Frontier's CIS modules were the ideal solution for our needs. They offer excellent efficiency, stable output and outstanding durability. We intend to install these panels in our facilities in other areas."

Tetsuya Muraki
Green Energy Group, NYK Trading Corp


Solagent, Germany


Baraclit, Italy


Yamasaki Giken, Japan

Utility-scale

Solar Frontier supplies modules and works with global partners to cover all steps of the power plant development process. We also develop and sell high-yield, high-quality turnkey solar power plants as part of our project development business. Our new global approach is to minimize the risk to investors by pursuing this model.

> *"Solar Frontier convinces with the high quality of its modules, accurate and professional project management, logistics service, contract loyalty, and customer support."*
>
> Karl Heinz Remmers
> CEO, SKW Solarkraftwerk Eberswalde GmbH


Saudi Aramco, Saudi Arabia


Belectric, Germany


Granite Construction, U.S.

Project Development Business:

Step. 1

Identify

- Government-backed schemes
- Active PV markets

Step. 2

Study

- Economic feasibility
- Risk mini-mization

Step. 3

Build

- Capitalize on Solar Frontier's experience
- 3rd party financing

Step. 4

Operate

- Capture real-time data
- Minimize risk for investors

Step. 5

Transfer

- Complete sale of power plant

Our Offices:

Asia [HQ]
Solar Frontier K.K.

Daiba Frontier Building
2-3-2 Daiba, Minato-ku
Tokyo 135-8074
Japan

Tel: **+81 3 5531 5626**

Americas
Solar Frontier Americas Inc.

2099 Gateway Place #310
San Jose
CA 95110
USA

Tel: **+1 408 916 4150**

Europe
Solar Frontier Europe GmbH

Bavariafilmplatz 8
82031 Grünwald bei
München
Germany

Tel: **+49 89 92 86 142 0**

Middle East
Solar Frontier K.K.
Representative Office

Eastern Cement Tower
#306 King Fahd Street
Al Khobar
Kingdom of Saudi Arabia

Tel: **+966 13 882 0260**

Our Leadership Team:

Atsuhiko Hirano	President & CEO
Satoru Kuriyagawa	Director and Executive Officer Vice President
Katsushi Takenaka	Director & Executive Officer
Shinji Kato	Director & Executive Officer
Kazuki Kakegawa	Director & Executive Officer
Yukihiro Oyama	Executive Officer
Wolfgang Lange	Executive Officer
Yuichi Kuroda	Executive Officer
Hiroshi Inoue	Executive Officer
Yasuhito Hyakutake	Executive Officer
Shin Yamamoto	Executive Officer
Charles Pimentel	Executive Officer
Shigeto Tsuru	Executive Officer

Solar Frontier K.K.
2016.04

SOLAR FRONTIER