Towards the sun: inclinometers in CSP

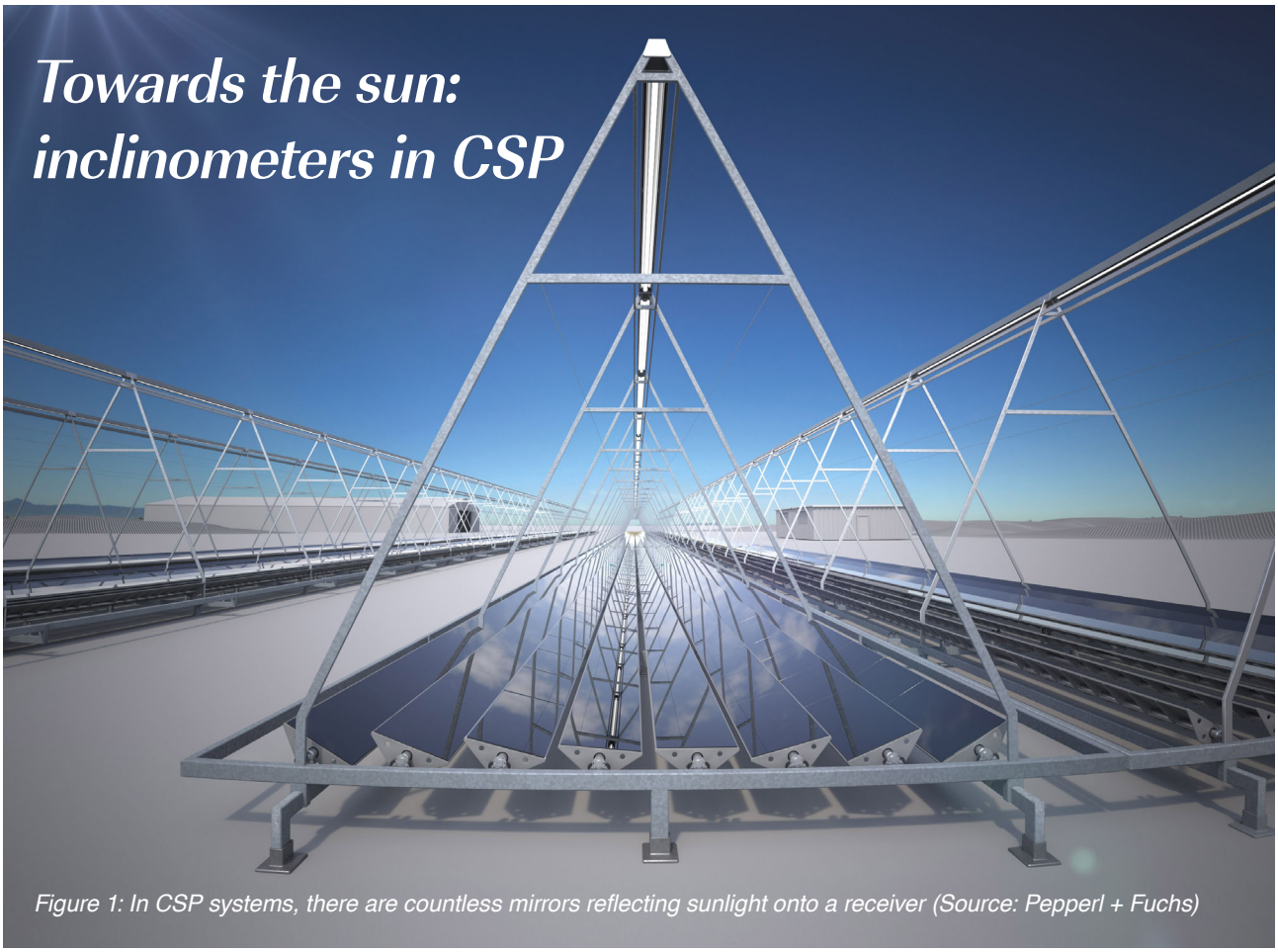

Figure 1: In CSP systems, there are countless mirrors reflecting sunlight onto a receiver (Source: Pepperl + Fuchs)

The F199 two-axes inclinometer is designed for precision measurements and comes in a robust housing suitable for concentrated solar power (CSP) systems.

The recently by Pepperl + Fuchs introduced tilt sensor features CANopen connectivity and supports the CiA 301 application layer and the CiA 410 profile for inclinometer. The two-axes sensor measures angles from 0° to 360° with an accuracy smaller than ±0,15° in both axes — across the entire measuring range. The legacy inclination sensors from the supplier are based on a two-piece mounting concept, which makes them sturdy. A metal mounting bracket provides the sensor module with impact protection. The F199 one-part inclination sensor supplements this existing portfolio. A corrosion-resistant aluminum housing, encapsulated electronics, and 100-g shock resistance make it robust.

To suit CSP applications, the product comes in IP68/69-rated housing. The ingress protection (IP) rating is standardized in IEC/EN 60529. The first indicates the degree of protection (of people) from moving parts, as well as the protection of enclosed equipment from foreign bodies: “6” is the protection against dust that may harm the sensor. The second digit defines the protection level that the enclosure enjoys from various forms of moisture (drips, sprays, submersion, etc.): “8” indicates a protection against temporary immersion and “9” against prolonged effects of immersion under pressure.

The rugged inclinometer can be used in CSP applications to generate energy from solar heat. CSP plants typically have countless mirrors that concentrate solar radiation onto a receiver or receiver area. A heat medium inside the receiver is heated by the sunlight and drives a steam or gas turbine, which in turn generates power. The more sunlight, the more power can be generated. To avoid scattering loss from inaccurate mirror alignment, tilt sensors detect the inclination angles of the mirrors. Besides the rugged housing, the sensors also feature an extended temperature range of -45 °C to +85 °C to meet the requirements of such challenging harsh environments.

The precious measuring of the inclination angle allows the mirrors to be aligned with the sun’s rays so that as much solar radiation as possible can be converted to power. With this, the products contribute to increased effectiveness and efficiency in CSP plants.

CSP systems focuse sunbeams by using mirrors or lenses to concentrate a large area of sunlight onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine connected to an electrical power generator. This technology is not yet commercially competitive with photovoltaic (PV) systems. CSP needs a large amount of direct solar radiation. PV ▷

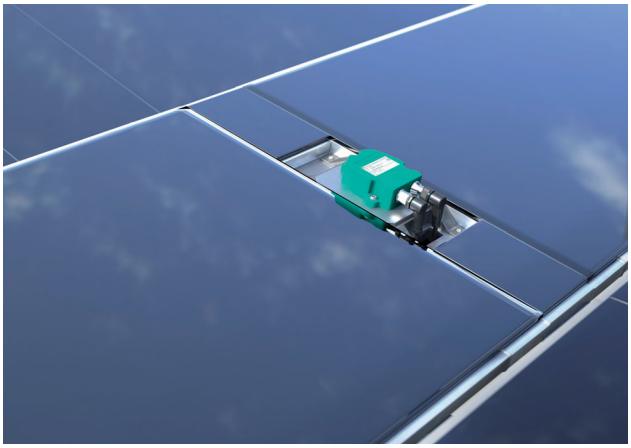

Figure 2: The F199 can withstand the heat in CSP plants and can be installed in direct sunlight (Source: Pepperl + Fuchs)

systems can be operated also in cloudy environments. The advantage of CSP over PV is the production of heat, which can be used running a conventional thermal power block. A CSP plant can store the heat of solar energy in molten salts, which enables these plants to continue to generate electricity whenever it is needed, whether day or night.

Trough solar concentrators use a parabolic mirror to focus the sunlight. A liquid filled tube is heated at the focal point. The tilt angle of the reflecting mirror is the key to ensure it is facing the sun. This ensures that the liquid filled tube is kept at the focal point. The track controlling require an accurate measuring of the tilt angle. As the inclinometer sensor is mounted directly onto the structure it can provide several advantages over shaft encoders and light sensors: it reads the angle of the structure directly so it is not affected by mechanical hysteresis; it measures the absolute position including errors introduced by wind loading; and it works over wide angular range under all lighting conditions.

Although the CSP technology has been introduced in the 1980s, growth was hindered by a number of factors such as high cost of capital, global economic slowdown resulting in lack of finance, competition from other low-cost renewable technologies such as wind power and PV, and lack of specific government support. CSP with energy storage has the ability to provide stable, scalable, and reliable power. Thermal storage helps retain solar heat generated during the sunny period to convert it to electricity when needed. Of the 5,6 GW active CSP capacity by the end of 2018, around 2,6 GW is with energy storage and around 3 GW is without storage. In contrast, of the total CSP projects under various stages of development, 95,8 % of the upcoming capacity has storage. Only 4,2 % of the under-development CSP capacity is without storage.

In the last years, CSP plants costs have been reduced. Morroco is the pioneer in combing CSP and PV systems. Besides the stand-alone CSP projects (Noor I to Noor III), the North African country has launched to hybrid solar plants at Noor Midelt with a CSP capacity of about 150 MW for each system.

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based on information of Pepperl + Fuchs