CAMPBELL SCIENTIFIC UPDATE
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The solar-energy market is one of the most rapidly expanding renewable energy markets in the United States. At Campbell Scientific, we've seen a significant increase during the last few years in requests for remote monitoring and control equipment for solar-energy applications. Just like many of the other industries that use our products, the solar-energy industry relies on measurements both for day-to-day operations and to advance the field through research. Whether you are assessing a site's potential for solar power generation, monitoring performance of existing solar installations, or advanced solar monitoring, reliable and accurate measurements are crucial. They aid in decision making, product development, system maintenance, and in many other ways.

Common meteorological measurements, including wind speed, wind direction, relative humidity, barometric pressure, and precipitation, all have their use in solar applications. Of course, solar-radiation measurements are especially important and sensors are available for measuring all aspects of solar radiation, including global horizontal radiation, direct normal irradiance, and diffuse radiation. Specialized systems with solar trackers are also available for applications that require advanced monitoring. See the article below for a list of new solar products that we will soon offer.

The requirement for continuous, remote, stand-alone monitoring makes our systems a great fit for these applications; however, it is our flexibility and reliability that really make a difference. Just like solar arrays and other solar installations that have to withstand all sorts of weather, so do the measurement systems that monitor them. With proper maintenance, our systems will provide years of reliable operation. Versatility comes through our systems' ability to measure nearly every available sensor, the high programmability of our dataloggers, and a wide range of telemetry options for retrieving data.

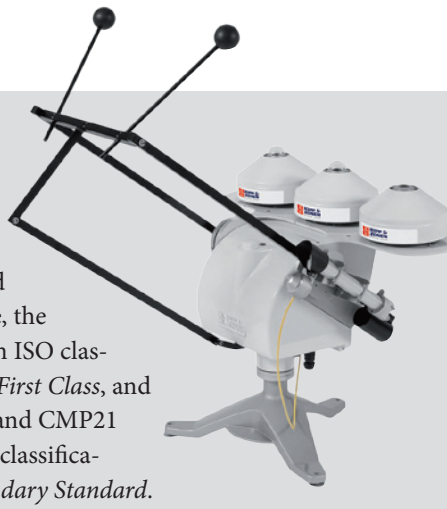
As a company, we have invested in our own solar-energy project involving the installation of a 13-kW photovoltaic array for both power generation and research purposes. (See the article on page 3.) We look forward to future contributions to the solar-energy industry through our products and support.

Give our renewable energy group a call if you have questions about how our measurement systems can benefit your application.

New Solar Sensors from Kipp and Zonen

Several new Kipp and Zonen sensors will soon be available for solar-energy research applications. A complete solar monitoring station for research or solar prospecting typically measures global horizontal radiation (GH), direct normal irradiance (DNI), and diffuse solar radiation (DSR).

For monitoring GH, Campbell Scientific will offer the CMP6, CMP11, and CMP21 pyranometers. These pyranometers measure solar radiation with a high-quality blackened thermopile protected by two glass domes. Based on differences in accuracy and performance, the CMP6 has an ISO classification of *First Class*, and the CMP11 and CMP21 have an ISO classification of *Secondary Standard*. The CMP21 also includes an internal



New Photovoltaic System Installed at Campbell Scientific

We have installed a major photovoltaic system for power generation and research at Campbell Scientific headquarters in Logan, Utah. We mounted a 40-by-27-ft solar array and sensors on a tracker, with a stationary reference panel and sensors nearby. We look forward to this installation benefiting our work (and our customers' work) in several ways.

The most visible benefit is actual power generation. The photovoltaic array mounted on a two-axis tracking tower is rated at 13 kW. The electricity it generates, along with the many energy-saving features that are incorporated in our newest building, will help us use less outside energy and reduce our carbon footprint.

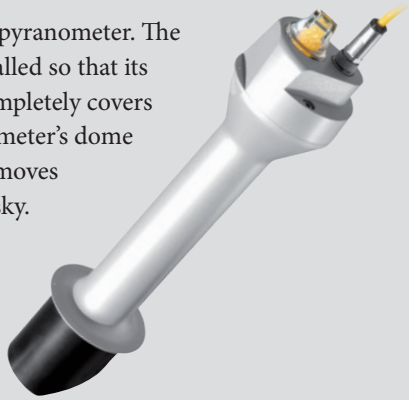
The behind-the-scenes benefit is the way the solar-power system lets us demonstrate and expand our expertise in renewable-energy research. We built a stationary station with a reference solar panel, and then instrumented that reference station and the tracking solar array with temperature sensors, pyranometers, and power-output sensors. We will be able to measure the output of a panel on the tracker tower and compare it to the output of the stationary panel for real-world comparison of their performance. The array on the tracking tower and the stationary test station will give us a continuous platform for testing instruments and techniques for use in the energy industry.

We are using our data-display software, RTMC Pro, to share the performance information from this solar-power system and the energy-saving components of our new building. It will be displayed on a screen in the new building, and at tracker.campbellsci.com.

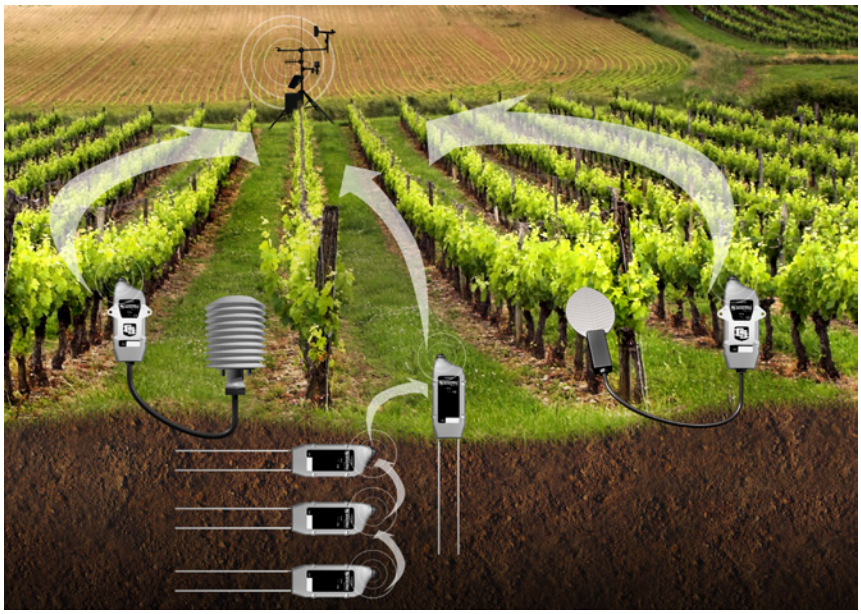
So much of the information that people depend on as they decide among renewable energy choices is based on theories and models. This new equipment will monitor the actual performance of the solar-power systems and so that Campbell Scientific can give customers real data to help them choose and implement energy solutions.

thermistor allowing individually optimized temperature compensation of the measurements. The optional CVF3 Ventilation Unit will be offered to keep the domes of any of these pyranometers free from ice, dust, and dew.

To monitor DNI, a CHP1 Pyrheliometer is mounted to the Solys2 Sun Tracker. The CHP1 pyrheliometer measures the direct-beam solar irradiance with a field of view limited to 5 degrees. The limited field of view requires the CHP1 to be continuously pointed toward the sun. The Solys2 Sun Tracker rotates on two axes and uses a GPS receiver to keep the CHP1 aimed at the sun throughout the day.
DSR is measured using a CM121 shadow ring with a CMP6, CMP11, or CMP21 pyranometer. The ring is installed so that its shadow completely covers the pyranometer's dome as the sun moves across the sky.



Wireless Sensors Expand Measurement Possibilities



It is particularly satisfying for us at Campbell Scientific when we develop technologies or products that benefit a large number of our customers. Because of this, we are excited to release our new wireless-sensor product line that allows sensors to be installed at a distance from the datalogger without connecting cables.

Freeing sensors from the location of the datalogger significantly expands the measurement possibilities in many applications, while at the same time simplifying installation and reducing costs. Networks of rain gauges can be scattered through a watershed as needed. Large numbers of strain gauges can more easily be interspersed on a structure. You can probably think of other scenarios where it would be useful to place a sensor several hundred meters away from the datalogger.

The new family of wireless products consists of the CWB100 base station, the CWS220 infrared radiometer, the CWS655 soil-water-content sensor, and the CWS900 configurable interface—a component that adds wireless functionality to a wide variety of sensors.

The most significant benefits of the new product line are the wireless communication, small size of the components, the low cost, and the simplicity of setup. Wireless communication allows for placement of sensors without the worry, effort, and expense of laying cable to each measurement point. In many measurement setups, cables present a difficulty and can be expensive and labor-intensive to install. Once installed, users may be inhibited from changing their configuration because of the time and effort already invested. Also, cables are susceptible to damage from machinery, weather, and pests. Wireless sensors eliminate these problems.

Power concerns have been minimized by a low-power design that requires only two AA batteries (they can last a year with 15-minute sensor polls), and by a solar-power option that can stay charged with just three hours of light per day.

Another benefit is that the wireless sensors can be easily configured without complex programming and they can be integrated into full datalogger systems. The base station resides at the datalogger and polls the sensors via radio. Data can be relayed through a mesh network that uses as many as three hops—from one wireless sensor in the network to another. The base station stores the data until the datalogger requests it. While the path to the datalogger is wireless, the sensor data is the same as if each sensor was directly connected to the datalogger.

Here at Campbell Scientific, we are excited about the potential that these new wireless products hold. They are compact, use little power, and are rugged and weather-sealed. The sensor modules are each leak tested before shipping, and in real-world testing they have withstood rain, snow, wind, and hail. Even when installed 3 ft below the canopy in a mature corn field, they were able to transmit up to 500 ft. The possibilities are very encouraging. Contact Campbell Scientific to see if these wireless networks can work for you.

Here are descriptions of each member of this new family of wireless sensors.

CWB100 Wireless Base Station

The base station is the master radio in the wireless network. It polls the wireless sensors (it can store data from up to 50 sensors) and passes the data to the datalogger when requested. It can connect to a PC for configuration, and communicates with the datalogger via serial protocol using a single control port. The base station uses a frequency-hopping, spread-spectrum radio in the 900-MHz range (other ranges available). These features give it longer range and less interference, so the radio can communicate with sensors over 1,000 ft away in optimal line-of-sight conditions. Data can be relayed up to three hops in a mesh network, since

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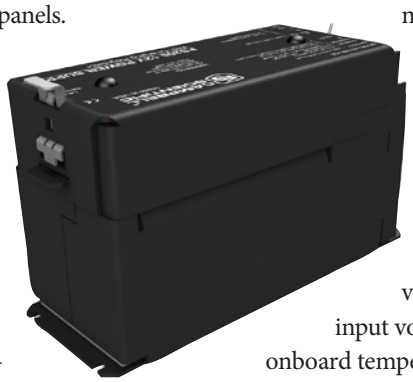
Paul & Paulette Campbell Receive Service Award

In September of 2010, the College of Agriculture at Utah State University (USU) presented to Paul and Paulette Campbell the Distinguished Service to Agriculture award. Paul was recognized for his service as president of Campbell Scientific, which has a long history of support for and cooperation with the College of Agriculture. The company has expended great effort to develop instruments for agricultural research. Paulette's father worked at the USU farms, and all five of the Campbells' children attended USU—two graduating as valedictorians. The company and Paul and Paulette have also donated generous scholarship funds to the university. Congratulations to the Campbells for their dedication to this college at USU, and may that association continue.

Smart Power Supplies Improve Remote Power

While renewable energy has recently become mainstream, solar panels and rechargeable batteries have provided energy for a large number of remote weather stations for years. Many of our measurement and control systems are powered by rechargeable batteries charged from solar panels.



To further help in this area, we are introducing two new smart battery-charge controllers, the PS200 and CH200, for recharging 12-Vdc, valve-regulated, lead-acid (VRLA) batteries. The PS200 includes a 12-Vdc, 7-Ahr rechargeable battery, whereas the CH200 is for applications where the user provides the battery, such as our BP12 or BP24.

These new charge controllers provide a new, powerful solution for battery charge control. Solar panel charging is enhanced by the 3.6-A typical current limit, two-step constant-voltage charging algorithm, and maximum power point tracking.

Several safety and protection features make the PS200 and CH200 valuable and rugged additions to a rechargeable battery system. Onboard measurements, along with a serial communication interface, provide users with charge input voltage, battery voltage, onboard temperature, battery current, and load current measurements. These measured parameters can be used to compute net charging currents, battery health, and power budgets for improved site management.

The PS200 and CH200 are compatible with the A100 and A105 adapters. The A100 Null Modem Adapter is used to connect and power two peripherals via two CS I/O, 9-pin connectors configured as a null modem. This is useful in linking different communication technologies at sites that do not have a datalogger. The A105 12-Vdc Terminal Expansion Adapter may be used to provide extra 12-Vdc and ground terminals where the power supply is used to power several devices.

CAMPBELL SCIENTIFIC UPDATE

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Fuel Moisture Sensor Offers Improved Accuracy

We have replaced the CS505 with the new CS506 Fuel Moisture Sensor. The CS506 uses the proven technology of the CS616 reflectometer to measure the moisture content of the 26601 10-hour Fuel Moisture Stick. Improvements over the CS505 include more accurate measurements and more robust stainless-steel strips used to attach the fuel-moisture stick to the CS506 electronics. In the field, the CS506 is mounted with the CS205/107 fuel temperature sensor via the 26817 mounting stake.

New Temp & RH Sensor

Campbell Scientific has replaced the HMP50 with the HMP60 Temperature and Relative-Humidity Probe. Improvements over the HMP50 include lower power consumption and a wider humidity range of 0 to 100% RH. Like the HMP50, the HMP60 measures air temperature for the range of -40° to 60° C.

Cuajone Copper Mine, Peru

In 1996, Southern Peru Copper Corporation (SPCC) installed real-time meteorological monitoring stations at its various operating locations (Ilo Copper Smelter, Ilo Copper Refinery, Cuajone Copper Mine, and Toquepala Copper Mine). This network of 17 weather stations was set up to measure meteorological conditions and air-quality levels to fulfill Peruvian environmental laws, and to collect data for air-dispersion models and other studies.

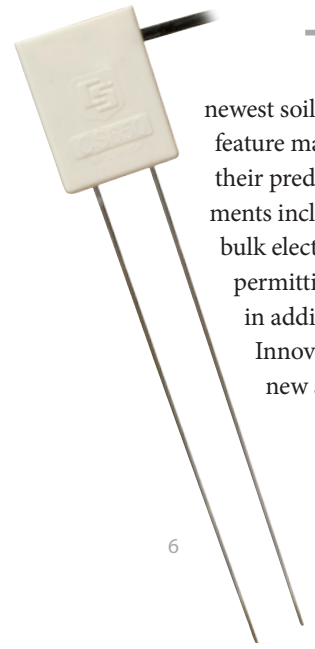
TRC Environmental installed the stations and trained SPCC staff members to verify and calibrate all sensors according to US EPA requirements. In 2007, Enviroequip upgraded the weather-station dataloggers to the Campbell Scientific CR1000.

The Cuajone meteorological and air-quality station is located at the Villa Botiflaca Camp (12,000 ft above sea level). This station has collected about 13 years of valid data. The data are collected and stored as 5-min averages computed from 1-s values using a Campbell Scientific CR1000 datalogger. Campbell Scientific's datalogger software is used for data retrieval, real-time display of numeric values, and datalogger program modifications.

Meteorological sensors are mounted on 10-m towers. Operators climb the towers for monthly verification, calibration, maintenance, and audits. The tower sensor configuration includes wind sensors, temperature probes, relative-humidity sensors, solar-radiation sensors, barometric-pressure sensors, and tipping-bucket rain gauges.

All the data and plots can be checked by meteorologists in the control center in order to examine any irregularities in the data and decide if some corrective action is needed. For air-quality monitoring, they use PM10 and PM2.5 monitors connected to Campbell Scientific CR1000 dataloggers. With the updated dataloggers, the network should provide many more years of valuable data.

Soil-Water Reflectometers Offer Additional Measurements



The CS650, CS655, and CWS655, our newest soil-water reflectometers, feature many improvements over their predecessors. These improvements include the ability to measure bulk electrical conductivity (EC), permittivity, and soil temperature in addition to soil-water content. Innovative techniques allow the new sensors to make accurate water-content measurements in soils with saturated bulk EC of up to 3.7 dS/m without performing a soil-specific calibration. The CS650 and CS655 output an SDI-12 signal that most of our dataloggers can measure.

Common applications include irrigation scheduling, soil-water transport and flow studies, soil-water model validation, and soil-water balance analyses. These reflectometers can also be used to compare the effects of varying soil conditions on a plant's health.

The CS650 and CS655 differ in their rod lengths—the CS650 has 30-cm rods, and the CS655 has 12-cm rods. The CWS655 is a wireless version of the CS655. (See *Wireless Sensor Networks* article on page 4 for more information).

Channel Tunnel IceWatch System

The Channel Tunnel (or Chunnel) connects the United Kingdom with France. It is actually a set of three tunnels, over 31 miles long, that pass beneath the seabed of the English Channel. Because of the huge amount of road and rail traffic at the large terminals at each end of the tunnels, a road-weather information system (RWIS) is critical for safety and efficiency.

An ice-warning system had been in use for 15 years, and had become so obsolete that it could not be upgraded. In addition, the old system was so unfriendly that the operators rarely used it, so user-friendliness was a key requirement for the new system. Eurotunnel, which owns and operates the Channel Tunnel, awarded a contract for an entirely new system to the team of Campbell Scientific Ltd. (CSL, Campbell Scientific's affiliate in Europe) and Weather Services International.

CSL designed and installed a replacement hardware and software system, named IceWatch, to be user friendly and appealing to the operators tasked with the safety of the facilities.

The system includes seven automated weather stations (AWS), a server and multiple displays at the terminal in each country, and documentation and training. Six of the AWSs were set up with RWIS features, including IRS21 road surface sensors from Lufft and infrared road surface sensors. Precipitation type is classified by present-weather sensors.

RTMC Pro software from Campbell Scientific was used to design and control the data displays, including showing data from two different sources. CSL set up the system so that the operators at the terminals in both the UK and France could see the weather and road-condition data from both countries.

With the IceWatch system, the Eurotunnel staff now has state-of-the-art equipment and displays to quickly and clearly show them the road and weather conditions at their terminals. They can make informed operational decisions to maintain site safety and reduce costly disruption.

New Heated Rain Gages Measure Snow

Campbell Scientific now offers the 52202 and CS700H heated rain gages. The 52202 is manufactured by R.M. Young and is intended for standard applications. It measures precipitation in 0.004-in. increments, with an accuracy of 3 percent for up to 2 in./hr.

The CS700H, manufactured by Hydrological Services, is ideal for measurement of high-intensity precipitation. It measures precipitation in 0.01-in. increments, and includes an internal siphon that allows the sensor to make accurate measurements for precipitation rates of up to 27.6 in./hr. The CS700H comes in an AC version that runs on 110 Vac and a DC version that runs on batteries. To minimize power consumption, the CS700H's heater is designed to only turn on when precipitation is present and the temperature is in the range of -20° to 4°C.

Wireless Sensors (cont'd)

every wireless sensor can act as a relay node for other wireless sensors in the network.

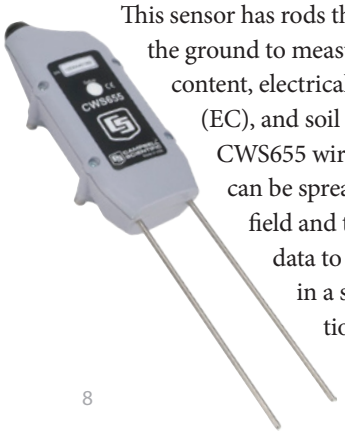
CWS220 Wireless Infrared Radiometer

The CWS220 integrates Apogee's SI-111 infrared sensor with a radio in one compact body. It is used to sense infrared radiation from surfaces to calculate the surface temperature without physical contact.

CWS900 Wireless Sensor Interface

The CWS900 is particularly exciting to introduce because of the broad spectrum of measurements it can bring into these wireless networks. It is a radio with a sealed connector that can be attached to a variety of sensors. It can measure analog voltage and frequency, count pulses, and supply excitation voltage, making it compatible with many types of low-power sensors. The connector to attach the sensor to the wireless interface is a conventional type that can be specified when ordering sensors from Campbell Scientific. We will also offer the A150 terminal interface that allows one of your existing sensors with a pigtailed cable to attach to the connector on the CWS900.

CWS655 Wireless Soil-Water Sensor



This sensor has rods that insert into the ground to measure soil-water content, electrical conductivity (EC), and soil temperature. CWS655 wireless sensors can be spread out over a field and transmit the data to a base station in a secure location away from the field.

RF500M OS Now Supports ALERT Protocol

A new operating system (OS) for our RF500M Radio Modem and RF500B Base Station allows a datalogger, RF500M modem, and radio to integrate seamlessly with existing ALERT networks.

The new OS supports concurrent ALERT and PakBus communications, our two-way protocol.

ALERT is a one-way communication protocol for collecting event-driven, real-time data from other ALERT stations. Our PakBus communication protocol can be used to retrieve historical data, initiate retries for missed data, perform remote diagnostics, synchronize clocks, and provide remote programming.

Training Offered

Campbell Scientific offers comprehensive training courses at our state-of-the-art training facility. Our list of courses includes classes on programming our dataloggers, making the best use of our software, and professional-level expertise in research methods.

Each training course is taught by experienced Campbell Scientific application engineers. Class size is limited to ensure personalized instruction and assistance. Course fees include training manuals and the use of dataloggers, computers, and sensors. Lunch is provided on all course days, and there will be a tour of Campbell Scientific's facilities as time permits.

If you have questions about which course will best meet your needs, please contact an application engineer. We can also help you arrange a self-study course or a customized course at your location. Visit our website at www.campbellsci.com/training to see the current schedule and to register online.

Trade Show Calendar

October		
Solar Power International	Los Angeles, CA	12-14
International Snow Science Workshop	Lake Tahoe, CA	17-21
GRC & Geothermal Energy Expo	Sacramento, CA	24-27
Geological Society of America 2010	Denver, CO	31-3
ASA Annual Meeting	Long Beach, CA	31-4
November		
CASQA-Storm Water Conference	Rancho Mirage, CA	1-3
AWRA Annual Conference	Philadelphia, PA	1-4
CAST 2010	Houston, TX	10-13
Water Quality Technology Conference	Savannah, GA	14-18
December		
Irrigation Show 2010	Phoenix, AZ	5-8
Ground Water Expo & Annual Meeting	Las Vegas, NV	7-10
American Geophysical Union	San Francisco, CA	14-17
Colorado River Water Users	Las Vegas, NV	15-17

Visit our website for training class schedules and additional listings.

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