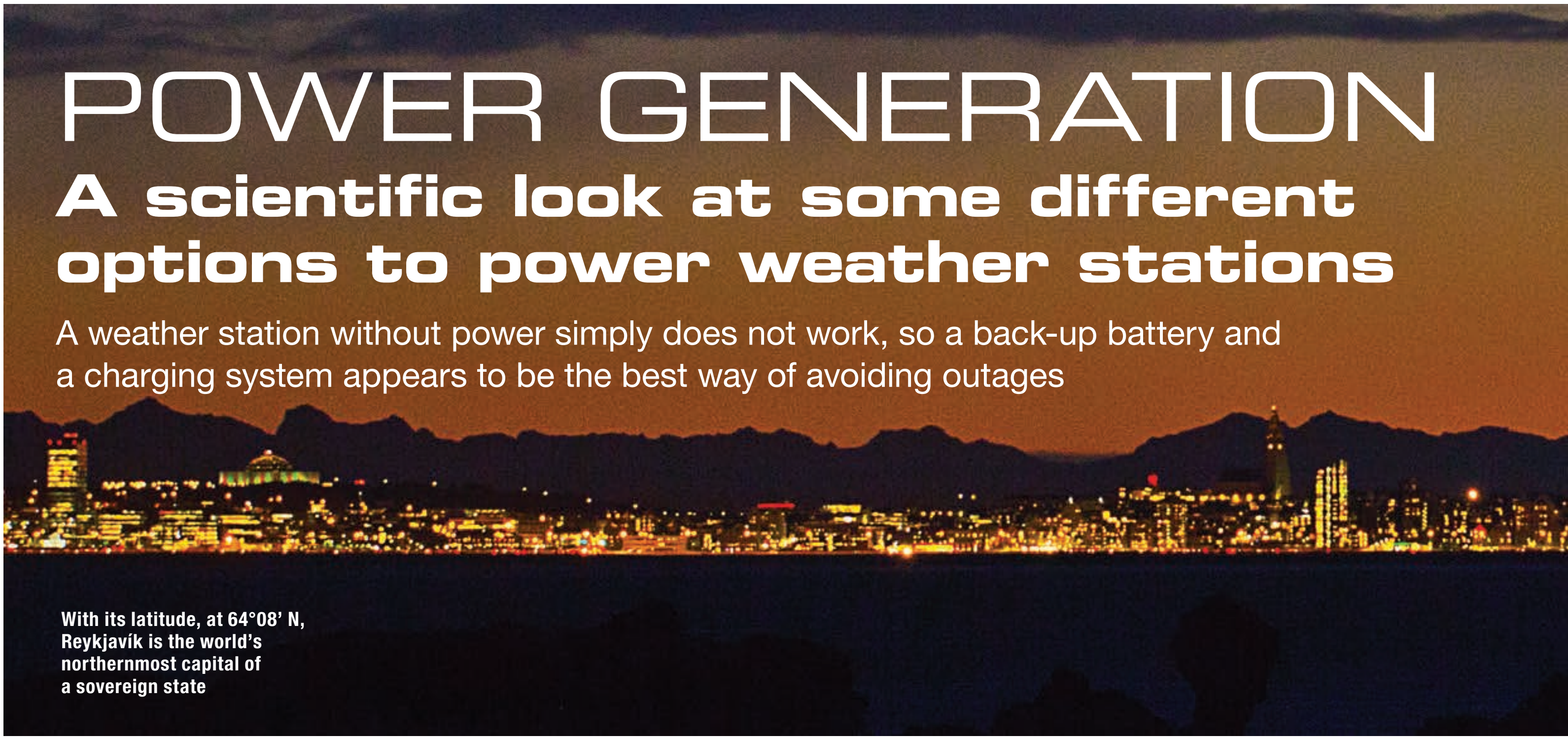
by Andres Thorarinsson

POWER GENERATION

A scientific look at some different options to power weather stations

A weather station without power simply does not work, so a back-up battery and a charging system appears to be the best way of avoiding outages



With its latitude, at 64°08' N, Reykjavík is the world's northernmost capital of a sovereign state

In most cases, a weather station is driven by a 12V battery charged by mains, solar panel or a wind generator. For a more temporary setup, a battery as sole power source will work, but for all permanent installations or power-hungry applications an external power source is needed to keep the battery charged. Most weather stations use one of three external power sources – mains power, solar power or wind generator. As the condition of the battery is very important to successful operation of the weather station – including all instruments, the datalogger and communications – it is useful to understand the behavior of the battery and its voltage. Here we investigate four cases: two types of battery charging by solar panel; using mains power; and by wind generator.

Case 1: Solar panel in sunny areas

This weather station is at 35° north. Figure 1 shows voltage of a 7Ah battery as charged by a solar panel during the day. The graph shows a one-week period that has been carefully selected as it includes December 21 (winter solistice) – the shortest day of the year.

During broad daylight the battery is being charged, taking in less energy on a cloudy day but more on a sunny day. During the night the battery voltage drops as its power is used to run the weather station and communications. It is interesting to see that straight after sunset the battery voltage falls to

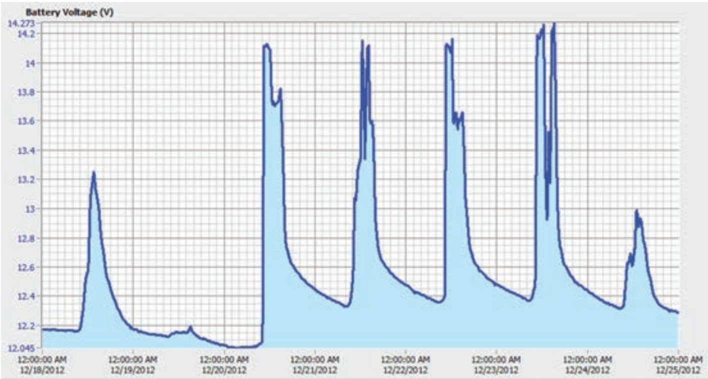


Figure 1: Graph showing battery being charged by solar panel

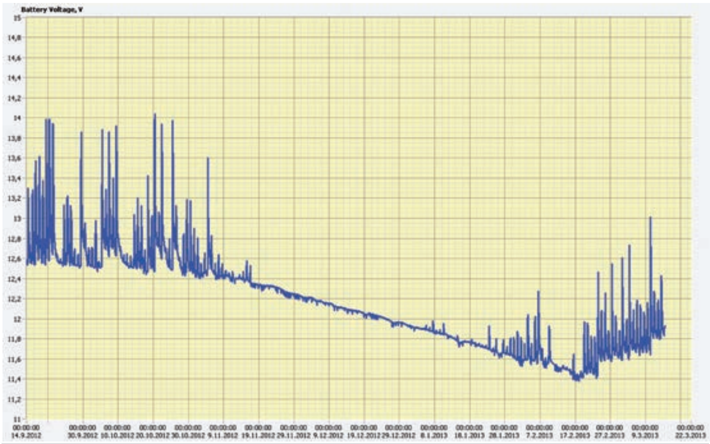
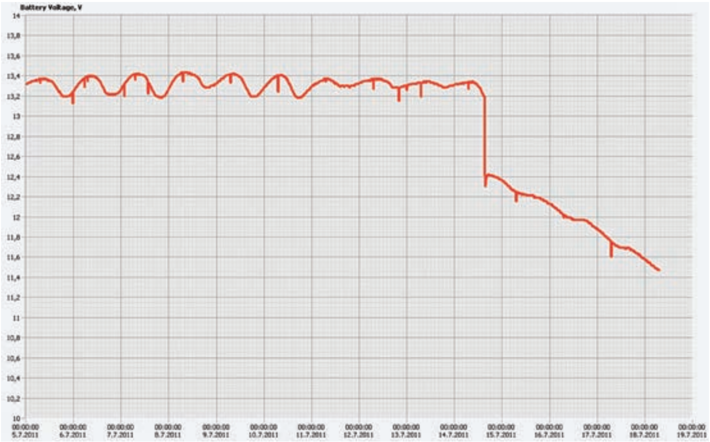
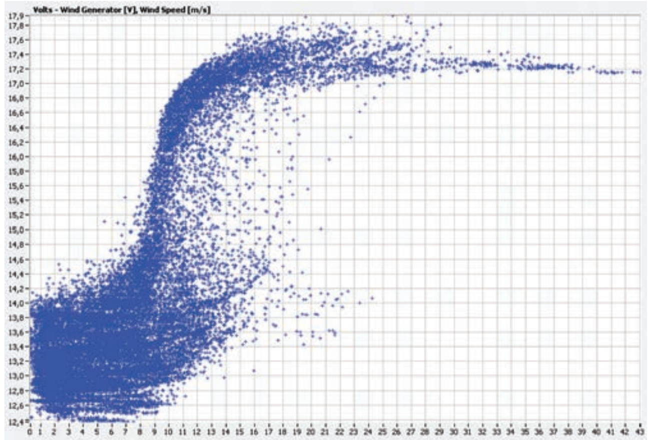


Figure 2: Battery being slowly discharged throughout the long, dark arctic night





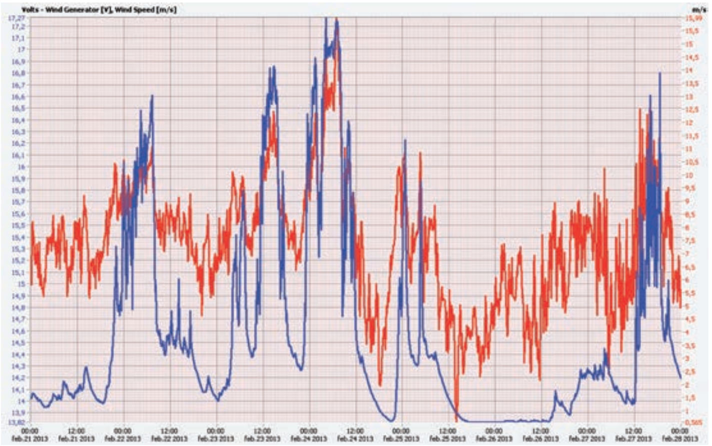


Figure 3: (Top left) Battery charging by mains

Figure 4: (Left) Wind generator voltage and wind speed

Figure 5: (Above) XY graph showing battery voltage as function of wind speed

its internal floating voltage 12.6V, indicating a healthy battery. Just before sunrise the battery voltage measures as low as 12.2V, which means that only half of the battery capacity is still there. The measurements show that this battery might last for two additional days without any charging. An observer with a keen eye will notice that the solar panel is partly shaded for three hours every day and therefore missing 20% of the possible charging to the battery.

Case 2: Solar panel in a less sunny area

This weather station is located at 66° north. Figure 2 shows the voltage of a 105Ah battery over a period of six months, including the mid-winter with limited daylight. The solar panel stops charging around the first week of November and start to charge again more than three months later – around the third week of February. All through the dark winter, the battery voltage drops 0.3V per month.

It is not the datalogger itself that uses all this power, but the cellular IP modem used for communications. However, the modem is automatically switched on for just one hour every day and data is collected during this time. As the battery voltage has dropped as low as 11.4V during the winter, the capacity of the battery is too low for this power plan and the weather station is on the brink of collapse due to power loss. The new power plan for next winter would be to double the size of the battery, or simply collect data less frequently, for instance once every three days.

Case 3: Mains charging

What is more secure and robust than mains-powered supply? Nothing really! Figure 3 shows a graph detailing two weeks of battery voltage of a weather station charged by mains. The weather station is located such that its cabin is affected by the sun's heat during the day and cools down during the night. It is interesting to see how the charger is sensitive to ambient temperature, dropping voltage as heat increases. Then, suddenly, disaster strikes as the mains disappear. Battery voltage falls to its internal floating voltage of 12.4V, and then the battery discharges rapidly by 0.5V per day. At 11.5V the datalogger stops functioning and there is no more logging.

Two lessons can be taken from this: firstly, the battery's internal floating voltage of 12.4V indicates that it has already lost half of its capacity due to age or overcharging. Secondly, a discharge of 0.5V per day means that the battery life is a maximum of 1.5 days, which is too short for it to be used as a reserve power for a weather station.

Case 4: Wind generator

This weather station is located 62° north at a windy location close to the sea. The wind generator of 50W is charging 2 x 105Ah batteries. Figure 4 shows the battery voltage (blue trend line and left-hand axis) as well as the wind speed (red trend line and right-hand axis). What can be learned from the graph is unexpected; the wind speed needs to be at least 8m/sec for any charging to take place. Furthermore, in this case, the wind generator's voltage regulator is not working too well, seemingly charging with a voltage only regulated by the wind speed.

It would be useful to be able to better understand the voltage profile of the wind generator. Luckily, this profile can be easily created by plotting wind speed and voltage on an XY graph (Figure 5).

The wind generator's voltage profile shows that the charging starts at 8m/sec, reaches its maximum at 15m/sec, and has a constant output up to 40m/sec This wind generator type has a proven record of withstanding the worst winter storms and icy conditions without faults.

The verdict? This is a fine tool for windy and power-hungry locations, but could benefit from voltage regulator refinement.

Take care of your batteries

Information about battery conditions is at your fingertips, and by reading it properly and acting with preventive maintenance, you can ensure lasting and error-free data-logging of weather data. Neglect the batteries and you will have gaps in data that will cause you problems in the long run. ∎

Andres Thorarinsson is CEO of Vista Data Vision, based in Reykjavik, Iceland