# Snow monitoring for sustainable development

One of the great challenges of the coming years, as emerged from the latest agreement at COP28 in Dubai, is to accelerate global ambitions to mitigate climate change and reduce greenhouse gas emissions. Today, sustainable development requires a greater and more efficient use of renewable energy, such as hydroelectric, wind and solar energy, which will therefore become increasingly important in the energy market.

**Water resources**

Snow cover is one of the most important resources for mountain regions, both economically and ecologically. The mountains act as natural reservoirs, collecting snow in winter and releasing it in spring when temperatures rise. Between 60 and 70% of water reserves comes from melting snow, with high mountain regions at the upper end of this range. Snow is a fundamental water resource that provides water to farms, forests and communities. Knowing how much water will come from the snow on an annual basis is important for short- and long-term planning.

**Hydroelectric energy**

Hydropower uses river water or stored in dams to produce electricity through the action of turbine blades.

Hydropower is significantly affected by the natural variability of water available in rivers. To make renewable energy production more efficient, accurate measurements of the water equivalent of snow and snow cover are required to predict the inflow to the turbines. A combination of satellite data, weather forecast modeling and in situ data can improve the estimation of these snow variables.

Hydropower is an important component of the production portfolio of many electricity companies, ensuring excellent diversification but also a significant exposure to the natural variability of the natural resource. Most production takes place in the mountains and the potential energy component is stored in the snow/ice layer above the mountains. A correct estimate of the water content in snow can provide information to better manage natural resources and portfolio exposure to hydropower.

In order to manage hydropower plants, to plan electricity production or water storage, and to evaluate its impact on the energy market, it is necessary to know not only the rain, but also the water contained in the snowpack or the snow water equivalent (SWE) which determines the amount of water contained in the snowpack, helping water managers and hydrologists to plan water use.

The water equivalent of snow and snow cover are key variables for the management of hydroelectric power production, as they constitute the main water deposit in the mountains.

**The Measurement of the SWE**

In situ measurements, combined with satellite and weather models, could improve the estimation of snow cover and snow equivalent and reduce exposure to their natural variability. A correct estimation of the water content in snow could allow energy producers to better manage natural resources and make renewable energy production more efficient.

In order to meet the need for sustainable development, making hydroelectric production more efficient, a tool is required that produces an estimate of the equivalent of water in snow and snow cover.

A better evaluation of the water stored in the snow could improve the prediction of hydropower production, with positive effects on productivity.

ool is needed to estimate the equivalent of snow water and snow cover in the most relevant areas for hydroelectric plants.

**The challenge**

Measuring the amount of water in the snow can be difficult, as the air temperature controls the amount of water contained in an inch of snow. An inch of rain can produce from two centimeters of sleet to 50 or more inches of snow, depending on the air temperature. Different storms bring different types of snow that can contain different amounts of water. Warmer snowstorms can create two inches of sleet for one centimeter of rain, while very cold snowstorms can create more than 50 centimeters of very dry and dusty snow for one centimeter of rain. During winter, different storms bring different types of snow, so the height of the snow does not directly translate into the amount of water retained in the snow. Because of this variability, SWE helps to understand how much water the snow holds.

Because 3 cm of precipitation can produce 6 cm of sleet to 130 cm of snow, depending on the coldness of the air, SWE is a more reliable method of measuring water reserves.

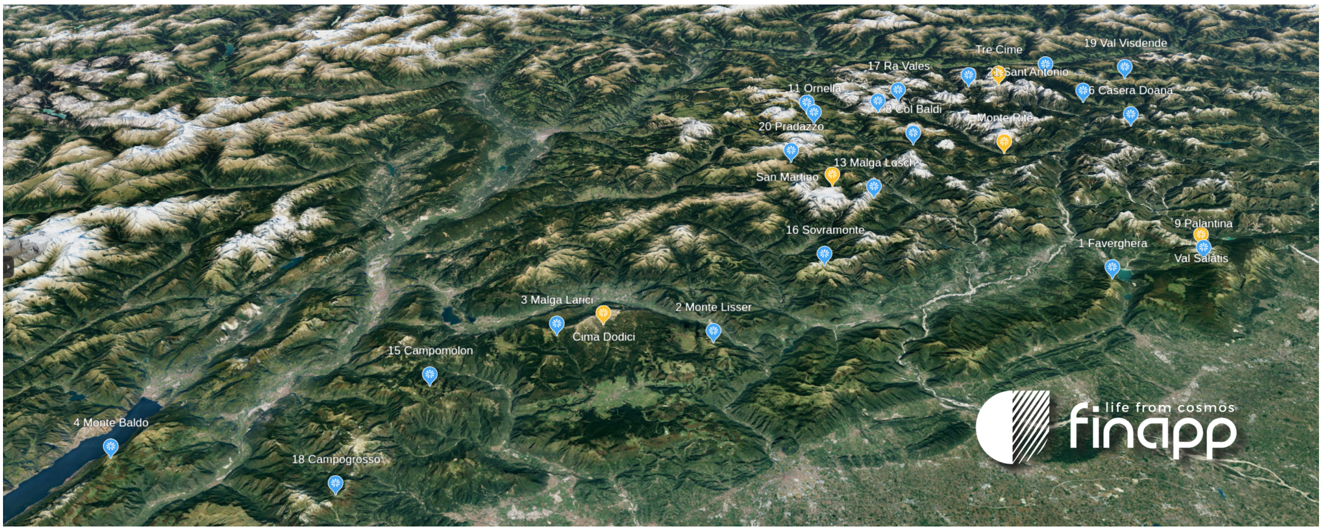
Measuring the water equivalent of snow (SWE) is important for a variety of applications. At the level of hydrological basin, in the management of water resources and hydropower, the use of SWE allows to estimate the reserve of liquid water contained in the snow. On a smaller scale, monitoring of avalanche risk or the structural health of large buildings can also benefit from SWE monitoring. Snow and weather research also needs to monitor the snowpack to understand its physical processes. SWE is one of the main macro properties of snow.

**Innovation**

The most innovative method of measuring the water equivalent of snow (SWE) is the use of cosmic ray sensors (CRNS), which can measure the volume of SWE at the installation site without contact, continuously and completely autonomous.

The CRNS probe is an integrated sensor for the measurement of environmental neutrons, generated by cosmic rays, which allows the estimation of the SWE, ie the water content in snow.

*In the image: Rete SWE ARPA Veneto - Italy*



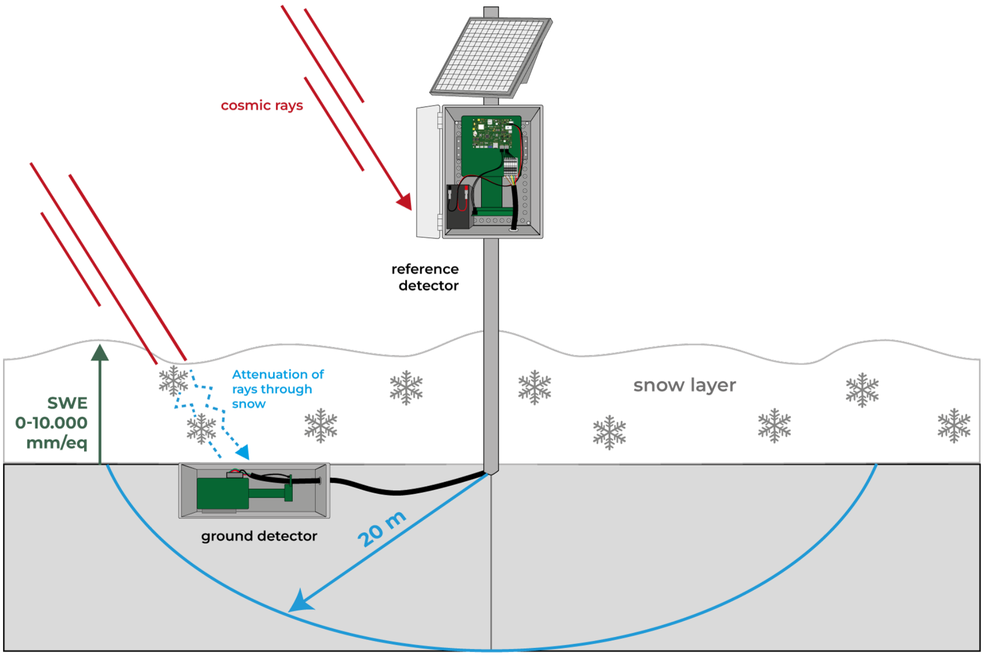

## The operating principle of CRNS probes

A sensor component is placed above the snowpack as a reference, and serves to measure incoming neutrons from space before they interact with snow. A second component is placed at ground level, burying it slightly, when it is free of snow. The snow cover will completely cover the probe, which will then count the neutrons that have already interacted with the snowpack. The difference in neutron count between the two probes provides an accurate measure of how much water is present in the snowpack.

Among the advantages the CRNS probe provides the SWE values already expressed in mm water equivalents, representative on a large scale (radius of more than 20m) with a saturation between 2'000mm and 10'000mm.

## Story case

Recently, the Italian environmental monitoring agency, ARPAV, equipped 25 sensor sites at CRNS, creating the first Italian regional network, able to provide SWE monitoring information based on this technology.




## Who is Finapp

The company has developed the latest generation sensor for the non-contact measurement of water content in soil and snow, based on the measurement of environmental neutrons produced by cosmic rays (Cosmic Ray Neutron Sensing).

Finapp solution allows a precise and digitalized water management, with the aim of reducing waste in agriculture, reducing energy cost, increasing productivity, improving the quality of water offering to the professional the value of the available water content at the root of the plants.

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