# PV monitoring: why not to use external ventilation for pyranometers

Internal ventilation offers a better alternative, compliant with IEC requirements

For utility-scale PV, ventilating and heating pyranometers have been required since 2017 by the IEC 61724-1 standard for PV system performance monitoring. The main purpose is to mitigate dew and frost deposition. Traditionally, ventilation was external, now also, internal ventilation is available at Hukx.
Advantages are:
– internal ventilation has the same effectiveness as external ventilation
– lower purchase cost
– lower power, lower electrical and mechanical infrastructure costs than external ventilation
– better corrosion resistance, dust resistance

## Introduction

Ventilation and heating of pyranometers have always been recommended by WMO, ISO, IEC and ASTM to reduce the effects of dew and frost, and to reduce zero offset errors.

Now, dew and frost mitigation is also a requirement for Class A systems for utility-scale PV system performance monitoring according to IEC 61724-1.

## New: SR300-D1 with internal recirculating ventilation and heating

A new solution to mitigate dew and frost is internal recirculating ventilation. Internally heated and recirculated air keeps the instrument dome above the dew point and at the same time, it forces the body to the same temperature. See also Figure 2.

**Figure 1** Two SR300-D1 Class A pyranometers with heating/dew and frost mitigation measuring GHI (Global Horizontal Irradiance)
and POA (Plane of Array) in a PV performance monitoring system.

Internal ventilation:
– Heats air and blows internally through the instrument so that the dome is above dew point.
– Makes sure the entire pyranometer is in thermal equilibrium, reducing zero offsets.
– Does not require extra heaters.
– Has no additional zero-offsets at high-heating.
– Consumes less power, because the heat is recirculated; typically 2 W consumption.

## Outdated: traditional external ventilation SR20 + VU0

The traditional solution is to use an external ventilation system, as seen in Figure 3. Heated and ventilated air is blown over the pyranometer. This solution was designed for scientific use.

This method of ventilation:
– Heats air and blows it over the pyranometer so that the dome is kept above dew point.
– Promotes thermal equilibrium between all components of radiometers and thereby reduces zero offsets.
– Usually employs extra heaters, because the ventilator heating power may not be enough.
– Is relatively energy inefficient, because the heat is carried away by ventilating air; typically around 10 W power consumption.
– Requires regular maintenance of the ventilator and air filters.
– Requires daily cleaning of domes (WMO recommendation).
– Is not recommended for use in areas with high atmospheric dust loads, such as deserts with regular sandstorms; rotating parts of ventilators tend to get stuck and are not designed to be cleaned.
– Is not recommended for use in corrosive environments, because the filter and ventilator are not corrosion resistant.

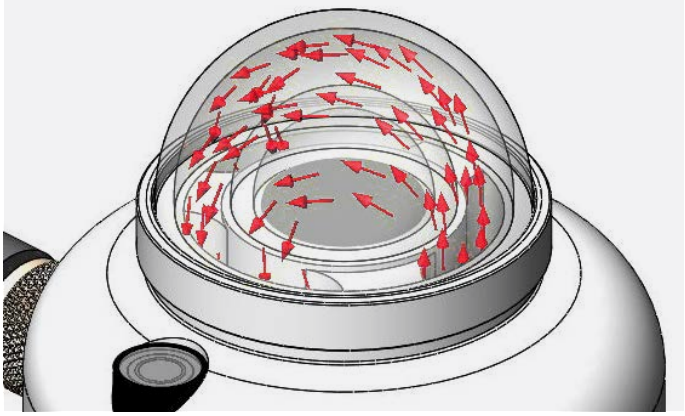

**Figure 2** How it's done: recirculating ventilation and heating between the inner- and outer dome is much more effective than traditional ventilation systems.

## SR300-D1: low cost of ownership

SR300-D1, with internal ventilation, is designed for low total cost of ownership. The cost of ownership is mainly determined by the costs of installation, on-site inspections, servicing and calibration:
– Low demand for infrastructure: SR300-D1's ventilation technology requires only 2.3 W power, compared to 12.8 W for traditional ventilation systems.
– No filter cleaning.
– Excellent surge protection reduces the risk of damage by lightning-induced surges.
– Best-in-class corrosion protection: SR300-D1 has no bolts for mounting through the housing.
– Reduction of unnecessary on-site inspections by remote diagnostics.
– Designed for efficient servicing; easy local diagnostics. Surge protection board can be replaced at local service centers.

**Figure 3** Outdated solution: example of an externally ventilated pyranometer, here in use for PV system performance monitoring.

## SR300-D1: best-in-class corrosion resistance

For mounting, SR300-D1 requires no bolts through the housing. Most competing pyranometers do have bolts through the housing. This typically is the weakest point for corrosion, because stainless steel bolts in contact with an aluminum body cause galvanic corrosion.

## In detail: improving measurement accuracy by dew and frost mitigation

Figures 5 and 6 show why IEC requires dew and frost mitigation. Dew and frost are among the most significant sources of error.

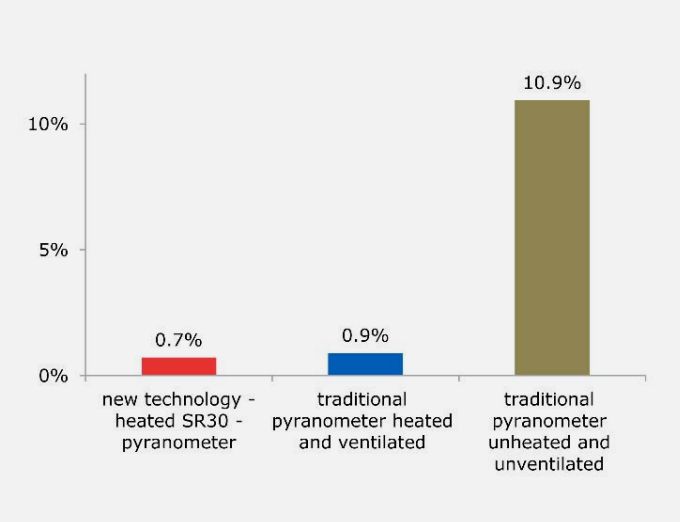


**Figure 5** Improving data availability by heating and ventilation. On the vertical axis: unreliable data in % of the total time. At our outdoor test facility, we analyzed the data availability with an outdoor camera. We manually marked the moments that the pyranometer was covered with dew or frost. In autumn season, with a traditional unheated and unventilated pyranometer (brown on the right), about 10 % of the time the data was not available. Because this was mainly in the early morning, this 10 % of time represented around 3 % of the total solar energy. With traditional external ventilation, the performance was much better, in blue around 1 %. With an SR30 pyranometer, equivalent to SR300-D1, with internal ventilation, in red, the performance is as good as with external ventilation.


**Figure 4** SR300-D1 with optional spring-loaded levelling and tube mount. LM01 levelling mount (one part), TLM01 tube mounted (2 parts). Spring-loaded levelling is a major time-saver during installation.

**Figure 6** Frost and dew deposition: clear difference between a non-heated pyranometer (back) and the heated SR300-D1.

## In detail: does external ventilation prevent pyranometer domes from getting soiled?

No. Contrary to popular belief, external ventilation has never been designed to mitigate soiling. Here in Figure 7, you can see the dome of a ventilated pyranometer in China. External ventilation was designed for scientific use, in which daily inspection is possible. In PV monitoring the inspection is weekly. In that case, if the atmosphere contains dust, the filter (see Figure 8) gets clogged, the air stops flowing and the ventilation is no longer effective.

**Figure 7** Dusty dome of an externally ventilated pyranometer.


**Figure 8** Pyranometer external ventilation systems have an air filter (item 3) to prevent dust from entering the ventilator's moving parts. In case there is dust in the air, the filter needs to be replaced or cleaned frequently.


**Figure 9** Saving money on infrastructure. SR300-D1 uses a lot less power than pyranometers with external ventilation systems and is lighter as well. Users save money on power supply, backup batteries, cabling, and mechanical mounting structures.

**Table 1** Comparison table SR300-D1 to pyranometers with external ventilation such as SR20 with VU01.

| | **SR300-D1 with internal ventilation** | **Pyranometer with external ventilation** |
|---|---|---|
| purpose | PV system performance monitoring | scientific experiments |
| compliance | with IEC 61724-1 | with IEC 61724-1 |
| recommended maintenance | weekly for dome cleaning | weekly for dome cleaning, when in dirty environments more frequently for air filter cleaning |
| purchase cost | | typically 20 % higher |
| infrastructure cost electrical | requires around 3 W, can be reduced remotely through RS485 commands.<br><br>cost savings on power supply, cabling, backup batteries | requires around 10 W |
| infrastructure cost mechanical | 0.6 kg pyranometer<br>cost savings on mounting structure | 1 kg ventilator + 0.6 kg pyranometer, large footprint |
| corrosion resistance | SR300-D1's internal ventilation is recycling air internally, so that the ventilator is not exposed to any outside moisture or corrosive salts and chemicals.<br><br>SR300-D1's structure does not need bolts through the housing. Only using bolts from below, mitigates galvanic corrosion. | The ventilators have rotating parts and contain electronic boards. These are protected against moisture but not specified as "corrosion resistant". |
| operation in dirty environments | no problem | Air filter tends to get clogged. |

## About Hukx

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