SR30 environmental impact analysis

Comparison with externally ventilated conventional pyranometers

We analysed the environmental impact of SR30 pyranometer by comparison with its nearest competitor, an externally ventilated and heated pyranometer, also classified as ISO 9060 Class A. We took model SR20 with ventilation unit VU01 to compare with SR30. The outcome: SR30's environmental impact is three times lower due to lower energy consumption and smaller transport volume!

Introduction

In general, customers show an increasing concern in the environmental impact of the products they use; so do users of pyranometers. Here is an example of our analysis of the impact of Hukseflux SR30 pyranometer.

Figure 1 shows the impact comparison between SR30 Class A pyranometer and SR20 Class A pyranometer with external ventilation (VU01). The SR30 environmental impact is three times lower compared to the SR20 with a VU01.

For analysis, we used "Eco-costs"; Box 1 and the following paragraphs explain the analysis.

BOX 1

ECO-COSTS

For analysis we use "Eco-costs"; a measure to express the amount of environmental burden of a product on the basis of prevention of that burden. They are the costs which should be made to compensate for the environmental pollution and materials depletion in our world to a level which is in line with the carrying capacity of our earth.

For example: for each 1000 kg CO_2 emission, one should invest EUR 116 in offshore windmill parks (and the other CO_2 reduction systems at that price or less). In short: "the eco-costs of 1000 kg CO_2 are EUR 116".
(text reference ecocostsvalue website DEC 2019)

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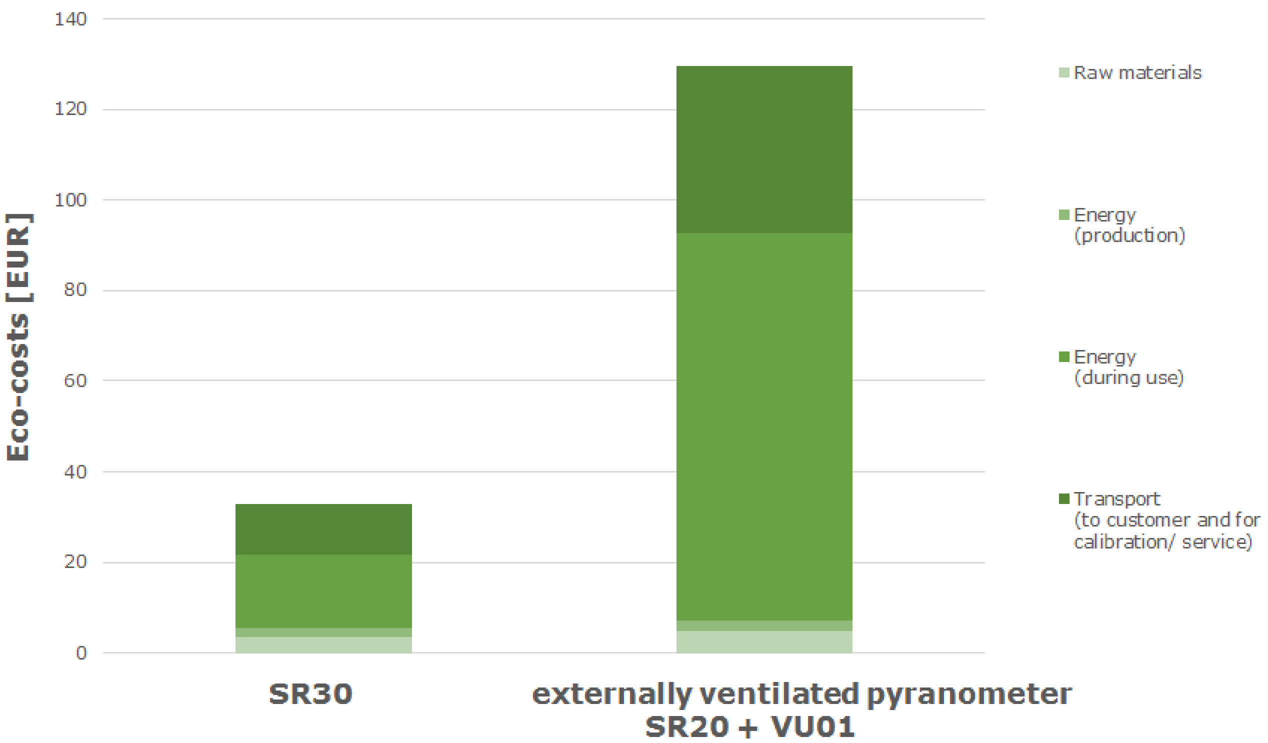
Figure 1 (below) *Eco-costs comparison over a 10-year lifetime between SR30 and its nearest alternative: SR20 with VU01 ventilation unit.*



Analysis

We studied the environmental impact of our model SR30 heated spectrally flat Class A pyranometer and compared it with the nearest competitor, an externally ventilated pyranometer, in this case model SR20. Both are offering a solution to mitigate dew and frost.

For analysis we use the "Eco-costs" methodology; see Box 1.

The main outcome is that for the environmental impact, the dominant factors are energy during use and transport. SR30 has a significantly lower impact due to lower power consumption during use and lower transport volumes.

Assumptions

We have used the following assumptions:

- 10-year product lifetime
- re-calibration every 2 years (4 times over its lifetime)
- ventilator servicing every 4 years
- continuous use of ventilator and heating

SR30 versus SR20 + VU01

The differences between SR30 and the SR20+ VU01 combination are in power consumption during use, and transport volume:

- 2.3 W versus 12.8 W
- 1 transport box versus 2 transport boxes

BOX 1

ECO-COSTS

Want to know more?:

http://www.ecocostsvalue.com

The Eco-costs website offers free of charge datasets. Analysis is based on the datasets available in NOV 2019.

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

Figure 2 *SR30 digital spectrally flat Class A pyranometer with internal ventilation, heating and tilt sensor is compared with an SR20 analogue spectrally flat Class A pyranometer equipped with a VU01 external ventilation unit.*

New: SR30-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 6.

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 low power because the heat is recirculated; 2 W consumption is normal
- requires replacement of the ventilator after > 5 year

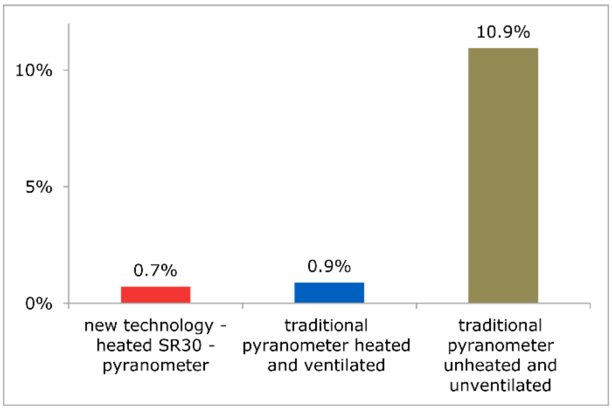


Figure 4 *Improving data availability by heating and ventilation. On the vertical axis: unreliable data in % of the total time. At our outdoor test facility, we analysed the data availability with an outdoor camera. We manually marked the moments that the pyranometer was covered with dew or frost. In autumn season, with a traditional 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 with internal ventilation, in red, the performance is as good as with external ventilation.*

BOX 2

WHY VENTILATE AND HEAT

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

Now it is also a requirement for Class A systems for PV system performance monitoring according to IEC 61724-1.

The purpose of the heating, according to IEC, is "to prevent accumulation of condensation and/or frozen precipitation", which is the main source of unreliable data in most climates. It is "required in locations where condensation and/or frozen precipitation would affect measurements on more than 7 days per year" for class A, and "more than 14 days per year" for class B.

Figure 4 shows what heating and ventilation do for data availability.

Figure 5 shows a practical situation.

Figure 5 *Frost and dew deposition: clear difference between a non-heated pyranometer (back) and the heated SR30.*

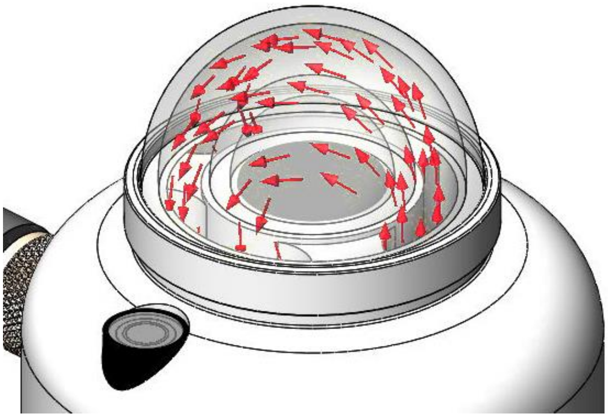


Figure 6 *How it's done: recirculating ventilation and heating between the inner- and outer dome is much more power efficient than traditional ventilation systems*

Low cost of ownership

Apart from Eco-costs: SR30 is designed for low cost of ownership, which is mainly determined by costs of installation, on-site inspections, servicing and calibration:

- low demand on infrastructure: SR30's RVH technology requires only 2.3 W power, compared to 12.8 W for traditional ventilation systems
- reduction of unnecessary on-site inspections by remote diagnostics
- designed for efficient servicing; easy local diagnostics.
- supported by an efficient calibration and maintenance organisation. Hukseflux offers local support in the main global economies: USA, EU, China, India, Japan and Brazil. Recalibration is recommended every 2 years, which is good practice in the industry.

Traditional external ventilation SR20 + VU01

The traditional solution is an external ventilation system as in Figure 3. Heated and ventilated air is blown over the pyranometer.

This ventilator:

- 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
- is not recommended for use in areas with high atmospheric dust loads such as deserts with regular sand storms; rotating parts of ventilators tend to get stuck and are not designed to be cleaned

Other pyranometers with external ventilation

The SR20 + VU01 combination has similar environmental impact as other such systems from competing manufacturers. There are however differences:

- we see power consumption of the main competing systems, with heater on, varying between 11 and 9 W, with fan power of 2 W.
- we see transport dimensions both larger and smaller than that of SR20 + VU01.

Conclusions

The analysis showed SR30 has three times less impact on the environment compared with the conventional SR20 with external ventilation (VU01).

SR30's impact during its lifecycle is mainly due to energy consumed during use and transport during calibration (70 %). SR20 + VU01's impact is 3 times higher due to higher energy consumption plus bigger transport volume. The total Eco-costs of one SR30 are around EUR 30 over a 10-year lifetime.

Suggestion for users to reduce Eco-costs:

- calibrate at a nearby calibration service provider
- switch heaters off whenever possible

About Hukseflux

Hukseflux Thermal Sensors offers measurement solutions for the most challenging applications. Our main area of expertise is measurement of heat transfer and thermal quantities such as solar radiation, heat flux and thermal conductivity. Hukseflux is ISO 9001 certified. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.