ARCAS

New assessment Methodology for social, sustainable and eco-friendly housing. Climate architecture for the Sudoe's area

CERTIFICATION GUIDEBOOK

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ROLES AND PROCEDURES

ARCAS – Arquitectura para el Clima (arcassudoe.eu)

2023

Version 0.1

Contact information
Arturo Gutiérrez de Terán Menéndez-Castañedo
Address: C/ Principado 11. 2° dcha. 33007 Oviedo (SPAIN)
E-mail: fecea@fecea.es

Web site: http://www.arcassudoe.eu/

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ARCAS - New assessment Methodology for social, sustainable and eco-friendly housing. Climate architecture for the Sudoe's area,

Certificacion Guide : Introduction to the ARCAS project (Publication version 0.1)

Title

ARCAS - New assessment Methodology for social, sustainable and eco-friendly housing. Climate architecture for the Sudoe's area, Certification guidebook : Roles and procedures (version 0.1)

Abstract

ARCAS focuses on the Sudoe's climatology and offers an instrument, based on key indicators, to allow the design of buildings, which maximize the energy efficiency and the air quality and promote the social well-being thanks to the use of the best available techniques.

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IV – Certification guidebook

IV.1 – ARCAS Certification

The ARCAS tool is developed with the aim of providing:

- A common methodological framework
- A multi-criteria methodology thanks to the ARCAS tool
- A link between Certifier and User

IV.1.1 – This guidebook is for…

All technicians involved in the design, execution and maintenance of buildings, mainly architects, engineers, technical architects.

IV.1.2 – How to obtain the ARCAS Certification?

The steps to follow to obtain the ARCAS building certification are:

1.- To know the initial state of the building. To do so, the measured or calculated values must be introduced into the ARCAS tool; for the ARCAS certification of the building the option to estimate the required values is not valid. These values can be measured on site in the building or calculated using accredited programs.

2.-Knowing the initial state of the building, the technician responsible for the rehabilitation drafts the project with the proposed measures. In the project and according to the three axes of the ARCAS tool, the values that the building will obtain once the rehabilitation has been carried out will be calculated. Precertification is obtained in the ARCAS tool, which will allow access to possible grants, financing, etc.

3.-Executed the works according to the drafted project, the building is monitored to measure the indicators that define the 3 ARCAS axes. After a period -to be defined- of monitoring the useful life of the renovated building according to the ARCAS tool, the final certification is obtained.

IV.2 – Role of actors in the certification process

The certification process may involve:

Final customer: that can be a community of owners or public administration as owner of the building. They will be the beneficiaries of energy improvements in the certified building.

Competent technicians: they write the rehabilitation project, make the study of the building in its initial state, supervise the works, issue the final certificate of work.

General Government: Grants or grants with the ARCAS Pre-Certification.

Certification authority: Checks and keeps the documentation sent by the technicians. They issue the ARCAS certificate. They provide training for technicians to use the ARCAS tool.

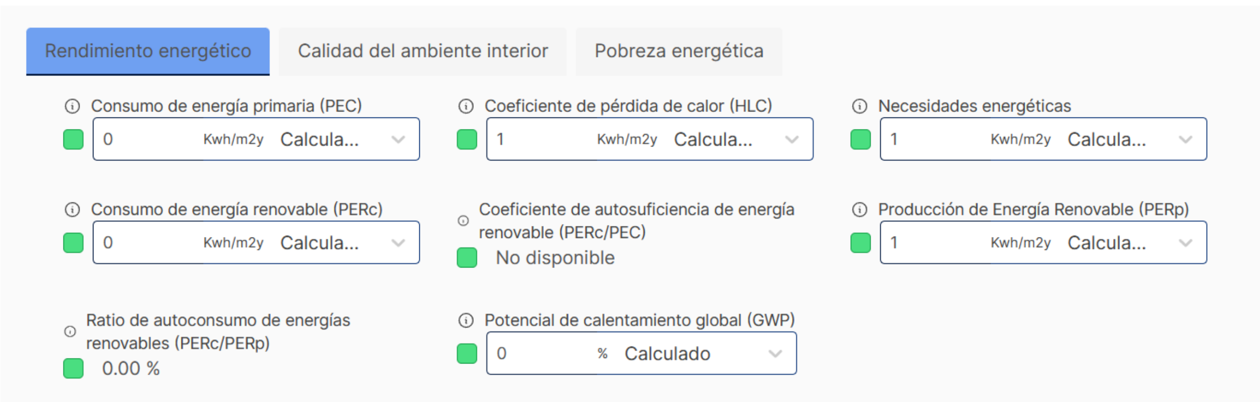
IV.3 – Steps to obtain the certification

STEP 1.- Initial status report of the building. –

To make the report of the building in its current state, all indicators must be measured with calibrated and characterized equipment in Annex or calculated with a tool accredited in ARCAS.

- AXIS 1: Energy efficiency. -

To define the energy efficiency of the building, 8 indicators are considered:



1.1.- Primary energy consumption. PEC. -

Total primary energy consumption of the building due to heating, cooling, domestic hot water, lighting and auxiliary services, obtained by direct measurement methods.

Unit: kWh/m^2. year

Limit: -&, &

1.2.- Heat Loss Coefficient. HLC. –

Total thermal losses of the building through the envelope (including thermal bridges and total air change) per unit of the temperature difference between indoor and outdoor temperatures, obtained by direct measurement methods.

Unit: kWh/m^2. year

Limit: 0, &

1.3.- Energy needs. –

Heat to be delivered to or extracted from a thermally conditioned space to maintain the intended space temperature conditions during a given period of time, obtained by means of the Energy Efficiency Certificate.

Unit: kWh/m^2. year

Limit: -&, &

1.4.- Renewable energy consumption. PERc. –

Description of the renewable energy consumption.

Unit: kWh/m^2. year

Limit: 0, &

1.5.- Renewable energy self-sufficiency ratio. PERc/ PEC. -

Ratio between the renewable energy consumption and total primary energy consumption (PER_C/PE_C), obtained by direct measurement methods.

Unit: %

Limit: 0, 100

1.6.- Energy renewable production. PERp. –

Description of the energy renewable production.

Unit: kWh/m^2. year

Limit: 0, &

1.7.- Renewable energy self-consumption ratio. PERc/PERp. –

Ratio between the renewable energy consumption and renewable energy production of the building, obtained by direct measurement methods.

Unit: %

Limit: 0, 100

1.8.- Global Warming Potential. GWP. –

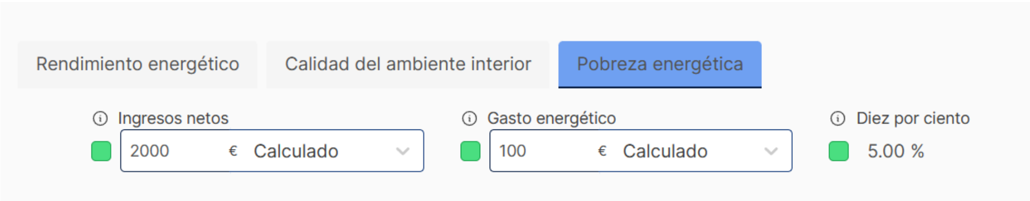
Reduction of the carbon footprint of the building achieved with its reform, obtained following the corresponding methodology. This value may be negative because the indicator may worsen the initial situation.

Unit: %

Limit: 0, 100

- AXIS 2: Energy Poverty. -

Defined as allocating more than 10 per cent of current net household income to the energy payment of housing.



These two indicators must be defined:

2.1.- Net incomes. –

The sum of the net annual income of the household is considered. The amount to be received after the payment of taxes and social insurance.

Unit: €

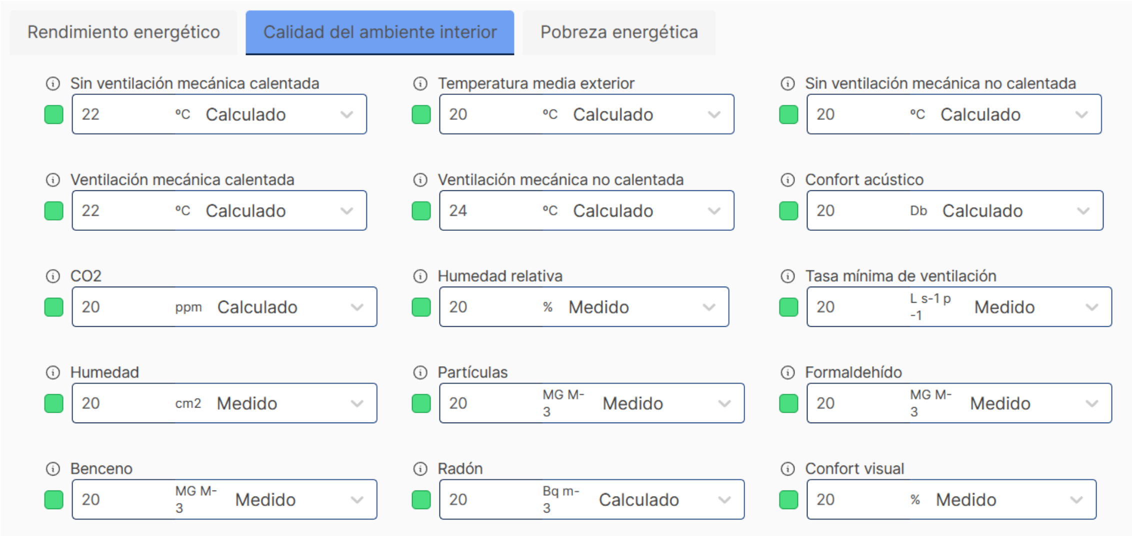
2.2.- Energy expenditure. –

Annual energy expenditure related to the energy needs of households.

Unit: €

- AXIS 3: Indoor Environment Quality. –

This Axis is defined by considering the following indicators:



3.1.- Thermal environment

Comfort temperature is defined according ventilation strategy and outdoor temperature.

- No mechanical ventilation heated.

Description of the mechanical ventilation heated.

Unit: ºC

Limit: -&, &

- No mechanical ventilation no heated.

Description of the no mechanical ventilation no heated.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: ºC

Limit: -&, &

- Mechanical ventilation heated. –

Description of the mechanical ventilation heated.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: ºC

Limit: -&, &

- Mechanical ventilation no heated. –

Description of the mechanical ventilation no heated.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: ºC

Limit: -&, &

- Average outdoor temperature. –

Description of the average outdoor temperature.

According to the **ARCAS Climate and Air Quality Map**.

Unit: ºC

Limit: 0, &

3.6.- Acoustic comfort. –

Description of the acoustic comfort.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: dB

Limit: 0, &

3.7.- CO_2 level. –

Description of the CO_2 level.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: ppm

Limit: 0, &

3.8.- Relative humidity. –

Description of the relative humidity.

According to the **ARCAS Climate and Air Quality Map**.

Unit: %

Limit: 0, 100

3.9.- Minimum ventilation rate. –

Description of the minimum ventilation rate.

Calculated according to applicable regulations

Unit: L/p.s

Limit: -&, &

3.10.- Humidity. –

Description of the humidity.

According to the **ARCAS Climate and Air Quality Map**.

Unit: cm^2

Limit: 0, &

3.11.- Particles. –

Description of the particles floating in the air.

According to the **ARCAS Climate and Air Quality Map**.

Unit: μg/m^3

Limit: 0, &

3.12.- Benzene. –

Description of the presence of benzene in the air.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: μg/m^3

Limit: 0, &

3.13.- Radon. –

Description of the presence of radon in the air.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: Bq/m^3

Limit: 0, &

3.14.- Visual confort. –

Percentage of time with illuminance between 300 and 500 lux at desk height.

Obtained by direct measurement methods with standard calibrated equipment.

Unit: %

Limit: 0, 100.

Step 2.- Project proposal for energy rehabilitation of the building.-

The rehabilitation project of the building will include a report of improvements according to the tool ARCAS, indicating the state of the building once the works are finished.

The Pre- Certificate is issued in ARCAS.

Step 3. –End of work Certificate. -

Once the works are finished, the competent technician issues the Certificate of Completion. The technician will record and custody all the technical sheets of the materials placed on the building, as well as the photos of execution and placement of these materials on the building, where material thicknesses, technical characteristics, correlation with the projected constructive detail, etc. can be checked.

Step 4. – Building monitoring. -

With the launching of the rehabilitated building, the building is monitored, calculating, or characterizing each of the indicators of the three AXIS, with the same equipment and calculation tools used in the initial stage.

After one year of monitoring, if the results coincide with those reflected in the improvement measures report with the ARCAS tool, the certification authority issues the ARCAS certificate.

IV.4 – Rules and performance index. -

- AXIS 1: Energy efficency. -

When considering each indicator in the ARCAS tool, 4 categories have been established, with category IV being the worst and category I the best. Specifically for the proposed indicators in the field of energy efficiency, the ranges within each category are shown below.

TABLE 1 – ENERGY EFFICIENCY INDICATORS CATEGORIES

Category	I	II	III	IV
PE_C [kWh/m²·y]	< 85	[85, 125)	[125,165)	[165,205)
Energy needs [kWh/m²·y]	< 18	[18, 50)	[50, 85)	[85, 115)
PER_C/PE_C [%]	≥ 60	[40, 60)	[20, 40)	[0, 20)
PER_C/PER_P) [%]	< 40	[40, 60)	[60, 80)	[80, 100)
HLC [W/m²·K]	< 2.4	[2.4, 3.1)	[3.1, 4.0)	[4.0, 4.7)
GWP [%]	≥ 30	[20, 30)	[10, 20)	[0, 10)

- AXIS 2: Energy poverty. -

Considering that the energy poverty indicator selected for the project predicts that the ratio between net income and energy expenditure should not exceed 10%, this is the limit and the optimal value of Category I. This and the following categories can be seen in Table .

TABLE 2 – 10% INDICATOR CATEGORIES

Category	I	II	III	IV
10% indicator	≤ 10%	(10%, 15%]	(15%,20%]	> 20%

- AXIS 3: Indoor air quality. –

➢ Thermal Environment

For this section we note the temperature inside the different rooms of the dwelling. Temperatures are measured over a week or so. Then we are careful if the housing is in a heating period or not.

The ranges of the indoor air temperature are determined according to the standard EN 16798 for residential buildings in living spaces. Compared to TAIL for offices and hotels, the ranges for dwellings during the heating season have been changed.

Table 3 – Ranges of the indoor air temperature

Quality of the thermal environment (T)	Buildings with mechanical cooling		Buildings without mechanical cooling	
	Heating season[1]	Non-heating[2] (cooling) season	Heating season[1]	Non-heating[3,4] (cooling season)
Green	23±2 ºC	24.5±1 ºC	23±2 ºC	upper limit $0.33\Theta_{rm}+18.8+2$ °C lower limit $0.33\Theta_{rm}+18.8-3$ °C
Yellow	22.5±2.5 ºC	24.5±1.5 ºC	22.5±2.5 ºC	upper limit $0.33\Theta_{rm}+18.8+3$ °C lower limit $0.33\Theta_{rm}+18.8-4$ °C
Orange	21.5±3.5 ºC	24.5±2.5 ºC	21.5±3.5 ºC	upper limit $0.33\Theta_{rm}+18.8+4$ °C lower limit $0.33\Theta_{rm}+18.8-5$ °C
Red	If other quality levels cannot be achieved		If other quality levels cannot be achieved	

[1] Assuming clo 1.0, sedentary activity and RH=50%

[2] Assuming clo = 0.5, sedentary activity and RH=50%

[3] Summer and shoulder seasons; Θrm is running mean outdoor temperature that can be calculated as follows : $\Theta rm = (1-\alpha) \{ \Theta_{ed-1} + \alpha\ \Theta_{ed-2} + \alpha 2\ \Theta_{ed-3} \}$

where:

Θrm = outdoor running mean temperature for the considered day (°C)

Θ_{ed-1} = daily mean outdoor air temperature for the previous day α = constant between 0 and 1 (recommended value is 0.8)

Θ_{ed-i} = daily mean outdoor air temperature for the i-th previous day

Alternatively, using the following approximate formula (when records of daily running mean outdoor temperature are not available):

$Qm = (Q_{ed-1} + 0.8\ Q_{ed-2} + 0.6\ Q_{ed-3} + 0.5\ Q_{ed-4} + 0.4\ Q_{ed-5} + 0.3\ Q_{ed-6} + 0.2\ Q_{ed-7})/3.8$

[4] Daily mean outdoor air temperature for previous day obtained from measurements or the nearby meteorological station

➢ Acoustic Environment

Acoustic comfort is a very important element in buildings, indeed too much exposure to noise can lead to irreversible sequelae (deafness, tinnitus, hyperacusis ...).

For this we will carry out a measurement of the indoor ambiant noise as well as the external ambient noise. The sound level will be measured for each frequency band (from 63 to 8000 Hz). This will then allow us to calculate the overall isolation of the building from the outside.

The categories are as follows:

Table 4– Ranges of the sound pressure level

Quality of the acoustic environment (A)	Living-room, daytime	Bedroom, nighttime
Green	≤ 30 dB(A)	≤ 25 dB(A)
Yellow	≤ 35 dB(A)	≤ 30 dB(A)
Orange	≤ 40 dB(A)	≤ 35 dB(A)
Red	If other quality levels cannot be achieved	If other quality levels cannot be achieved

➢ Indoor Air Quality

Indoor Air Quality is an essential element for the occupants of the building, it depends on many criteria :

- CO_2 Concentration
- Relative Humidity
- Ventilation flow
- The presence of mold
- VOC Concentration
- Particulate matter concentration ($PM_{2.5}$)

Compared to TAIL for offices and hotels, the ranges of ventilation rate have been changed using the default design ventilation air flow rates for residential buildings according to EN 16798, while the ranges of the other IAQ indicators have not been changed. Concerning the relative humidity, the ranges for dwellings are consistent with those for hotels to reduce the risks of house dust mites. Concerning the carbon dioxide, the living-room and bedroom have different ranges.

Table 5 – Ranges of the indoor air quality indicators

Quality of indoor air quality (I)	Green	Yellow	Orange	Red
Carbon dioxide (concentration above outdoors)[1,2]	≤ 550 ppm (living-room) ≤ 380 ppm (bedroom)	≤ 800 ppm (living-room) ≤ 550 ppm (bedroom)	≤ 1350 ppm (living- room) ≤ 950 ppm (bedroom)	If other quality levels cannot be achieved
Ventilation rate[3,7]	ACH ≥ 0.7 h^{-1}	ACH ≥0.6 h^{-1}	ACH ≥ 0.5 h^{-1}	If other quality levels cannot be achieved
Relative humidity[2,4,5]	≥ 30% and ≤ 50%	≥ 25% and ≤ 60%	≥ 20% and ≤ 60%	If other quality levels cannot be achieved
Visible mold[6,7]	No visible mold	Minor moisture damage, minor areas with visible mold (< 400 cm^2)	Damaged interior structural component, larger areas with visible mold (< 2500 cm^2)	Large areas with visible mold ≥2500 cm^2)

Benzene[7]	< 2 µg/m³	≥ 2 µg/m³	no criteria	≥ 5 µg/m³
Formaldehyde[7]	< 30 µg/m³	≥ 30 µg/m³	no criteria	≥ 100 µg/m³
Particles $PM_{2.5}$ (gravimetric)[7]	< 10 µg/m³	≥ 10 µg/m³	no criteria	≥ 25 µg/m³
Particles $PM_{2.5}$ (optical)[7]	< 10 µg/m³	≥ 10 µg/m³	no criteria	≥ 25 µg/m³
Radon[7]	< 100 Bq/m³	≥ 100 Bq/m³	no criteria	≥ 300 Bq/m³

[1] Outdoor CO_2 should be measured or assumed using https://www.co2.earth/.

[2] To be classified in each quality level, the measurements shall not exceed the range defined by the indicated quality level and the subsequent quality level by no more than 5% of the time, and the range defined by the subsequent quality level and the next lower quality level by no more than 1% of the time.

[3] Criteria based on pre-defined supply ventilation air flow rates for residential buildings according to EN 16798-1, assuming that air is supplied in living rooms and extracted from wet rooms.

[4] The levels match EN 16798-1 regarding humidification requirements.

[5] The higher levels selected to avoid house dust mite infestation (survival and reproduction).

[6] According to the Nordic classification system and Level(s); observations in the instrumented rooms should be supplemented by locations where the risk of mold is likely (e.g., using simulations of surface relative humidity).

[7] The permissible levels that cannot be exceeded.

➢ Luminous environment

For the well-being of users, it is necessary to ensure a good natural illumination of the housing, too low lighting will result in the use of artificial lighting and therefore an additional energy consumption. While too much illumination will create glare.

In addition, beyond the optimization of the illumination there will also be elements to take into account such as the orientation of the building, the inclination of the windows, the type of glazing, the presence of cap or side cheeks, the arrangement of the furniture inside, etc.

In our case we will be mainly interested in the percentage of time where the illumination is located in a given value range. In our case it will be between 300 and 500 lux during the day and 100 lux during night.

Table 6. Ranges of the visual environmental indicators

Quality of the luminous environment (L)	Daytime		Nighttime
	Daylight factor[1]	% of the time with measured illuminance between 300 and 500 Lux[2]	% of the time measured with≥100 Lux[3]
Green	≥5.0%	≥60% and ≤100%	0 %
Yellow	≥3.3%	≥40% and <60%	>0 % to ≤50 %
Orange	≥2.0%	≥10% and <40%	>50 % to ≤90 %
Red	If other quality levels cannot be achieved	If other quality levels cannot be achieved	If other quality levels cannot be achieved

[1] The lowest daylight factor to reach respectively ≥750 Lux, ≥500 Lux, ≥300 Lux and ≥100 Lux, according to EN 17037 for Brussel.

[2] Following the requirements of the HQE green building certification scheme (HQE, 2019).

[3] Following the requirements of CASBEE (2014); CASBEE requirement is only for the illuminance level and not for the frequency of occurrence.

IV.5 – Evaluation methods and communication rules

The communication with the certification authority will be done through the web, according to the following communication protocol:

Documents will be sent by e-mail in. pdf format to the following email address: certificacionarcas@fecea.org

PHASE 1.- Includes steps 1 and 2 of the certification process. The initial report issued by the ARCAS tool will be sent as well as the ARCAS characterization report of the project to be developed. Documentation to be provided in pdf format:

- Initial ARCAS report.
- ARCAS Report with the execution project measures.

After checking the data of these certificates by the certification authority, this will issue the ARCAS Pre-Certified.

PHASE 2.- Includes steps 3 and 4 of the certification process. Once the works have been completed and after a year of monitoring, the certificate of completion will be sent to the certification authority, as well as all the technical data sheets of the materials and photos of their execution and commissioning. The measurement reports for each indicator will also be sent.

Documentation to be provided one year after the end of the works:

- Certificate of completion
- Technical data sheets for materials placed on the building
- Inform with photos of the process of execution and commissioning of materials.
- Report with measurements of all indicators during the past year.

Once the documentation provided has been verified and the measurement report data has been reviewed, the certification authority will issue the ARCAS Certificate.

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ANNEX 1

CONFORT METERS		**SUPPLY**	**TEMPERATURE RANGE**	**ACCURACY**	**RH RANGE**	**ACC.**	**CO2 RANGE [ppm]**	**ACC. [ppm]**	**COMMUNICATION PROTOCOL**
MET	t6540	9 - 30 VDC	-30 - 80 ºC	± 0.6 ºC	5 - 95%	± 2.5%	0 - 2000 ppm	±50	Modbus, XML, WWW, SNMPv1, SOAP
ARCUS	SK-08-CO2-TF	21 - 32 VDC	-10 - 55 ºC	± 0.5 ºC	10 - 90%	± 3%	0 - 5000 ppm	± 20	KNX bus
PressacSensing	60. CO2 SLR TMP HUM	3,6 V	0 - 51 ºC	± 0.5 ºC	0 - 100%	± 5%	0 - 2550 ppm	± 125	Enocean protocol
VAISALA	GMW95RD	18 - 35 VDC, 24 VAC	-5 - 55 ºC	± 0.5 ºC	0 - 95%	± 0.5%	0 - 5000 ppm	± 30	RS-485 (BACnet, Modbus)
Schneider Electric	SED-CO2-G-5054	3,6 V	0 - 50 ºC	± 0.3 ºC	0 - 100%	± 3%	0 - 5000 ppm	± 60	Zigbee
NibbleWave	Triple MODBUS CO2…	24 VDC (7-28 VDC)	-20 - 50 ºC	± 0.3 ºC	1 - 100%	± 3%	400 - 4000 ppm	± 20	ModBus RTU

CALORIMETERS		SUPPLY	COMMUNICATION PROTOCOL	TEMPERATURE RANGE	NOMINAL DIAMETER	DATA LOGGER	DOWNLOAD
B METERS	HYDROCAL-M3	Battery	M-Bus (integrated), wireless M-Bus	5 / 90 °C	DN15, DN20	-	In-situ
	HYDROSONIS-ULC	Battery	M-bus, wireless M-Bus	5 / 105 °C	DN15, DN20	24 m, every 15 days	In-situ
	HYDROSPLIT-M3	Battery /Power	M-Bus (integrated), wireless M-Bus	5 / 180 °C	> DN20	-	In-situ
ARMATEC	AT 7500 F	Battery, 230 VAC (opt.)	M-Bus, pulse output	1 / 180 °C	DN15, DN20,…,DN100	-	In-situ
	AT 7505	Battery, 230 VAC (opt.)	M-Bus, pulse output	- 20 / 130 °C	DN15, DN20,…,DN100	-	In-situ
KAMSTRUP	MULTICAL 302	Battery (3.6 VDC) - (230 VAC)	M-Bus (integrated), wireless M-Bus	2 / 150 °C	DN15, DN20	960h, 460d, 36m, 15y	In-situ
	MULTICAL 403	Battery (3.6 VDC) - (230 VAC)	M-bus, wireless M-Bus, RS232	2 / 180 °C	DN25, DN40, DN 50	1400h, 460d, 36m, 20y	In-situ
	MULTICAL 603	Battery (3,6 VDC) - (230 VAC)	M-Bus, wireless M-Bus	2 / 180 °C	-	-	In-situ

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DIEHL	SHARKY 775	3.6 VDC, 24 VAC, 230 VAC	M-Bus, RS 232, RS 485, Modbus RTU RS485, pulse output	5 / 130 °C	DN15, DN20	Daily, monthly, yearly	Online
	SHARKY 774	3.6 VDC 2*AA Cell	M-Bus, wireless M-bus	5 / 105 °C	DN15, DN20	720d, 120m	Online/In-situ

POWER METERS		SUPPLY	COMMMUNICATION PROTOCOL
ABB	EM/S 3.16.1	21 - 30 V CC	KNX
Schneider Electric	Zelio Logic Serie Sr2/Sr3	12 - 24 V DC	Modbus, Ethernet
	iEM 3150	Auto	RS485
	PM 800 series		RS485
(Electro Industries/GaugeTech	Shark 100		RS485
Siemens	SENTRON 7KM PAC2200	Auto	M-bus

PYRANOMETERS		SUPPLY	RADIATION RANGE	SPECTRAL RANGE	TEMPERATURE RANGE	COMMUNICATION PROTOCOL
ARCUS	SK-08 GLBS-MES	21 - 32 VDC	0 - 1800 W/m^2	400 - 1100 nm	-40 - 65 ºC	KNX Bus

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APOGEE	SP-420	5V	0 - 2000 W/m^2	360 - 1120 nm	-40 - 70 ºC	USB
	SP-421-SS	5,5 - 24 V DC	0 - 2000 W/m^2	360 - 1120 nm	-40 - 70 ºC	SDI-12
	SP-422-SS	5,5 - 24 V DC	0 - 2000 W/m^2	360 - 1120 nm	-40 - 70 ºC	Modbus
KIPP & ZONNEN	SP Lite 2	-	0 - 2000 W/m^2	400 - 1100 nm	-40 - 80 °C	-
	SMP3	5 - 30 V DC	0 - 2000 W/m^2	300 - 2800 nm	-40 - 80 °C	RS-485
	CMP3	-	0 - 2000 W/m^2	300 - 2800 nm	-40 - 80 °C	-
	SMP22	5 - 30 V DC	0 - 2000 W/m^2	200 - 3600 nm	-40 - 80 °C	RS-485
EKO	MS-80S	5 - 30 V DC	0 - 4000 W/m^2	285 - 3000 nm	-40 - 80 °C	Modbus 485 RTU, SDI-12, 4-20mA…
	MS-80M	12 - 24 V DC	0 - 4000 W/m^2	285 - 3000 nm	-40 - 80 °C	Modbus RTU
	MS-60S	5 - 30 V DC	0 - 2000 W/m^2	285 - 3000 nm	-40 - 80 °C	Modbus 485 RTU, SDI-12, 4-20mA…
	MS-60M	12 - 24 V DC	0 - 2000 W/m^2	285 - 3000 nm	-40 - 80 °C	Modbus RTU

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