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Microsensors Challenge 2019

January 2020

Last revision: 07/02/2020

Microsensors Challenge 2019: announcement of the results

***Paris, January 21, 2020* - the winners of the «2019 Microsensors Challenge» were rewarded by Airlab partners at the end of the international workshop on teachings and challenges related to microsensors measuring the air quality organized by Airparif and the AFD. This new international edition has allowed willing manufacturers to have their solutions evaluated by using Airparif's know-how and an independent evaluation composed by a jury of French and international experts. It thus makes it possible to enlighten the potential users regarding the adequacy and the performances of the product with respect to the intended uses.**

The rise of connected sensors for air quality monitoring

More and more experimental and innovative projects are developing around miniaturized air quality sensors, aimed at equipping cities, buildings, vehicles and citizens. However, there is currently no regulation for these technologies, which represent a market in full development and which arouse the interest of the various stakeholders: authorities, citizens, NGOs, economic actors... whatever the continents. What are the performances of these **devices according to the uses? How do their performances evolve over time? What have been the technological evolutions since the last edition of the challenge?** The objective of this initiative is to highlight innovations while providing information and choice criteria for users according to their needs in relation to these new technologies.

For the AFD, these questions are omnipresent in many of the emerging and developing countries where it supports the authorities. In these countries, there are often very significant levels of pollution, an incomplete or nonexistent monitoring system, and limited technical and financial resources: the stakes are high around these measurement devices, which form the basis of public policies for the improvement of air quality.

34 Microsensors screened by the teams of Airparif for 4 months, under the aegis of an international jury

At the end of a selection phase, the **34 sensors were made available by the voluntary manufacturers, half of which were foreign companies. These evaluations covered 44 parameters on average, 15 pollutants were studied, and this during 4 months in the Paris region (in a metrology laboratory, on mobility in vehicles and on people, as well as on Airparif stations). This represents more than 50 million processed data.**

These tests were conducted under the aegis of an international jury composed of members of the first edition (Airparif, ATMO Auvergne-Rhône-Alpes, ATMO Grand Est, CSTB, EMPA, FIMEA, OQAI and VEOLIA), to which were added the French Development Agency, the World Meteorological Organization, Engie and EDF, the Network of Research Partners of the Île-de-France Region DIM QI², the Commission for Atomic Energy and Alternative Energies and two new Air monitoring associations: ATMO Hauts-de-France and ATMO Normandie. This 2019 edition has been financially supported by the French Development Agency, EDF, ENGIE, the Network of Research Partners of the Île-de-France Region DIM QI² and Véolia. An important technical support was provided by Bruitparif for the measurement of the noise level of the sensors and by the CSTB for evolving the indoor air

measurement tests.
Each sensor was competing for one or several uses (measurement in outdoor air or indoor air, fixed or mobile measurement, public awareness, etc.) and was evaluated according to five criteria: the accuracy of the measurement, the ergonomics, the relevance of the measured pollutants compared to the use, cost and suitability of the solution in the competing category (congestion, interoperability, handling, data management). The results are presented in the form of a star number ranging from 1 (lowest level) to 5 (highest performance).

The results of this 2019 edition: Four award-winning sensors of the 2019 Challenge

4 sensors marketed by 3 companies are at the top of the bill of this second edition and are the winners of this challenge with a result of 4.5 out of 5 stars:

- In the category «Indoor Air - Piloting (IA-P)”: **The E 4000NG sensor marketed by NanoSense (France)**
- In the category «Indoor Air - Monitoring (IA-M)”: **The E 5000RE sensor also marketed by NanoSense (France)**
- For all «Indoor Air» categories, whether it is monitoring, awareness or piloting: **AIRVISUAL PRO+ sensors marketed by IQAIR (Switzerland) and LASER EGG marketed by KAITERRA (China)**

An improvement of the proposed solutions compared to the 2018 edition

Overall, the results of the challenge reflect the differences in market maturity with fairly similar performances according to the categories of use, but with offers whose quality has increased in one year. As in 2018, the evaluation of these sensors shows that the best performing currently available solutions are for fixed indoor air sensors: both for air quality awareness uses, and for piloting and managing air

LAUREATE 2019
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MICROSENSORS
International Challenge
PARIS

MICROSENSORS CHALLENGE 2019

NanoSense
• E4000NG • E5000RE

IQAir
• AIRVISUAL PRO+

Kaiterra
• LASER EGG

*AIRLAB

quality inside a building, and this category, to which the winners of 2018 already belonged, has further progressed with the laureates getting 4.5 stars, compared to 4 stars in 2018.
Similarly, solutions intended for measuring for regulatory oversight, personal exposure assessment, or in mobility, have also improved in terms of measurement quality and the number of pollutants, but remain one level lower.

The 34 sensors tested during this second edition all have a satisfactory level of ergonomics and improved by more than 10% compared to the 2018 edition. Although the quality of the measurements varies from excellent (for carbon dioxide in indoor air) to unsatisfactory, with differences depending on the pollutants for the same sensor, a clear improvement has been observed in the accuracy which has increased on average by more than 30% on the 2019 edition. In addition, the jury points out that they have not observed a solution in major dysfunction this year, unlike the previous edition.

Possible improvements on measurement accuracy and the actual cost of solutions

While the technological maturity of these sensors works well in indoor air, developments are encouraging in outdoor air, but the technology is not yet ready to meet regulatory requirements. The solutions intended to measure for the purpose of regulatory monitoring of personal exposure assessment, or in mobility, remain indeed to be improved, notably on the quality of measurements and the number of pollutants monitored. The conclusions of the challenge, on this point, are in line with the work of the World Meteorological Organization, the World Health Organization and the United Nations Environment Program, for whom low-cost sensors are not a direct substitute for reference measurements, especially for regulatory issues, but they represent a complementary source of information, provided that an appropriate device is used[1].

Moreover, regarding the cost and contrary to expectations, the calculation of the overall cost (purchase and operation) over three years shows that all these solutions are not always «low cost» products with an amount ranging from nearly 200 euros to more than 17,000 euros. And there is also the question of their environmental impact, which has not been evaluated in the context of the challenge, given their lifespan (typically 1 year to 18 months).

In addition, these results are representative of the sensors tested but cannot necessarily be extrapolated to other batches, for which performance can differ. Similarly, apart from the laboratory assessment, these results were obtained with pollution levels which are those of a large European capital and the weather conditions of Île-de-France. In outdoor air, differences from these results may be observed in other areas of the globe with higher levels of pollution and higher temperature and humidity conditions. Before any installation of a device of this type, verification of proper operation comprising metrological tests is recommended.

Is the metrological criterion the only parameter to take into account when setting up a project based on these measurement devices? Experiments, of more or less large-scale, are developing in France and abroad and are presented within the framework of a workshop organized by the AFD and Airparif before the results of the Challenge. Beyond the individual metrological performance of the sensors (as assessed in the challenge for a given batch), these feedbacks point to other questions. The experimentation of Urban Lab, Paris&Co and the City of Paris, in partnership with AIRLAB, ADEME and the Caisse des Dépôts[2] highlights in particular the importance of «an evaluation of the effectiveness and sustainability of proposed solutions to move towards a responsible and sustainable purchase» and recommends arbitration according to an overall cost / benefit approach.

The evaluations freely available on www.airlab.solutions

All the sensor results are freely available on the AIRLAB website (www.airlab.solutions) in accordance with the Challenge rules so that each sensor potential user can clarify his choice according to the expected use of these technologies. These evaluations are available in English and French.

[1] Source: Low cost sensors for the measurement of atmospheric composition: overview of topic and future applications - World Meteorological Organization (WMO), World Health Organization (WHO), United Nations Environment Program (UNEP) - International Global Atmospheric Chemistry (IGAC), EMEP - May 2018.

[2] Program aimed at experimenting with the implementation of concrete projects to improve the quality of outdoor and indoor air, which are innovative and economically viable, mainly involving measurement with microsensors, and remediation. Results available online: https://www.parisandco.paris/Sitepage/Synthese-de-l-evaluation-Qualite-de-l-air - October 2019.

Results by category of use

The Challenge rules provided for 8 categories of use. The supply and maturity of sensors available on the market vary widely. The sensors registered for the challenge reflect this variety. Therefore, the categories with most candidate solutions are:

Outdoor Air (OA)

Monitoring (OA-M)
Awareness (OA-A)
Vehicular (OA-V)

Indoor Air (IA)

Monitoring (IA-M)
Awareness (IA-A)
Piloting (IA-P)

Citizen Air (CA)

Exposure (CA-E)
Awareness (CA-A)

The 8 categories of use grouped into 3 classes as a function of the application environment

- OA-M : Outdoor Air – Monitoring
- OA-A : Outdoor Air – Awareness raising
- IA-M : Indoor Air – Monitoring
- IA-A : Indoor Air – Awareness raising
- IA-P : Indoor Air – Piloting and managing air inside buildings

The sensor results for these categories are presented in the summary tables below.

Outdoor Air – Monitoring (OA-M)

brand	name	star-score
• 42 Factory	ATMOTRACK	★★★☆☆
• LoThoSoft	AVC2	★★★☆☆
• RUBIX S&I	WT1	★★★☆☆
• SIM Engineering	SIM-MONI	★★★☆☆
• ADDAIR	AQMesh	★★★⯪☆
• AGRISCOPE	PM-SCOPE	★★★⯪☆
• Airlabs	AIRNODE	★★★⯪☆
• Decentlab GmbH	Air Quality Station	★★★⯪☆
• Kunak Technologies	KUNAK AIR A-10	★★★⯪☆
• Pollutrack	Pollutrack	★★★⯪☆
• VAISALA SAS	AQT410	★★★⯪☆
• Airly	Airly	★★★★☆
• Clarity Movement Co.	Node-S	★★★★☆
• ECOMESURE	ECOMSMART	★★★★☆
• HabitatMap	AirBeam2	★★★★☆
• NanoSense	QAA-RE	★★★★☆

Outdoor Air – Awareness raising (OA-A)

brand	name	star-score
• Azimut-Monitoring	Greenbee Secteur	★★★☆☆
• Azimut-Monitoring	Greenbee Solaire	★★★⯪☆
• Clarity Movement Co.	Node-S	★★★⯪☆
• Decentlab GmbH	Air Quality Station	★★★⯪☆
• Pollutrack	Pollutrack	★★★⯪☆
• VAISALA SAS	AQT410	★★★⯪☆
• Airly	Airly	★★★★☆
• HabitatMap	AirBeam2	★★★★☆
• NanoSense	QAA-RE	★★★★☆

Indoor Air – Monitoring (IA-M)

brand	name	star-score
• ethera	NEMo XT	★★★⯪☆
• Decentlab GmbH	Indoor Ambiance Monitor	★★★★☆
• ECOMESURE	ECOMZEN	★★★★☆
• ethera	NEMo	★★★★☆
• HabitatMap	AirBeam2	★★★★☆
• inBiot Monitoring	MICA	★★★★☆
• meo air analytics	meo	★★★★☆
• NanoSense	E4000NG	★★★★☆
• RUBIX S&I	Rubix POD	★★★★☆
• IQAir	AirVisual Pro+	★★★★⯪
• kaiterra	Laser Egg	★★★★⯪
• NanoSense	EP5000RE	★★★★⯪

Indoor Air – Awareness raising (IA-A)

brand	name	star-score
• ZAACK	ZAACK QAI	★★★☆☆
• Azimut-Monitoring	Fireflies	★★★⯪☆
• Decentlab GmbH	Indoor Ambiance Monitor	★★★★☆
• HabitatMap	AirBeam2	★★★★☆
• inBiot Monitoring	MICA	★★★★☆
• meo air analytics	meo	★★★★☆
• NanoSense	E4000NG	★★★★☆
• NanoSense	EP5000RE	★★★★☆
• IQAir	AirVisual Pro+	★★★★⯪
• kaiterra	Laser Egg	★★★★⯪

Indoor Air – Piloting and managing air inside buildings (IA-P)

brand	name	star-score
• Azimut-Monitoring	Fireflies	★★★⯪☆
• ZAACK	ZAACK QAI	★★★⯪☆
• Decentlab GmbH	Indoor Ambiance Monitor	★★★★☆
• HabitatMap	AirBeam2	★★★★☆
• inBiot Monitoring	MICA	★★★★☆
• meo air analytics	meo	★★★★☆
• NanoSense	EP5000RE	★★★★☆
• IQAir	AirVisual Pro+	★★★★⯪
• kaiterra	Laser Egg	★★★★⯪
• NanoSense	E4000NG_P	★★★★⯪

Although the performance has improved for all categories of use, the difference remains important between sensors operating in indoor versus outdoor air. An essential reason for this difference lies in the higher complexity of the outdoor environment in terms of the variability of influencing parameters (temperature, humidity) and for particle measurements in terms of chemical composition and their structure.

Some solutions were evaluated on the categories: measuring the quality of outdoor air in mobility (with a vehicle), documenting personal exposure to pollution for the purposes of sanitary interpretations or raising awareness of the air quality encountered during your daily activities, for which the number of participants is much lower. The results are thus presented directly in the sensor evaluation sheets.

Results by pollutant

The Challenge tested around fifteen pollutants. The availability and maturity of these measures vary widely. For example, NO2 and PM2.5 are often included in microsensors intended for outdoor use, however the NO2 technology generally performs considerably better compared to that used for PM measurements (PM1, PM2.5, and PM10) for this type of environment. Ozone measurements, although generally using the same type of technology as for NO2 offers less consistent results, with some microsensors attaining similar performance as for NO2, while others greatly underperforming.

For indoor air, CO2 and PM2.5 are the most commonly targeted pollutants, with VOCs gaining more popularity this year. In terms of performance, the technologies for CO2 and PM measurements (PM1, PM2.5, and PM10) are very mature for the indoor settings, while VOC technology needs significant further improvement. This technological immaturity is an even more significant issue for the less commonly available formaldehyde measurements.

The most relevant and best-in-class pollutants, with only the ratings greater than 7 out of 10 are presented below:

In outdoor air (OA)

>> PM2.5

brand	name	score
• ADDAIR	AQMesh	7.8
• Airly	Airly	7.7
• Clarity Movement Co.	Node-S	7.2
• NanoSense	QAA-RE	7.2
• Pollutrack	Pollutrack	7.1
• 42 Factory	ATMOTRACK	7.1
• AGRISCOPE	PM-SCOPE	7

>> PM10

brand	name	score
• ADDAIR	AQMesh	7.9
• AGRISCOPE	PM-SCOPE	7.2
• Airly	Airly	7.1

>> NO2

brand	name	score
• Azimut-Monitoring	Greenbee	8.9
• ECOMESURE	ECOMSMART	8.5
• SIM Engineering	SIM-MONI	8.5
• Decentlab GmbH	Air Quality Station	8.4
• ADDAIR	AQMesh	8.3
• LoThoSoft	AVC2	8.1
• VAISALA SAS	AQT410	8
• Airlabs	AIRNODE	8
• RUBIX S&I	RUBIX WT1	7.9
• Kunak Technologies	KUNAK AIR A-10	7.5
• Azimut-Monitoring	Greenbee	7.1

In indoor air (IA)

>> PM2.5

brand	name	score
• kaiterra	Laser Egg	9.4
• HabitatMap	AirBeam2	9.4
• IQAir	AirVisual Pro+	9.3
• meo air analytics	meo	9.2
• ECOMESURE	ECOMZEN	9.2
• NanoSense	EP5000RE	9.2
• ZAACK	ZAACK QAI	8.2
• RUBIX S&I	Rubix POD	7.2

>> CO2

brand	name	score
• IQAir	AirVisual Pro+	9.4
• NanoSense	E4000NG	9.3
• Azimut-Monitoring	Fireflies	9.3
• ZAACK	ZAACK QAI	9.2
• meo air analytics	meo	9.1
• Decentlab GmbH	Indoor Ambiance Monitor	9.1
• NanoSense	EP5000RE	8.4
• ethera	NEMo	8.4
• RUBIX S&I	Rubix POD	8.2
• inBiot Monitoring	MICA	7.9
• ECOMESURE	ECOMZEN	7

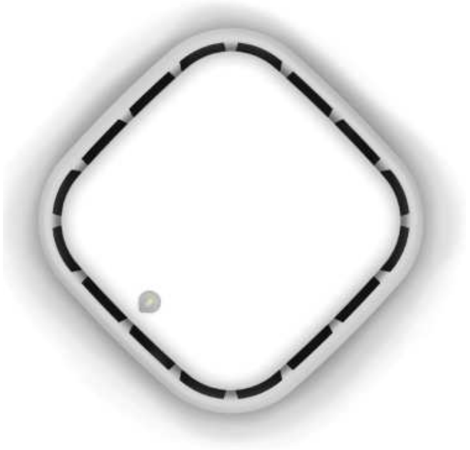
>> VOCs

brand	name	score
• NanoSense	E4000NG	7.7
• Azimut-Monitoring	Fireflies	7.4
• meo air analytics	meo	7.1
• kaiterra	Laser Egg	7.1
• IQAir	AirVisual Pro+	7

42 FACTORY ATMOTRACK

Use for which the evaluation was the best : Outdoor air vehicular

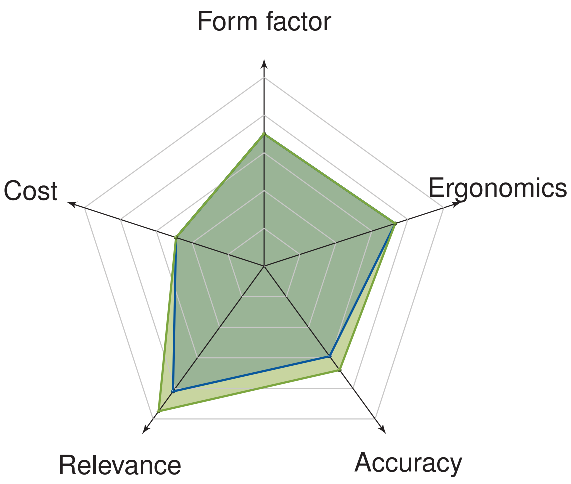
OA-V ★★★⯪☆



Jury's opinion

Designed to be attached to a vehicle for mobile outdoor measurements, the latest version of the Atmotrack has added new parameters beyond particulate matter and now includes NO_2, NH_3, temperature, humidity and pressure measurements. The PM measurements quality varies from good to very good, when mobile, and from poor to good, when in static settings, depending on the particle size range. However, further development is needed for NO_2 which has a very poor performance. NH_3 was not evaluated in this edition. The user interface includes improved data visualization. Its cost is relatively high for the intended use and restricts it to a professional market.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Data storage location : Europe

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
☑ NH_3
○ NO

☑ NO_2 (NO_x)
○ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
☑ GPS

☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Detailed test results

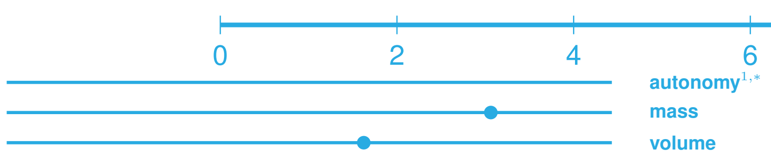
Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

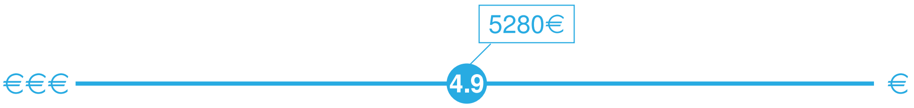
ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M** and **OA-V**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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Partenaires du challenge/Challenge's partners

ADDAIR AQMESH

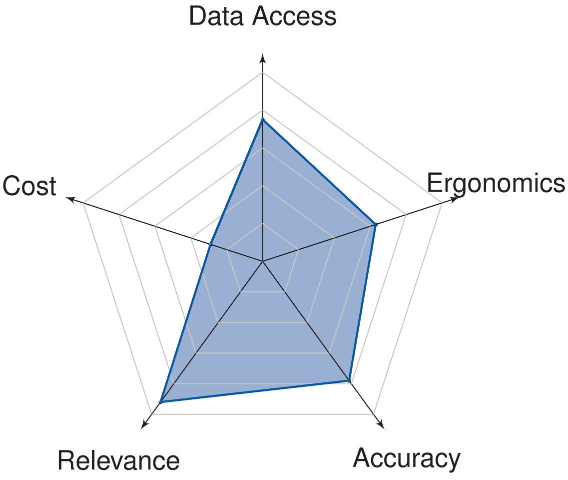
Use for which the evaluation was the best : Outdoor air monitoring

Jury's opinion

Multi-pollutant station for measuring outdoor air quality. The particulate matter (PM_{10}, $PM_{2.5}$ and PM_1) measurement quality has been improved compared to the previous Challenge edition reaching a good level of performance. The NO and NO_2 have remained consistently very good, while the O_3 performance is average. Easy to install and deploy, its data access and visualization via the cloud interface has seen a massive improvement. Because of its high cost, it remains a professional device, inaccessible to private users. Note : Because of a technical problem not caused by the candidate sensor in itself, the PM results of one of the three test units were invalidated.

OA-M ★★★½☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
☑ NO
☑ NO_2 (NO_x)
☑ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

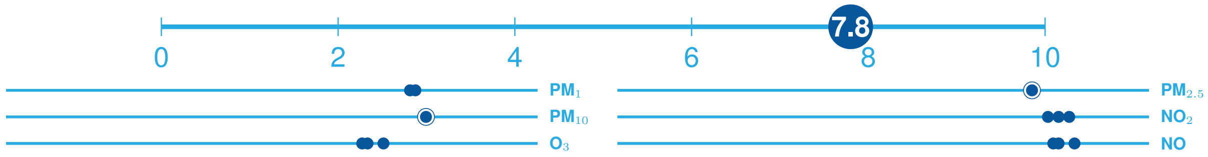
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

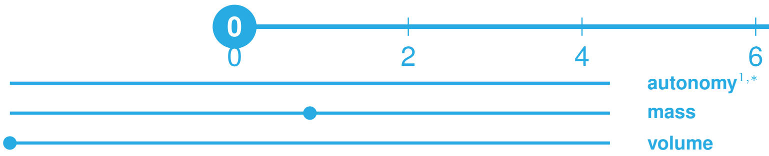
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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Entreprise/Company

ADDAIR
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189 rue Audemars
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www.addair.fr

Partenaires du challenge/Challenge's partners

AGRISCOPE PM-SCOPE

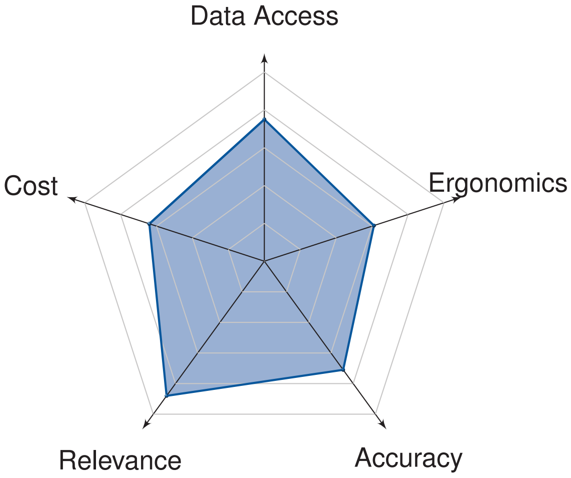
Use for which the evaluation was the best : Outdoor air monitoring

Jury's opinion

As indicated by its name, the PM-Scope targets particulate matter measurements (PM_{10} and $PM_{2.5}$) for outdoor air settings. In its latest version, the device has integrated a new calibration method which significantly improved its measurement quality compared to last year to reach a good performance level. Furthermore, temperature and humidity measurements are now also reported. It has an advanced cloud interface which features alerts and reporting and is relatively inexpensive for the monitoring category.

OA-M ★★★⯨☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
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☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS

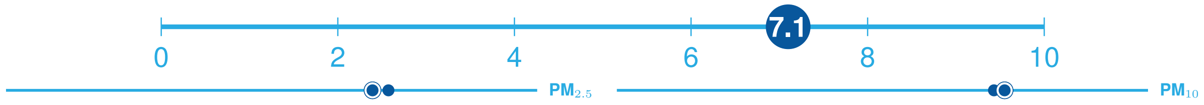
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

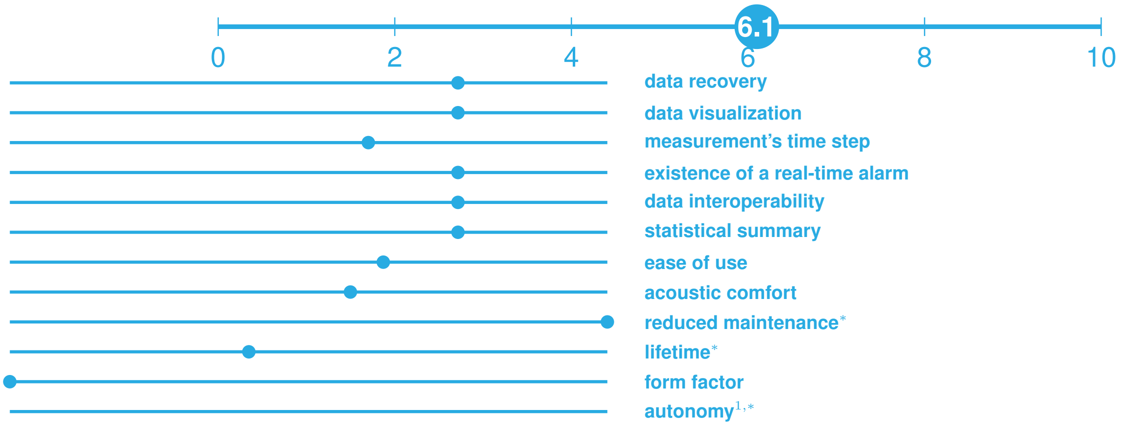
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

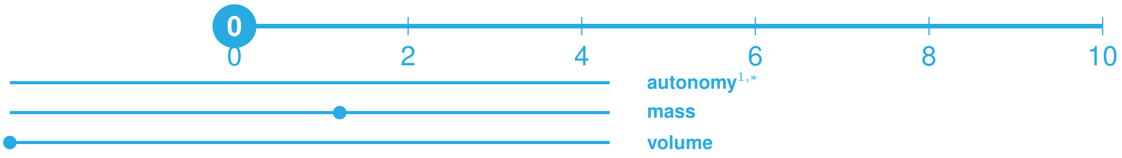


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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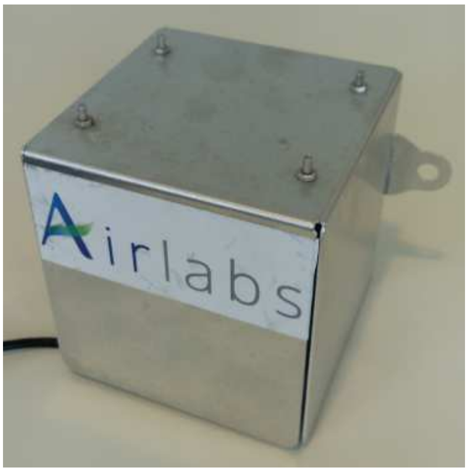
Partenaires du challenge/Challenge's partners

AIRLABS AIRNODE

Use for which the evaluation was the best : Outdoor air monitoring

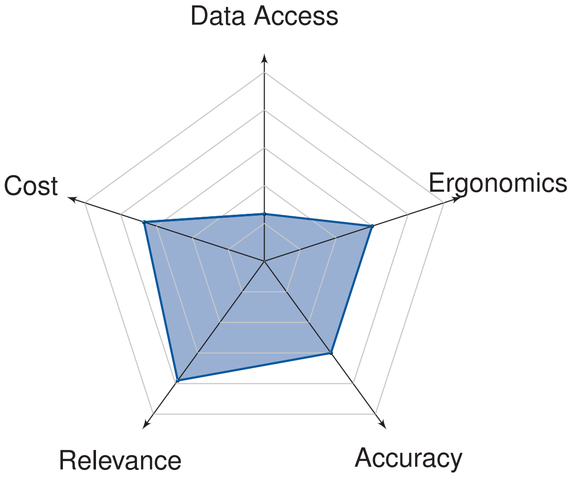
OA-M ★★★⯪☆



Jury's opinion

The AIRNODE is a very compact and light multi-pollutant sensor for outdoor air quality. It provides a very good performance for NO_2 and an average performance for O_3, but is very poor for particulate matter (for both PM_{10} and $PM_{2.5}$). It is an inexpensive solution for the monitoring category, however no visualization interface was available at the time of our tests. Even more importantly, considering its competing category, no long-range wireless communication is currently included with this solution.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ☑ CO_2
- ○ COV
- ○ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ☑ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ☑ PM_{10}
- ○ SO_2
- ○ Particules en nombre

Other measurements

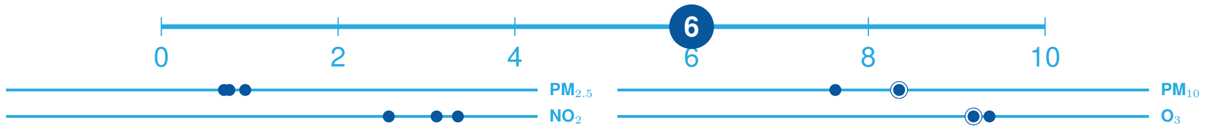
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

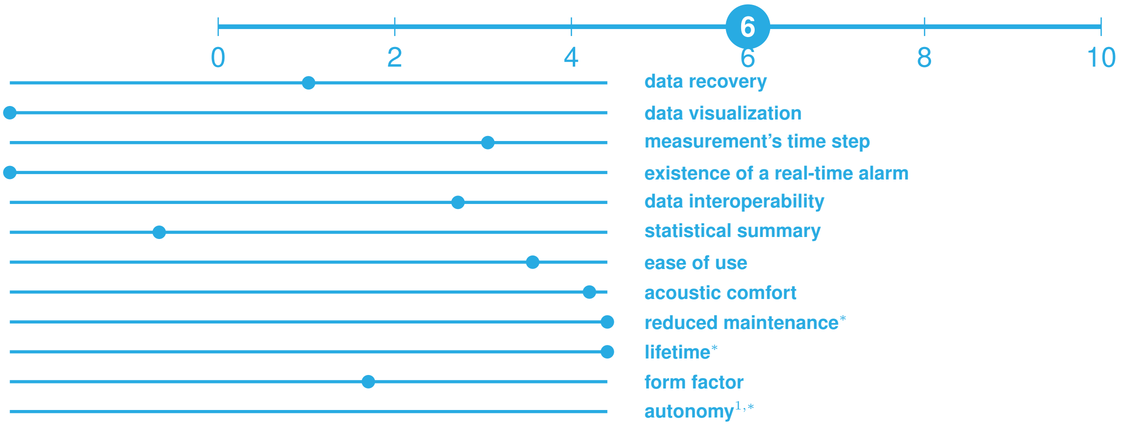
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

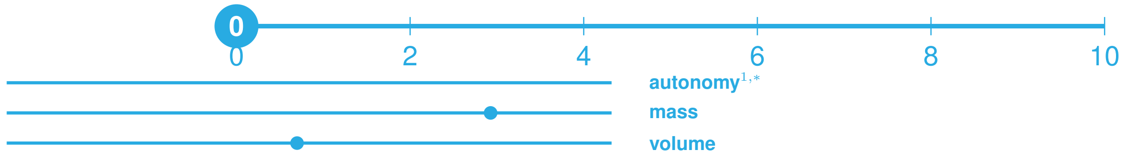


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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@air_labs

Partenaires du challenge/Challenge's partners

AIRLY AIRLY

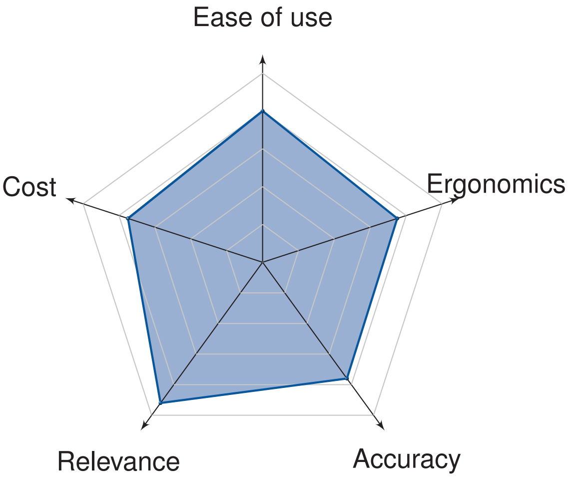
Use for which the evaluation was the best : Monitoring and awareness in outdoor air

Jury's opinion

With a very clean, robust, and discrete design, the Airly sensor targets both monitoring and awareness raising for outdoor air quality, and its relatively small price allows access to both markets. The performance of its particulate matter measurements is good for PM$_{10}$ and PM$_{2.5}$ and very good for PM$_{1}$, being the best performing PM sensor for outdoor air this year. Gas sensing is also possible through an add-on module, however this was not available for testing in this edition.

OA ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

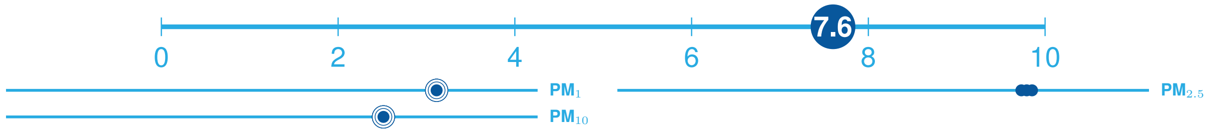
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

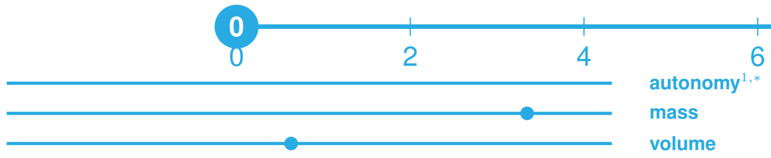
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M and **OA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

Airly

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@airlyeu

Partenaires du challenge/Challenge's partners

AZIMUT MONITORING FIREFLIES

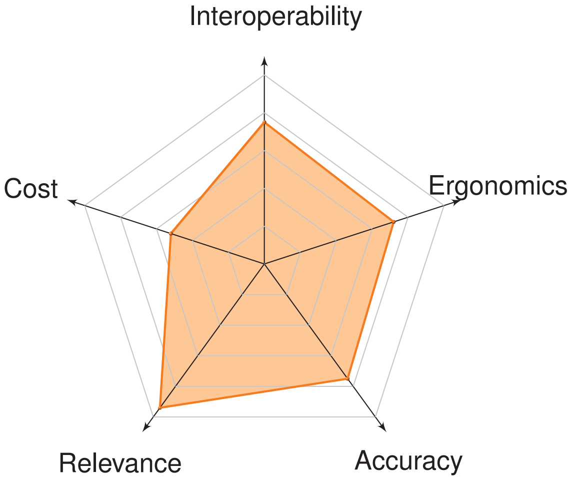
Use for which the evaluation was the best : Piloting and awareness in indoor air

Jury’s opinion

The Fireflies is a multi-pollutant indoor sensor targeting awareness raising and building air quality piloting. It measures particle number concentrations, CO_2, light and total VOCs (the only sensor to include both types of VOC measurement). Its performance is excellent for CO_2, good for total VOCs and particle number concentration, and average for light VOCs. Its distinctive mechanical design is more suitable for awareness applications than for building air quality piloting. Data recovery can be done manually from the cloud platform or via an API that pushes data to a client-side server, a relatively more complicated set-up compared to request based APIs. Its price is relatively high for the targeted applications.

IA ★★★⯪☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Data storage location : Europe

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
○ $PM_{2,5}$
○ PM_{10}
○ SO_2
☑ Particle number (concentration)

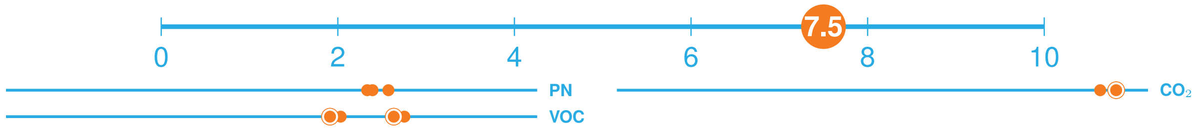
Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
☑ Acoustic comfort
○ Anemometer

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

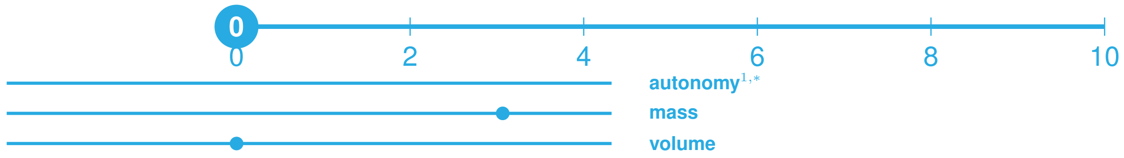
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



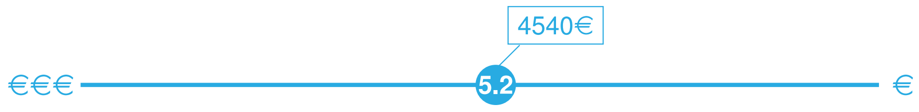
ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-A** and **IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
[2] The values on the graph correspond to the categories marked in bold
* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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ATMO GRAND EST
Atmo HAUTS-DE-FRANCE
Atmo NORMANDIE
cea
CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
OQAI
Observatoire de la qualité de l'air intérieur
VEOLIA
WORLD METEOROLOGICAL ORGANIZATION

AZIMUT MONITORING GREENBEE Secteur

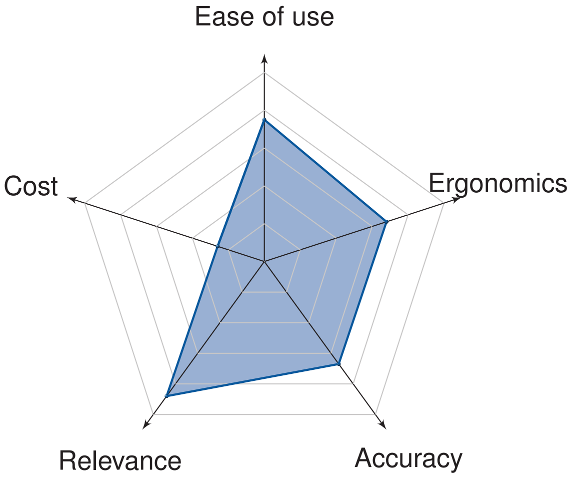
Use for which the evaluation was the best : Awareness in outdoor air

Jury's opinion

OA-A ★★★☆☆

The Greenbee is designed to measure the quality of outdoor air. The measurement performance is good for NO_2, although suffering from some reproducibility issues, and average for particle number concentration. Temperature and humidity measurements are also available, but the integration of these sensors complicates the handling of the sensor. Data recovery can be done manually from the cloud platform or via an API that pushes data to a client-side server, a relatively more complicated set-up compared to request based APIs. Its price is relatively high for the targeted application.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO
☑ NO_2 (NO_x)
○ O_3
○ PM_1
○ $PM_{2,5}$
○ PM_{10}
○ SO_2
☑ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

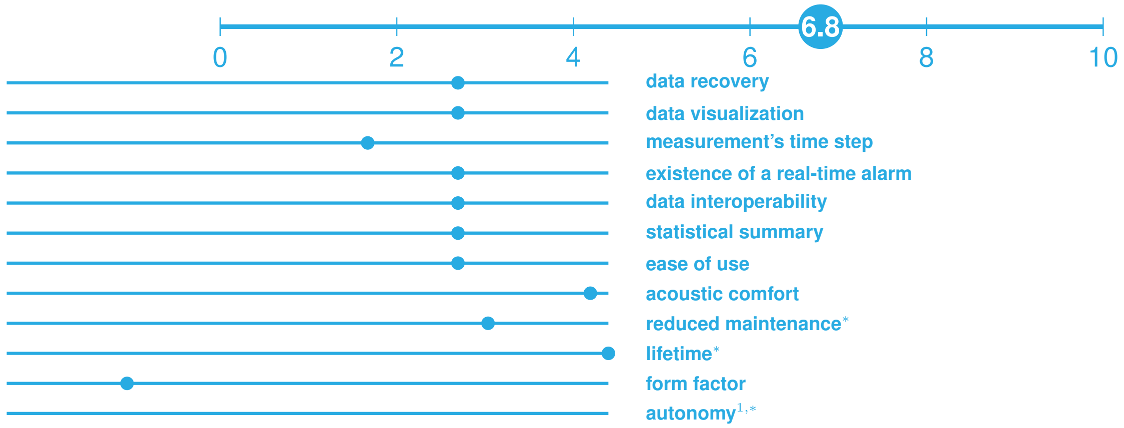
Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

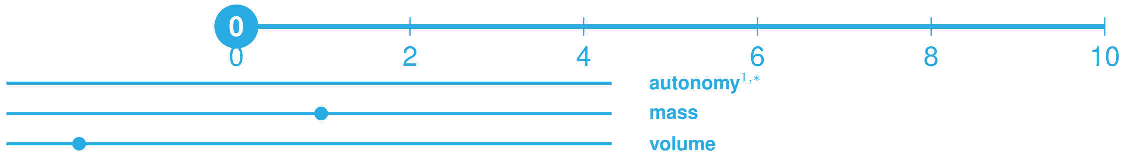
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-A)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

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[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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Entreprise/Company

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AZIMUT MONITORING GREENBEE Solaire

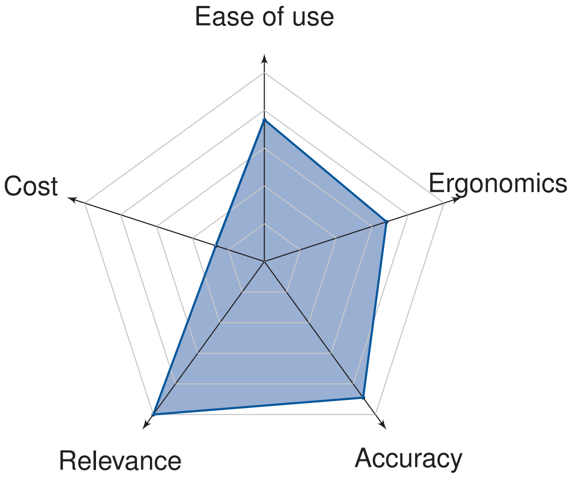
Use for which the evaluation was the best : Awareness in outdoor air

OA-A ★★★⯪☆

Jury’s opinion

The Greenbee is designed to measure the quality of outdoor air. In its solar panel powered version the Greenbee measures only NO_2 and achieves very good performance levels. Temperature and humidity measurements are also available, but the integration of these sensors complicates the handling of the sensor. Data recovery can be done manually from the cloud platform or via an API that pushes data to a client-side server, a relatively more complicated set-up compared to request based APIs. Its price is relatively high for the targeted application.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO

☑ NO_2 (NO_x)
○ O_3
○ PM_1
○ $PM_{2,5}$
○ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS

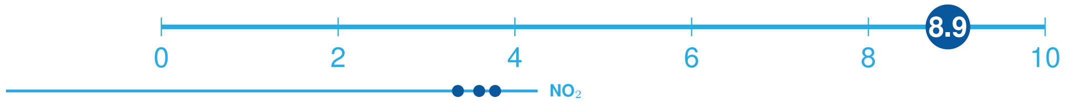
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

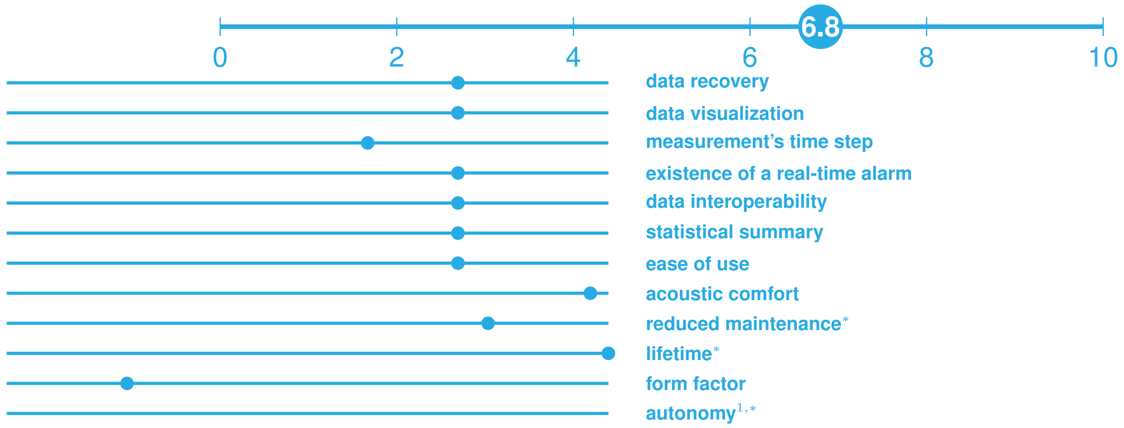
Detailed test results

Evaluated uses :
● outdoor air
● indoor air
● mobility
● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

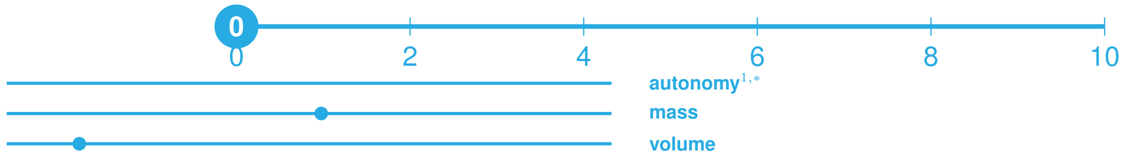


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

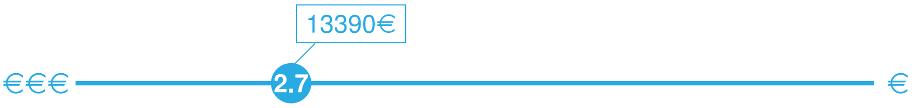


RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
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CLARITY MOVEMENT CLARITY NODE-S

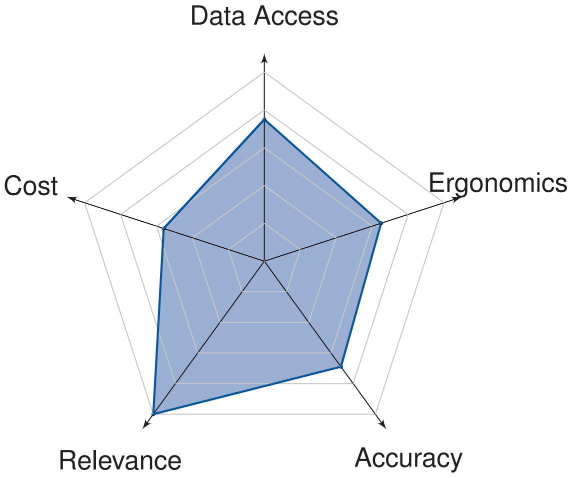
Use for which the evaluation was the best : Outdoor air monitoring

OA-M ★★★★☆

Jury's opinion

This multi-pollutant sensor is designed to measure outdoor air quality. Data quality is good for $PM_{2.5}$, and average for the NO_2 measurements. The performance for NO_2 is weaker compared to the last edition, with some reproducibility issues observed. A calibration algorithm is available, which can benefit from access to measurements from the reference monitoring network. The device is easy to install, has a discreet and pleasant design, and can operate autonomously by using a solar panel, which was also tested in this edition.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

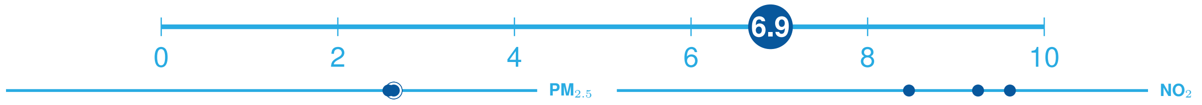
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : United States of America

Detailed test results

Evaluated uses :
● outdoor air
● indoor air
● mobility
● all uses

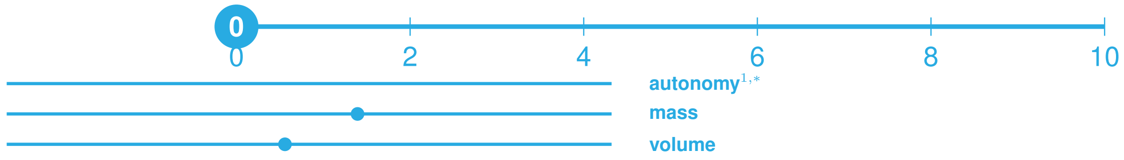
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M** and **OA-A**)^2

PORTABILITY^{1,*}



COST investment and running costs over 3 years

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[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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Atmo Auvergne-Rhône-Alpes
Atmo Grand Est
Atmo Hauts-de-France
Atmo Normandie
cea
CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
Qi² Réseau de recherche Qualité de l'air en Ile-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
World Meteorological Organization

DECENTLAB AIR QUALITY STATION

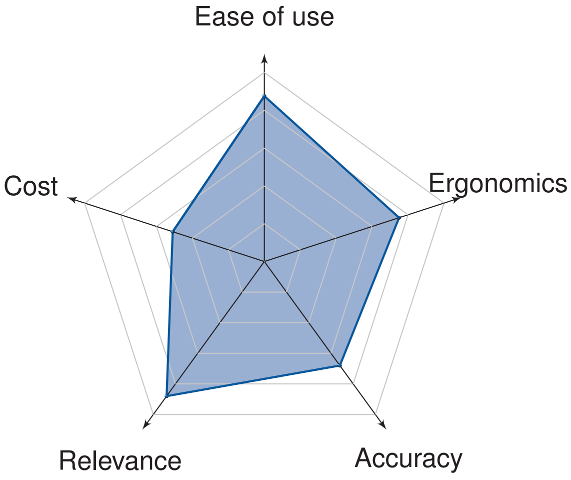
Use for which the evaluation was the best : Monitoring and awareness in outdoor air

Jury's opinion

OA ★★★½☆

This device is intended for measuring outdoor air quality. It provides very good NO_2 measurements, but has a poor performance for O_3. It comes in a minimalistic design and is easy to use and deploy. Operating on batteries, and using very low power communication (LoRa) it achieves an autonomy of 6 months. Its price is high for a solution that does not include a particulate matter measurement. Unfortunately, only two sample units were available for testing.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ☑ O_3
- ○ PM_1
- ○ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

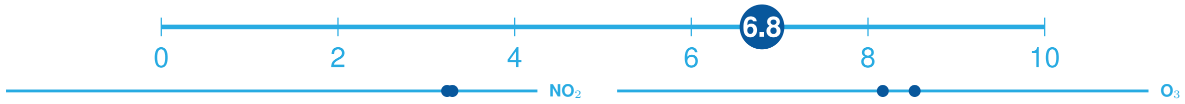
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

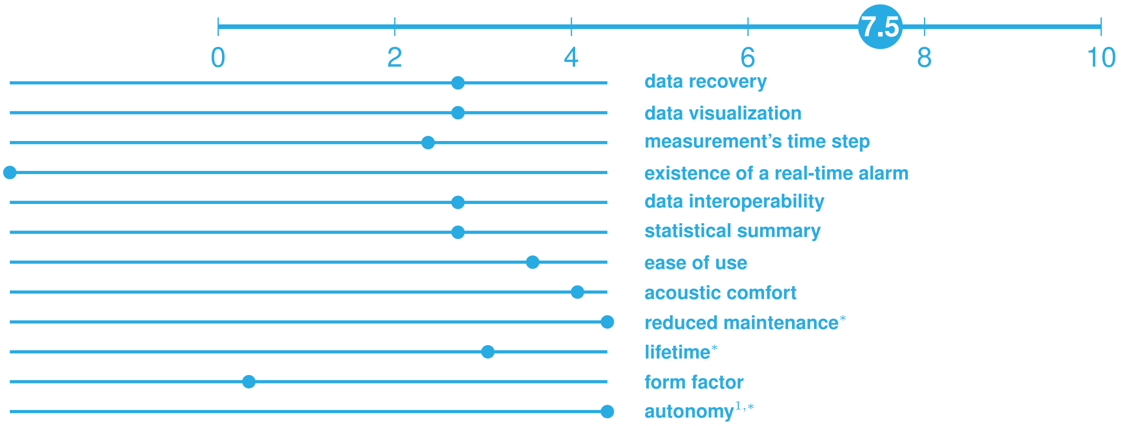
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

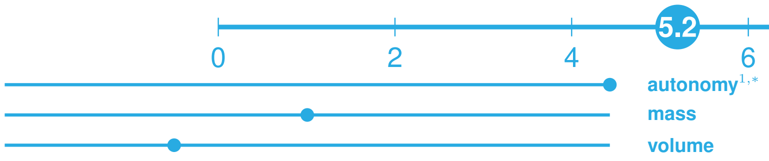


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

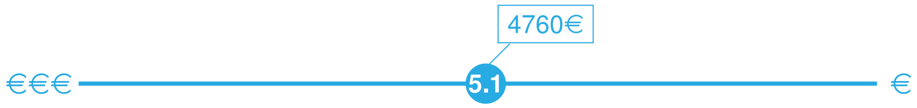


RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M and **OA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



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[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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DECENTLAB INDOOR AMBIANCE MONITOR

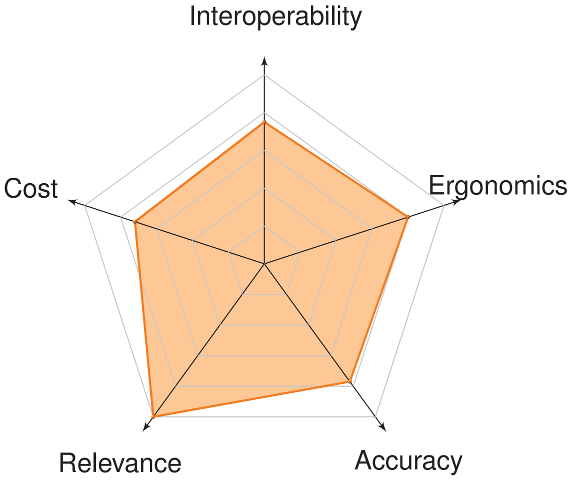
Use for which the evaluation was the best : All uses in indoor air

Jury's opinion

IA ★★★★☆

This device is intended for measuring indoor air quality for all categories of applications. Its attractive price enables it to access all indoor air markets. It measures CO_2 and VOCs and provides an excellent performance for the former and an average one for the latter. It comes in a small, clean and discreet design, easy to integrate in different indoor environments and is very easy to use. Operating on batteries, and using very low power communication (LoRa) it achieves an excellent autonomy (3 years).

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
○ $PM_{2,5}$
○ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

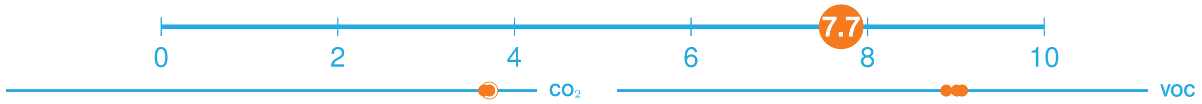
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

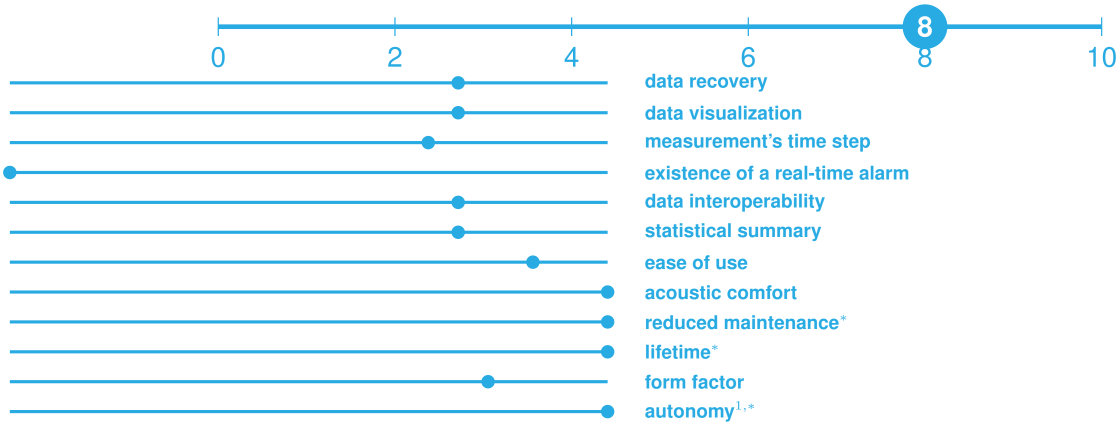
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

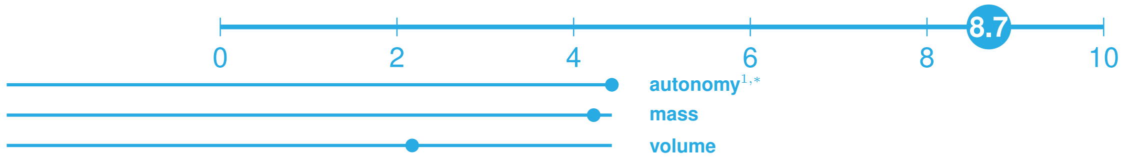


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (IA-M, **IA-A** and **IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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*AIRLAB

MICROSENSORS CHALLENGE

2019

ECOLOGICSENSE PICTURE

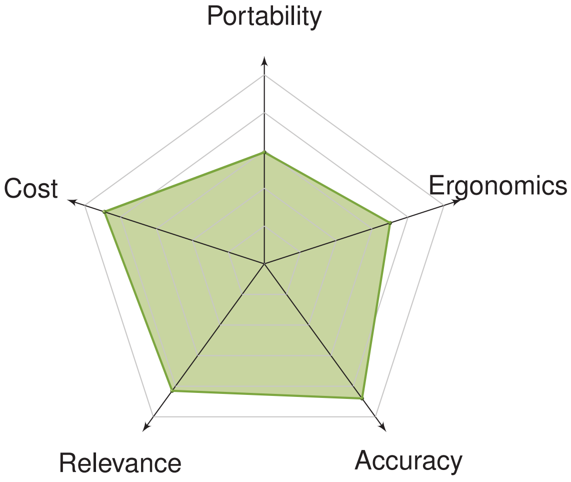
Use for which the evaluation was the best : Portable awareness raising

Jury's opinion

Intended for measuring personal air quality, the PICTURE is a very small and light particulate matter sensor and provides very good data quality for PM_{10} and $PM_{2.5}$, and excellent for PM_1. It is designed to be used in conjunction with a smartphone which it leverages for GPS, long range communication, and providing a direct user interface. It is still in a prototype version (TRL 7), and as such suffers from some shortcomings on connectivity and autonomy, which could be resolved for its final commercial version. Its low estimated cost would make it very attractive for large scale projects.

CA-A ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO

○ NO_2 (NO_x)
○ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

○ Temperature
○ Humidity
○ Odours
○ GPS

○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

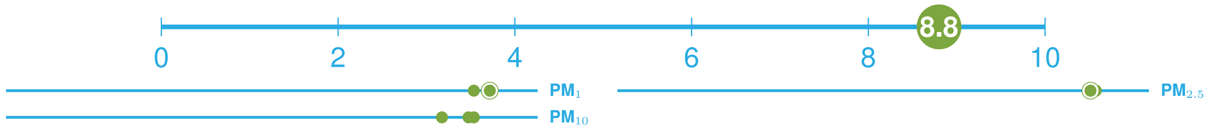
Data storage location : Europe

AIRPARIF

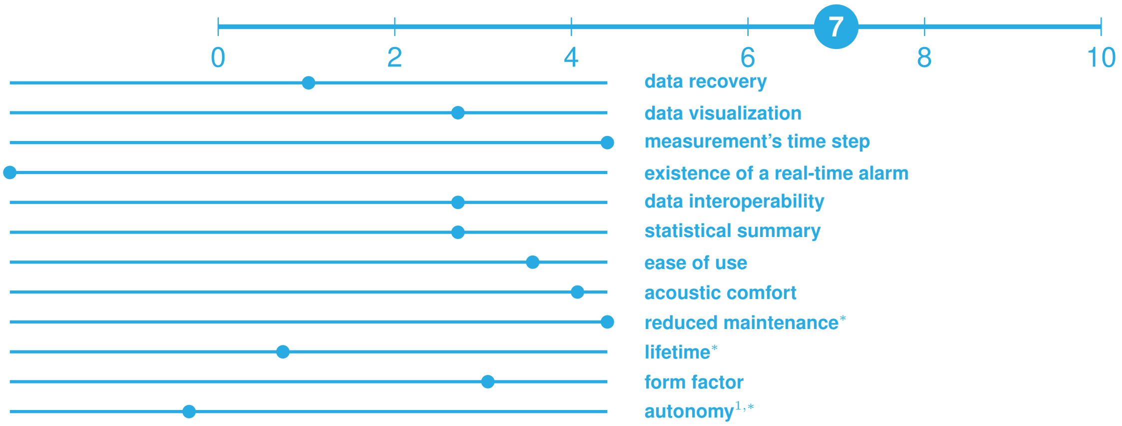
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

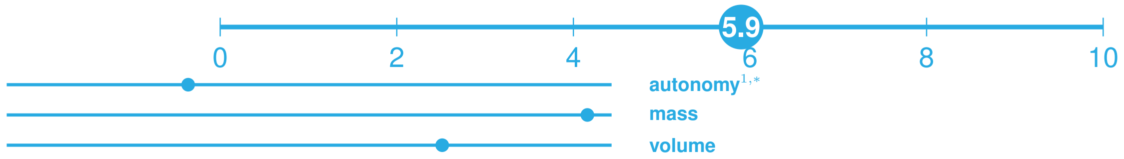


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (CA-E and **CA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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Atmo Hauts-de-France
Atmo Normandie
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CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
Qi2 Réseau de recherche Qualité de l'air en Ile-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
World Meteorological Organization

ECOMESURE ECOMSMART

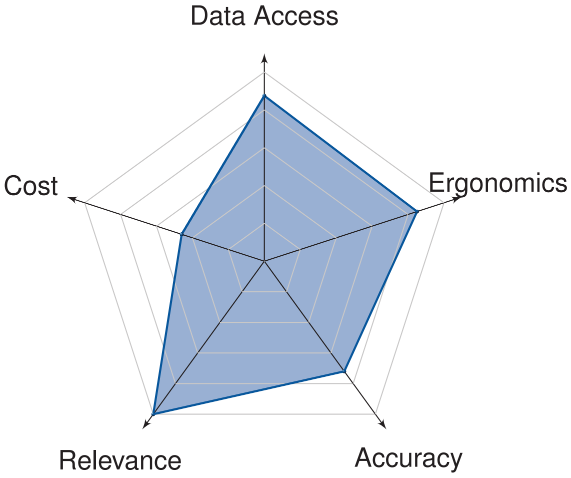
Use for which the evaluation was the best : Outdoor air monitoring

Jury's opinion

This device is designed to measure ambient air quality for monitoring applications. The quality of the measurement is very good for NO_2 and average for particulate matter (PM_{10} and $PM_{2.5}$). The data can be recovered either through manual downloads from the cloud platform, automatic FTP transfer or API requests.

OA-M ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Data storage location : Europe

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ✓ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ✓ $PM_{2,5}$
- ✓ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

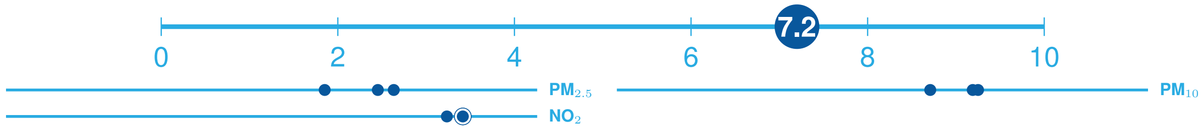
Other measurements

- ✓ Temperature
- ✓ Humidity
- ○ Odours
- ○ GPS
- ✓ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

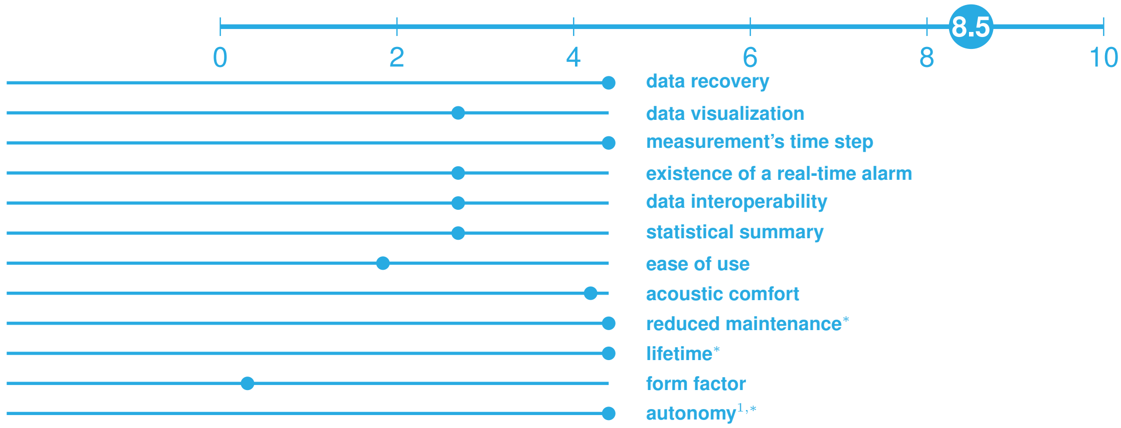
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

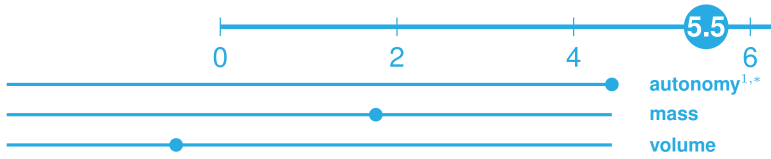


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

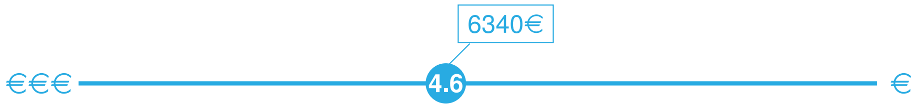


RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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VEOLIA
World Meteorological Organization

AIRLAB

MICROSENSORS CHALLENGE

2019

ECOMESURE ECOMZEN

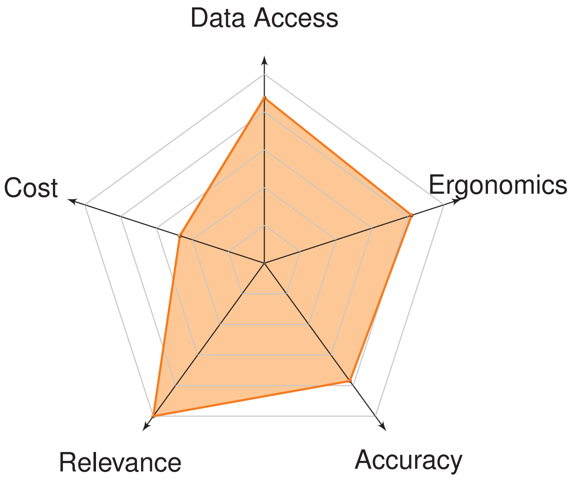
Use for which the evaluation was the best : Indoor air monitoring

Jury's opinion

This sensor is intended for measuring indoor air quality. Its minimalist design allows easy integration into different indoor environments and has the advantage of measuring several pollutants (CO_2, total VOCs, $PM_{2.5}$ and NO_2). The quality of the measurement is excellent for $PM_{2.5}$, very good for $NO_2$and average for VOCs. The performance of the CO_2 sensor was, unfortunately, affected by sensor failures. The data can be recovered either through manual downloads from the cloud platform, automatic FTP transfer or API requests. Its price is relatively high for the targeted application.

IA-M ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
☑ NO_2 (NO_x)
○ O_3
○ PM_1
☑ $PM_{2,5}$
○ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

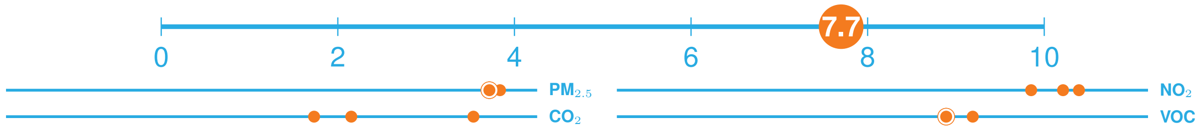
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

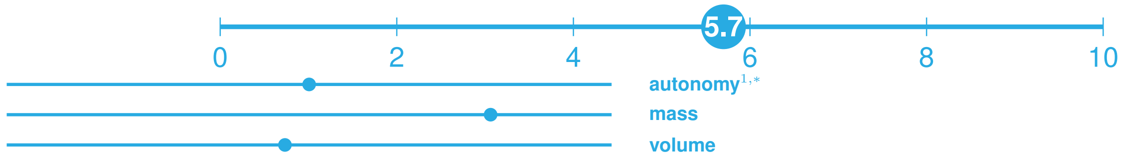
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



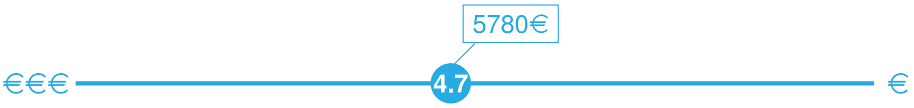
ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



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AIRLAB

MICROSENSORS CHALLENGE

2019

ETHERA NEMO

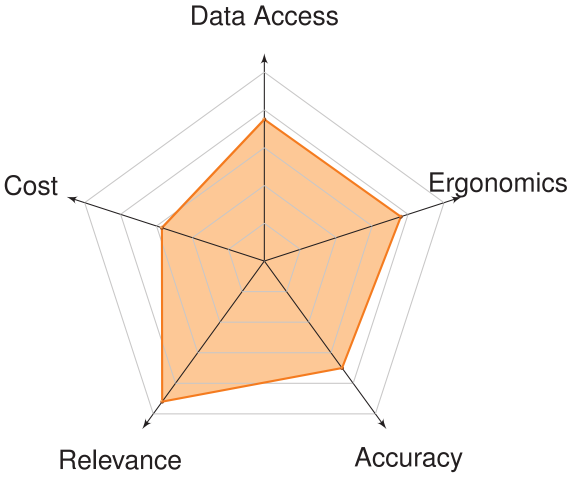
Use for which the evaluation was the best : Indoor air monitoring

Jury's opinion

Designed for monitoring indoor air for professional use, this device has the advantage of being multi-pollutant (light VOCs, CO_2, $PM_{2.5}$, NO_2, and formaldehyde as an option). The data quality is very good for CO_2, good for NO_2, and average for VOCs. The $PM_{2.5}$performance has reproducibility issues, with performance ranging from good to very poor. The device is easy to install. The optional measurement of formaldehyde is an advantage, even if it is punctual (by means of consumable optical strips). However it implies additional operating costs. The only option for accessing the data is by downloading from the cloud interface. An API option would be welcomed.

IA-M ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ☑ CH_2O
- ○ CO
- ☑ CO_2
- ☑ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ☑ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

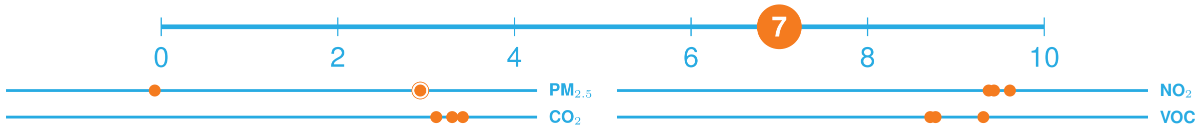
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ☑ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

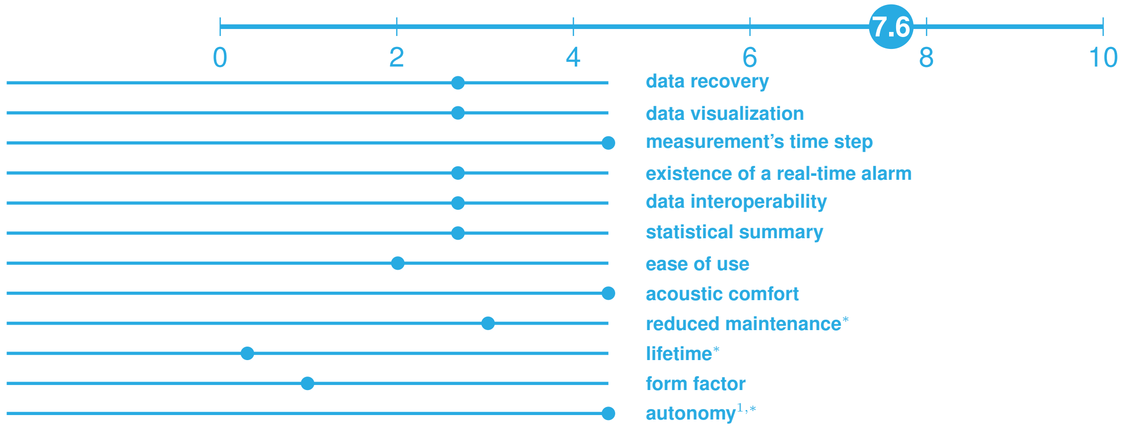
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

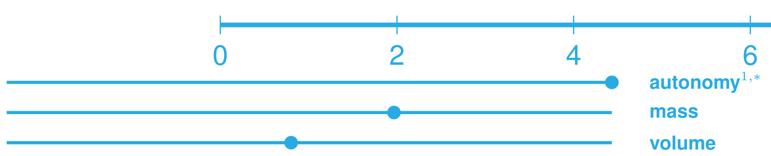


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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ETHERA NEMO XT

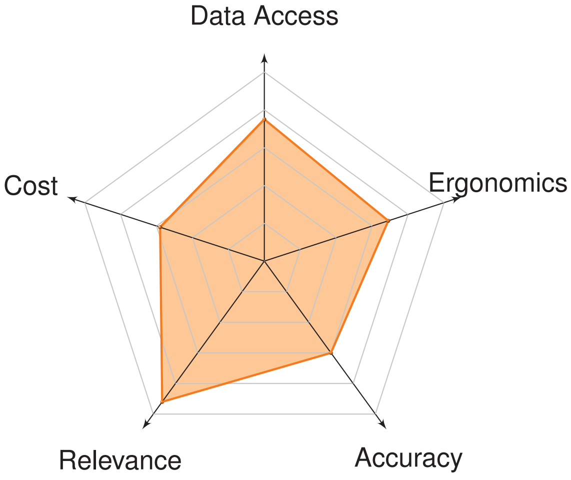
Use for which the evaluation was the best : Indoor air monitoring

IA-M ★★★½☆

Jury's opinion

Designed for monitoring indoor air for professional use, this device has the advantage of being multi-pollutant (light VOCs, CO_2, $PM_{2.5}$, NO_2, and formaldehyde as an option). The general data quality is average with the performance being strongly affected by the malfunctioning of one of the three tested sensor units. The device is easy to install. The optional measurement of formaldehyde is an advantage, even if it is punctual (by means of consumable optical strips). However it implies additional operating costs. The only option for accessing the data is by downloading from the cloud interface. An API option would be welcomed.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ☑ CH_2O
- ○ CO
- ☑ CO_2
- ☑ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ☑ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

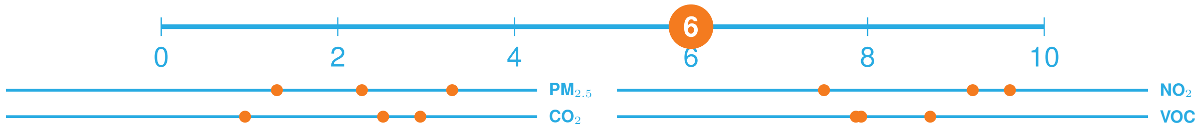
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ☑ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

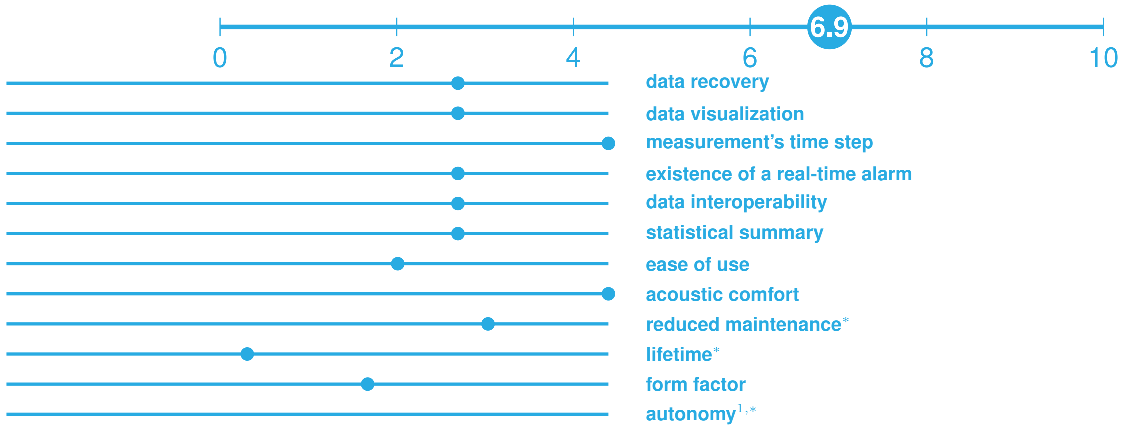
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

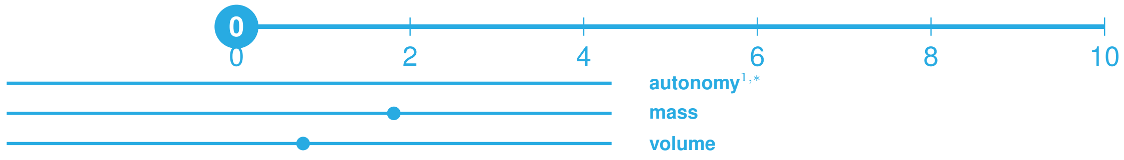


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-M**)^2

PORTABILITY^{1,*}



COST investment and running costs over 3 years

---

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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HABITATMAP AIRBEAM2

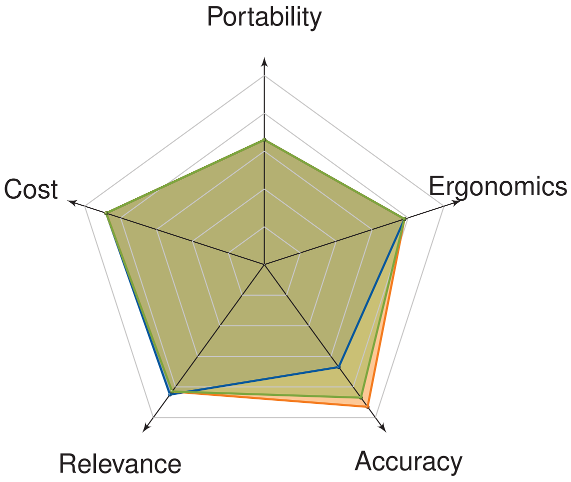
Use for which the evaluation was the best : All uses in indoor air

Jury's opinion

This open-source and open-hardware platform is designed for raising public awareness of pollution. In its second version, the Airbeam presents an evolved design and new connectivity options, as well as the measurement of PM_{10} and PM_1 particles, in addition to fine particles $PM_{2.5}$. The quality of its measurements are excellent for indoor air and very good for citizen air applications. For outdoor fixed settings its performance drops particularly for PM_{10}. It is an inexpensive solution. However, a recent Android smartphone is required for configuration and logging, when not using the WiFi or 3G options.

IA ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

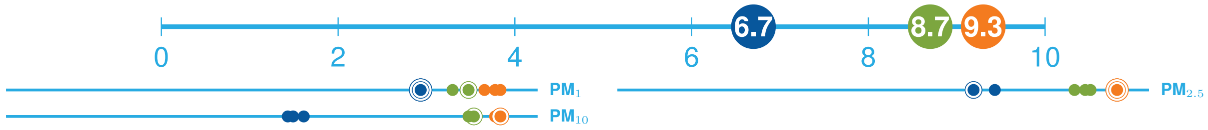
☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : United States of America

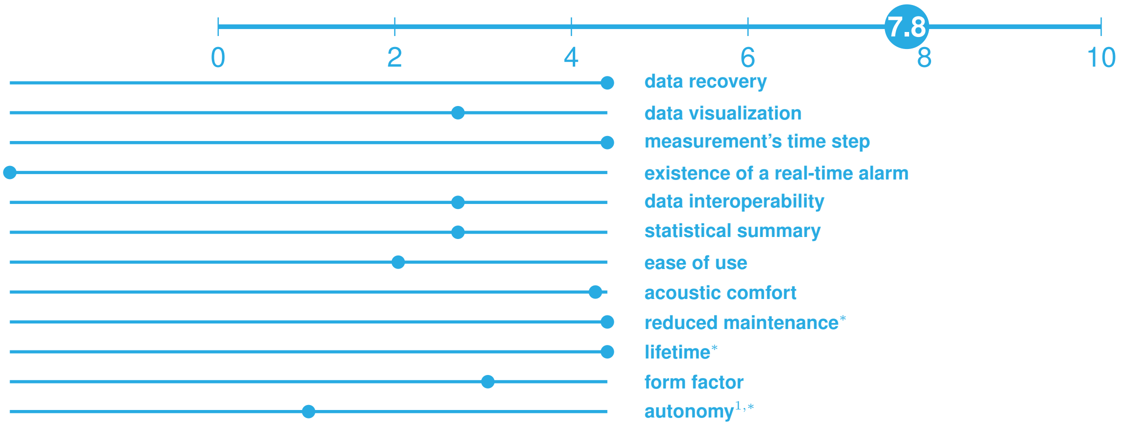
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

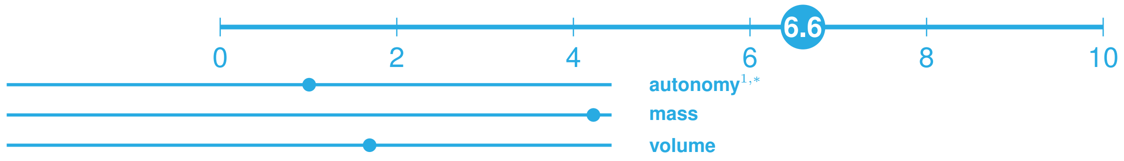


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M, **OA-A**, IA-M, **IA-A**, **IA-P**, CA-E and **CA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

---

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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INBIOT MONITORING MICA

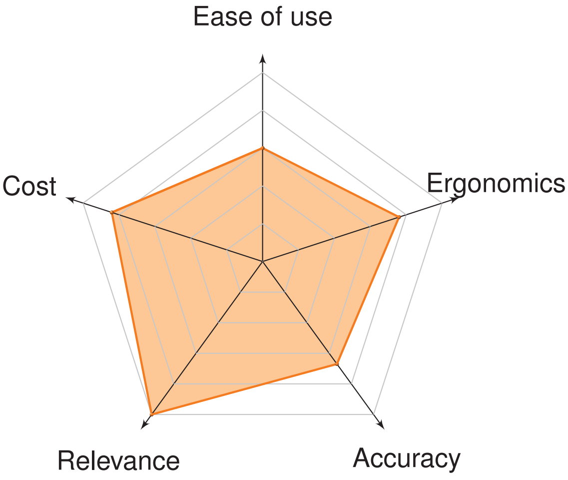
Use for which the evaluation was the best : All uses in indoor air

IA ★★★★☆

Jury's opinion

This light and small sensor is designed for measuring indoor air quality. It targets CO_2 and formaldehyde and achieves good results for the former and poor results for the latter. The low performance for formaldehyde can to some extent be discounted when considering current sensor technology limitations for this pollutant. The sensor data can be recovered either by direct download from a cloud interface or through a functional API. A battery pack is also available for autonomy, however this option was not tested within the Challenge.

Evaluation



Evaluated uses :
● outdoor air
● indoor air
● mobility

Measured pollutants

- ☑ CH_2O
- ○ CO
- ☑ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ○ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ○ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

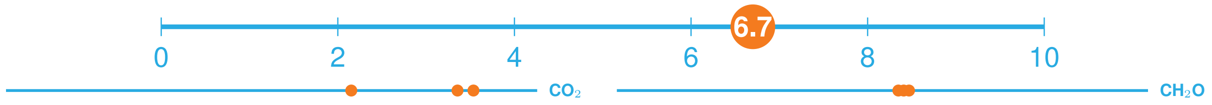
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

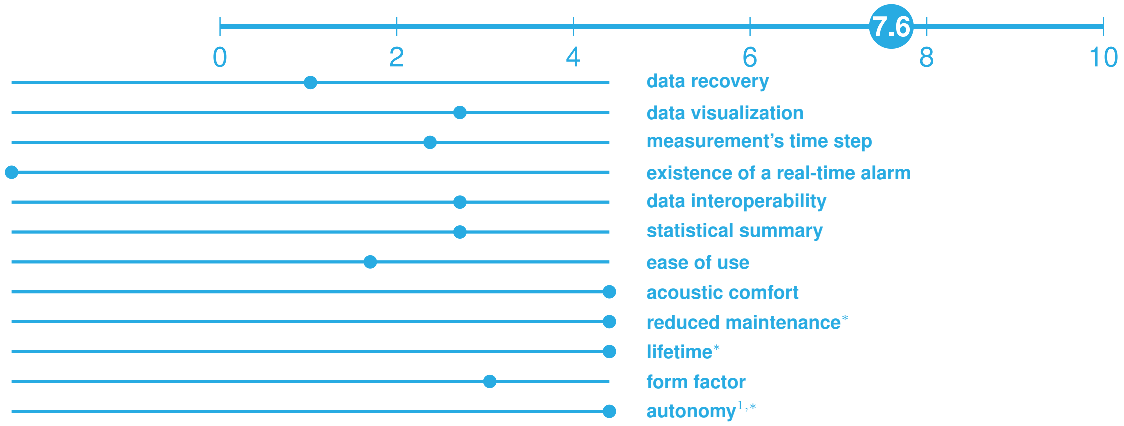
Detailed test results

Evaluated uses :
● outdoor air
● indoor air
● mobility
● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

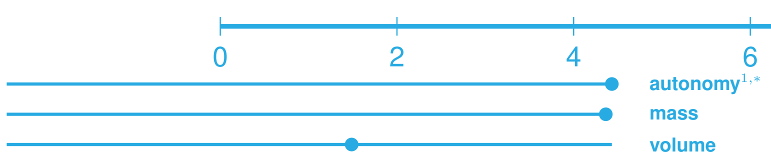


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (IA-M, **IA-A** and **IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
[2] The values on the graph correspond to the categories marked in bold
* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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inBiot
Sense your building

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Atmo AUVERGNE-RHÔNE-ALPES
AtMO GRAND EST
Atmo HAUTS-DE-FRANCE
Atmo NORMANDIE
cea
CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
Qi2 Réseau de recherche Qualité de l'air en Ile-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
WORLD METEOROLOGICAL ORGANIZATION

IQAIR AIRVISUAL PRO+

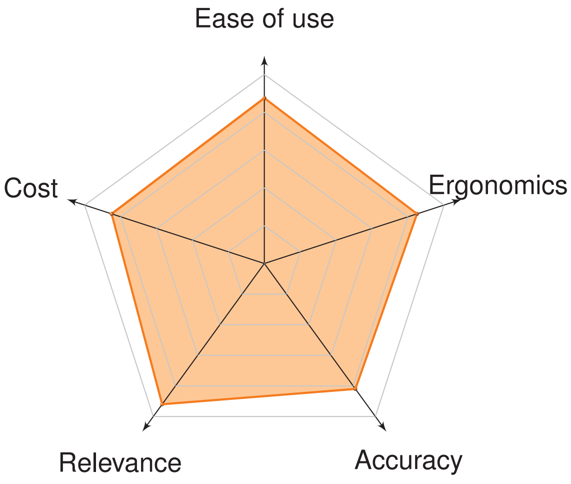
Use for which the evaluation was the best : All uses in indoor air

Jury's opinion

IA ★★★★½

This device is designed to measure indoor air quality. In its latest version the Airvisual PRO+ has added new measurements for PM_1, formaldehyde, and total VOCs. The quality of its CO_2 and particulate matter measurements is excellent. For VOCs the performance is good, while for formaldehyde it is poor and lacking reproducibility. Its large range of targeted pollutants, a nice design which includes a large display, and an excellent price-performance ratio make it ideal for awareness applications. Furthermore, its API enables it to also tackle more complex scenarios (e.g., air quality piloting).

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

☑ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO

○ NO_2 (NO_x)
○ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS

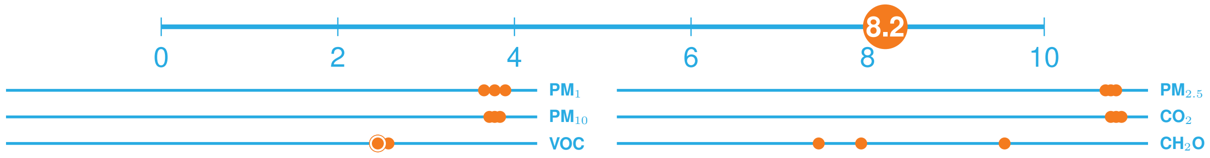
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

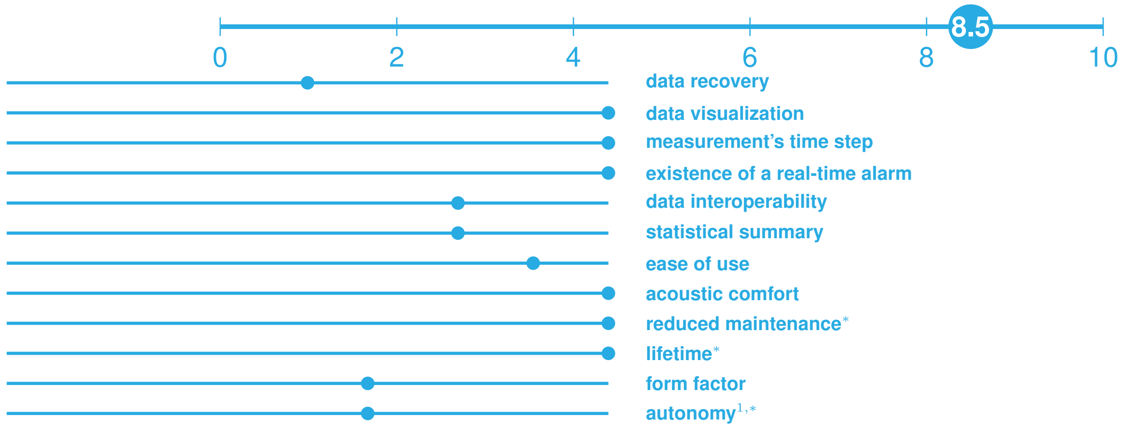
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

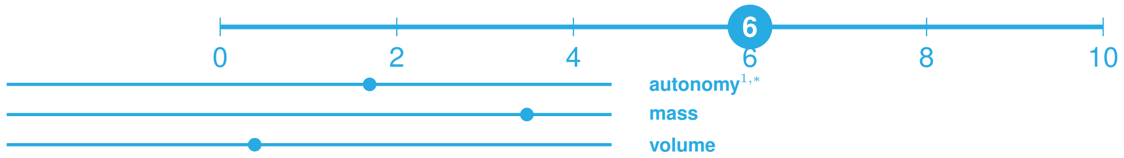


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (all **IA** categories)[2]

PORTABILITY^{1,*}



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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Partenaires du challenge/Challenge's partners

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KAITERRA LASER EGG

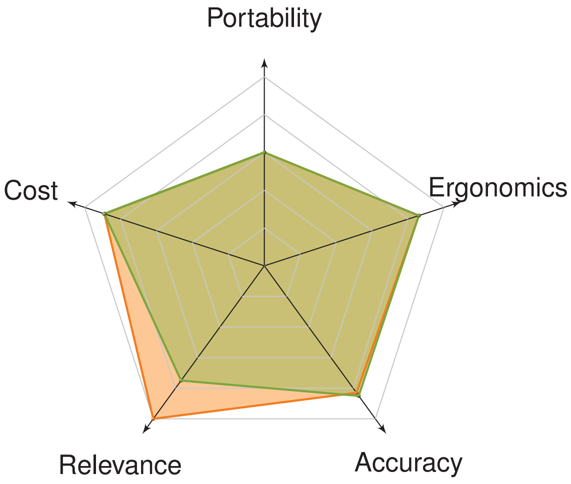
Use for which the evaluation was the best : All uses in indoor air

Jury's opinion

IA ★★★★½

This device is mainly intended for monitoring indoor air for $PM_{2.5}$ and VOCs. Indoors, its measurement quality is excellent for $PM_{2.5}$ and good for VOCs. Although its battery autonomy and light weight allows it to be used in mobility, its otherwise beautiful design is not adapted for being carried or attached to an item of clothing or a backpack, and a lower $PM_{2.5}$ performance was noticed when used outdoors. Furthermore, some connectivity issues were observed when testing it in mobility. Its low price and high performance make it an attractive option for indoor air applications.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ☑ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ○ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

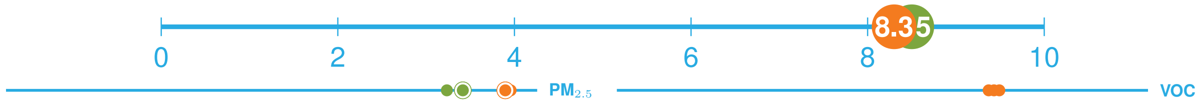
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Asia

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

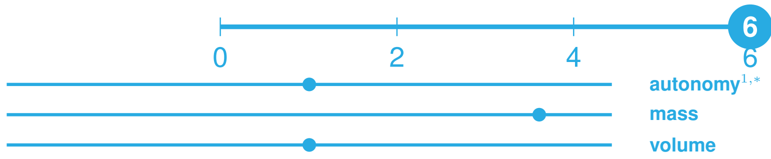
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (all **IA** and **CA** categories)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
[2] The values on the graph correspond to the categories marked in bold
[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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Atmo Grand Est
Atmo Hauts-de-France
Atmo Normandie
cea
CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
Qi² Réseau de recherche Qualité de l'air en Île-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
World Meteorological Organization

KUNAK TECHNOLOGIES KUNAK AIR A-10

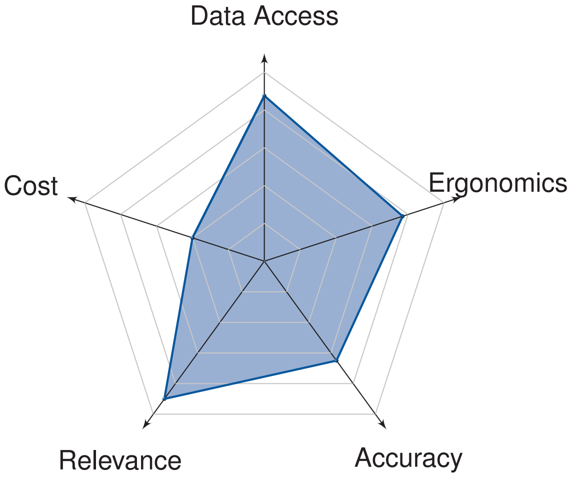
Use for which the evaluation was the best : Outdoor air monitoring

OA-M ★★★⯪☆

Jury's opinion

The KUNAK AIR A-10 is a multi-pollutant solution for monitoring outdoor air quality. Its very professional design provides a large list of measured pollutants (NO_2, O_3, PM_1, $PM_{2.5}$ and PM_{10}), and weather parameters (temperature, humidity, pressure, and wind). The data quality is excellent for O_3 good for PM_1 and NO_2, average for PM_{10} and very poor for $PM_{2.5}$. Its integrated solar panel allows it to run autonomously. Although not cheap, its price is relatively competitive for the monitoring category.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO

☑ NO_2 (NO_x)
☑ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS

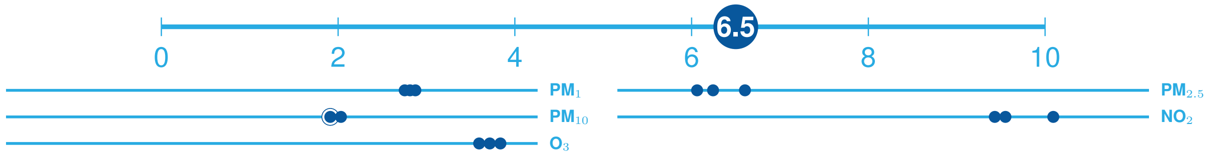
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
☑ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

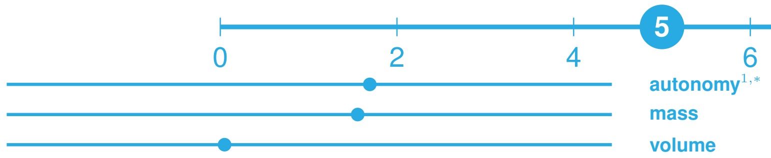
 # ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



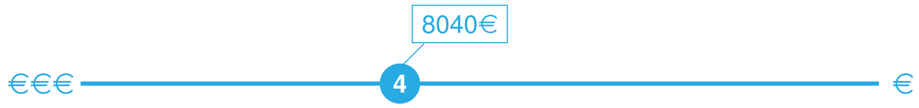
 # ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

 # RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

 # PORTABILITY[1,*]



 # COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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LOTHOSOFT AVC2

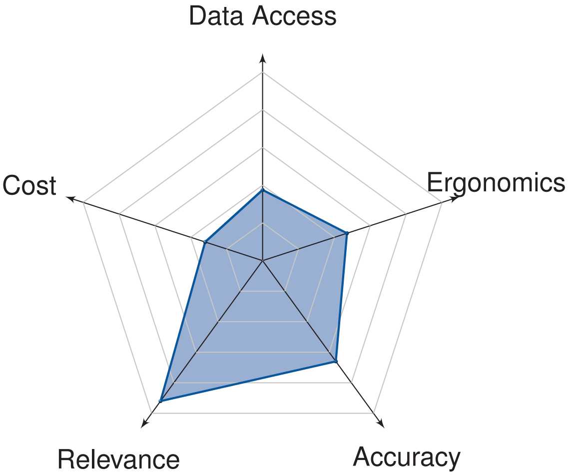
Use for which the evaluation was the best : Outdoor air monitoring

OA-M ★★★☆☆

Jury's opinion

The AVC2 is a sensor platform designed for outdoor air monitoring. Its data quality is very good for NO_2 and good for O_3. For PM_{10}, the platform, which is still in a prototype version (TRL 7), suffered an unrecoverable failure on two of the three platforms due to a heat wave during the test period, which massively affected the performance. In its current version no data visualization service is available, and data is recovered over FTP. For its final commercial version adding a $PM_{2.5}$ measurement would be welcome, especially considering the high price of the solution.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO
☑ NO_2 (NO_x)
☑ O_3
○ PM_1
○ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

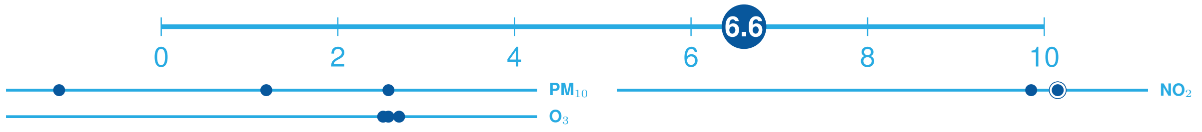
☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

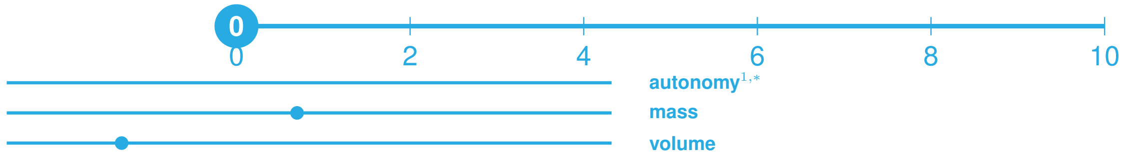
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

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[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

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Entreprise/Company

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Partenaires du challenge/Challenge's partners

MEO AIR ANALYTICS MEO

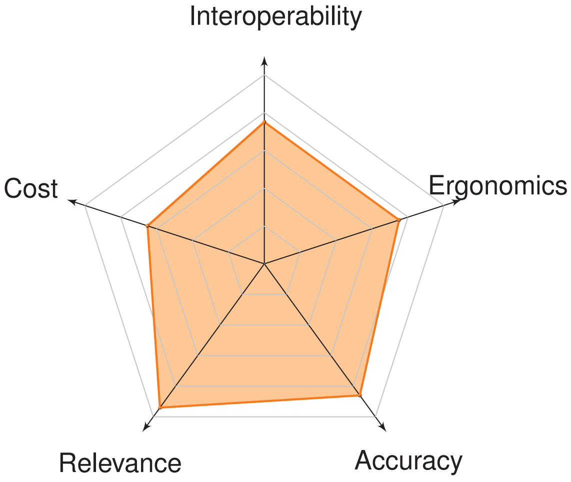
Use for which the evaluation was the best : All uses in indoor air

Jury's opinion

This multi-pollutant device is designed for measuring indoor air quality. In its latest version, the MEO includes also a CO_2 measurement. Its data quality is excellent for CO_2 and $PM_{2.5}$, very good for PM_{10}, and good for total VOCs. It is a very compact solution for the number of different targeted pollutants, however it is expensive compared to other similar devices.

IA ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

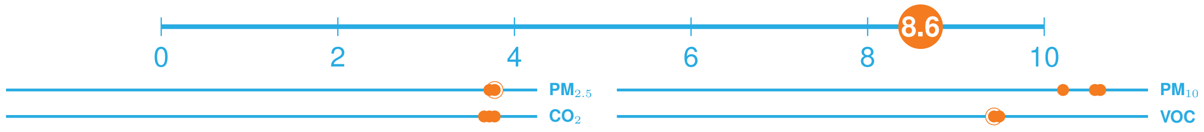
☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

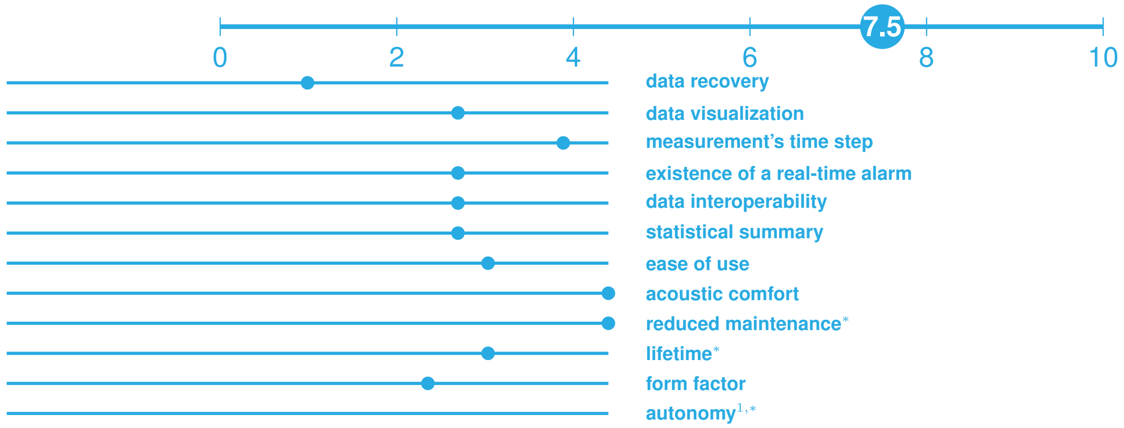
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

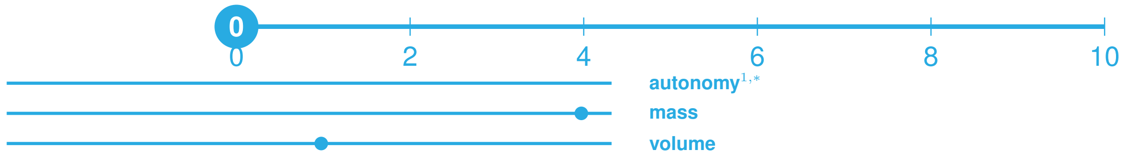


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (all **IA** categories)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
[2] The values on the graph correspond to the categories marked in bold
[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

Entreprise/Company

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Partenaires du challenge/Challenge's partners

NANOSENSE E4000NG

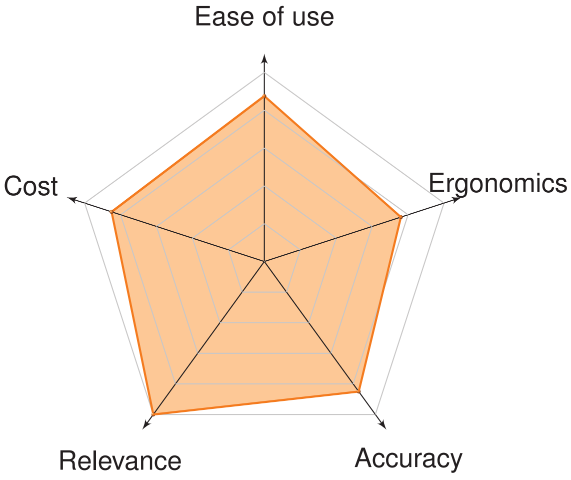
Use for which the evaluation was the best : Monitoring and awareness in indoor air

IA ★★★★☆

Jury's opinion

This device is to be used for indoor air quality monitoring or awareness and can be supplemented with other Nanosense sensors. It has a design that is very well adapted for easy integration with building equipment. The quality of the CO_2 measurement is excellent and the VOC measurement is good. It is a device whose price is attractive, even when factoring in the subscription for the Pando2 data visualization interface. Its setup however requires some specific technical skills and should be done by a professional.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ☑ CO_2
- ☑ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ○ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ○ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

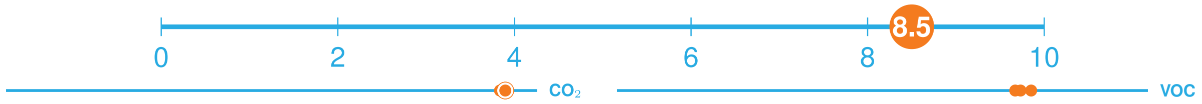
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

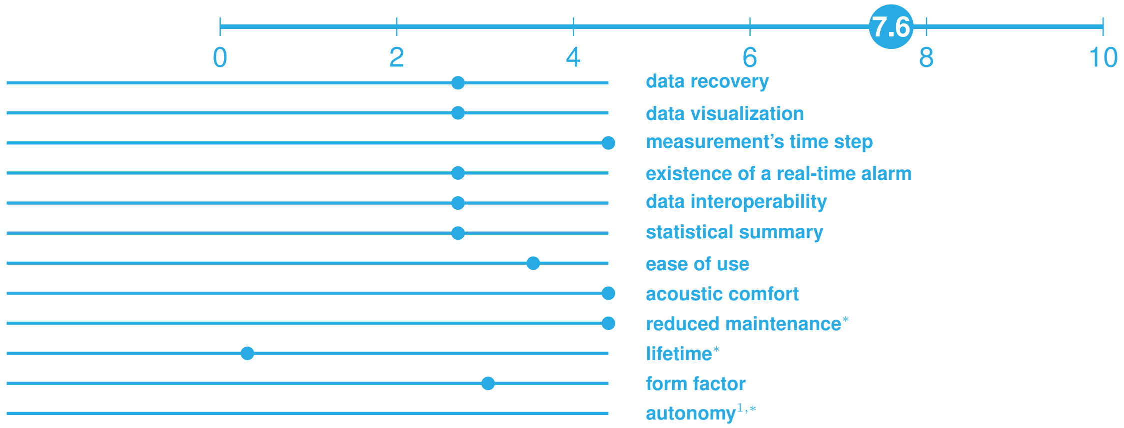
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

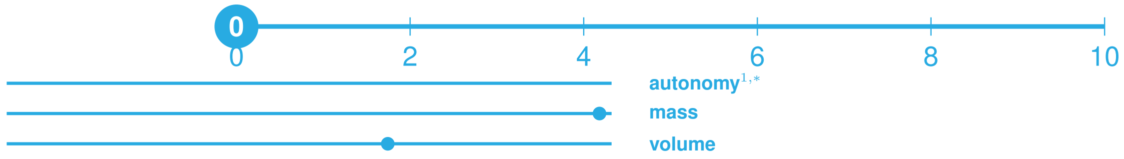


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (IA-M and **IA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

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Entreprise/Company

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NANOSENSE E4000NG P

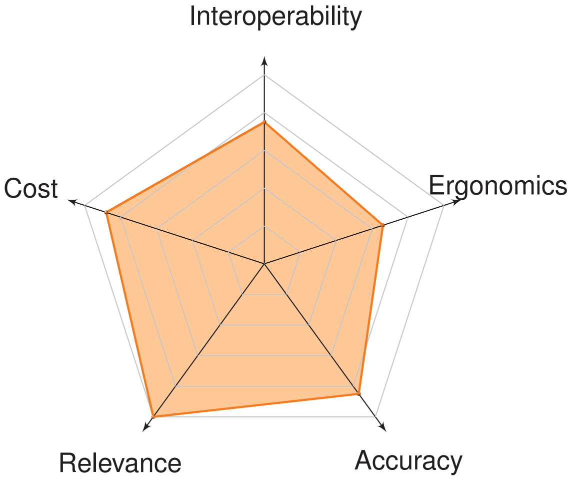
Use for which the evaluation was the best : Indoor air control

Jury's opinion

IA-P ★★★★½

This device is to be used for indoor air quality piloting and can be supplemented with other Nanosense sensors. It has a design that is very well adapted for easy integration with building equipment. The quality of the CO_2 measurement is excellent and the VOC measurement is good. For this piloting version, no data visualization interface is available, leading to a further cost reduction. Its setup requires some specific technical skills and should be done by a professional.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
○ $PM_{2,5}$
○ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

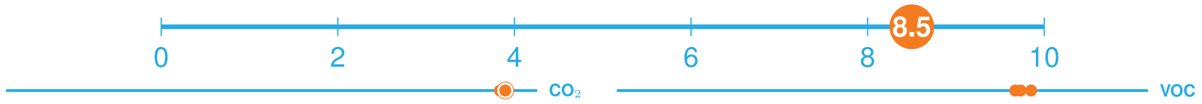
☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

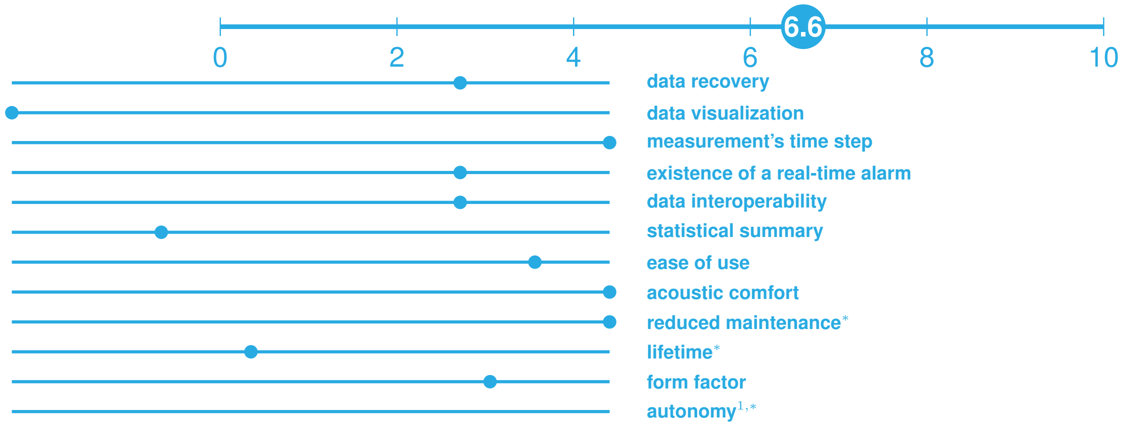
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

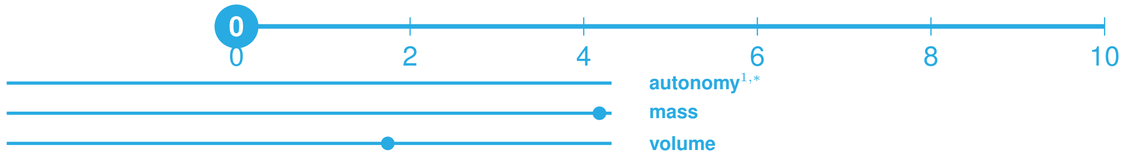


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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NANOSENSE EP5000RE

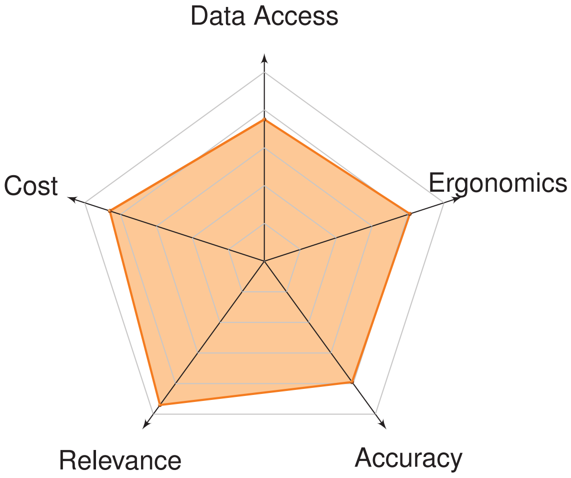
Use for which the evaluation was the best : Indoor air monitoring

IA-M ★★★★½

Jury's opinion

This device is to be used for indoor air quality monitoring or awareness and can be supplemented with other Nanosense sensors. It has a design that is very well adapted for easy integration with building equipment. The measurement quality is excellent for particulate matter (PM$_{2.5}$, PM$_{10}$) is excellent, very good, but with some reproducibility issues, for CO$_2$, and very poor for VOCs. It is a device whose price is attractive, even when factoring in the subscription for the Pando2 data visualization interface. Its setup however requires some specific technical skills and should be done by a professional.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH$_2$O
○ CO
☑ CO$_2$
☑ VOC
○ H$_2$S
○ NH$_3$
○ NO

○ NO$_2$ (NO$_x$)
○ O$_3$
○ PM$_1$
☑ PM$_{2,5}$
☑ PM$_{10}$
○ SO$_2$
○ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
○ Odours
○ GPS

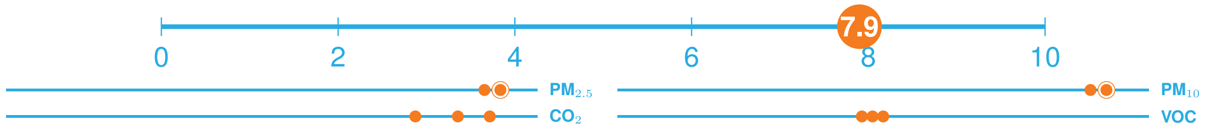
☑ Atmospheric pressure
○ Luminosity
☑ Acoustic comfort
○ Anemometer

Data storage location : Europe

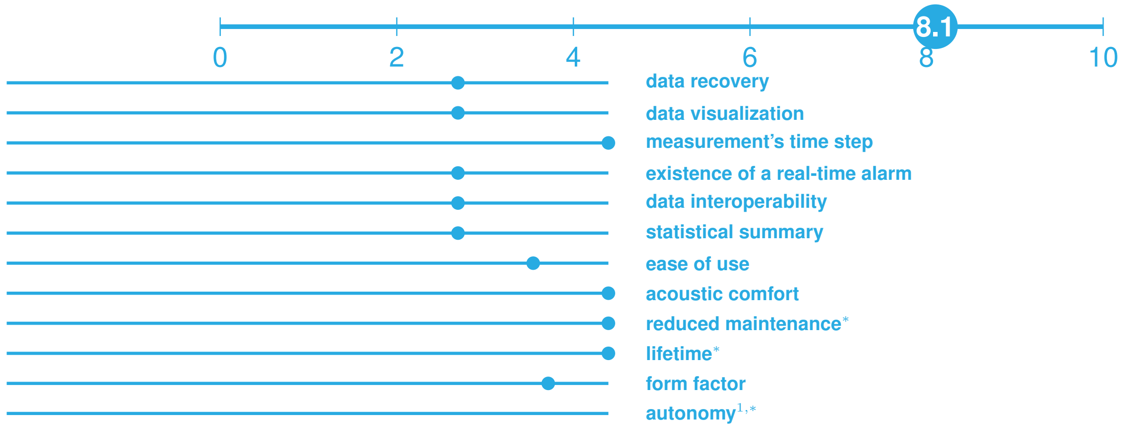
Detailed test results

Evaluated uses :
● outdoor air
● indoor air
● mobility
● all uses

 # ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

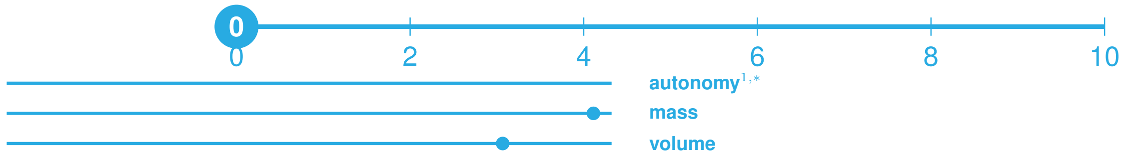


 # ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



 # RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-M** and **IA-A**)[2]

 # PORTABILITY[1,*]



 # COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability
[2] The values on the graph correspond to the categories marked in bold
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ATMO GRAND EST
Atmo HAUTS-DE-FRANCE
Atmo NORMANDIE
cea
CSTB le futur en construction
EDF
Empa Materials Science and Technology
ENGIE
FiMea
Qi² Réseau de recherche Qualité de l'air en Ile-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
WORLD METEOROLOGICAL ORGANIZATION

NANOSENSE EP5000RE P

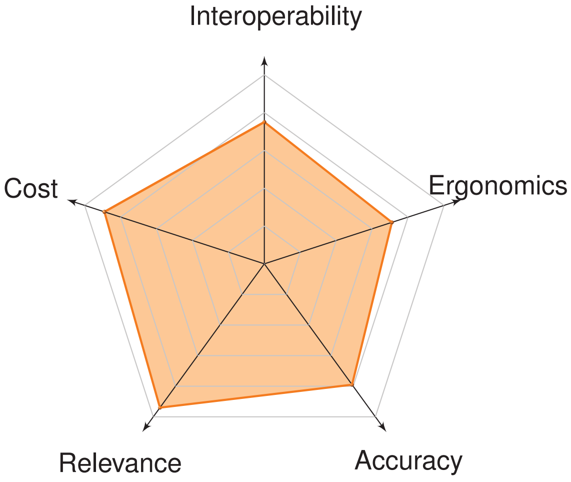
Use for which the evaluation was the best : Indoor air control

Jury's opinion

IA-P ★★★★☆

This device is to be used for indoor air quality piloting and can be supplemented with other Nanosense sensors. It has a design that is very well adapted for easy integration with building equipment. The measurement quality is excellent for particulate matter ($PM_{2.5}$, PM_{10}) is excellent, very good, but with some reproducibility issues, for CO_2, and very poor for VOCs. For this piloting version, no data visualization interface is available, leading to a further cost reduction. Its setup requires some specific technical skills and should be done by a professional.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

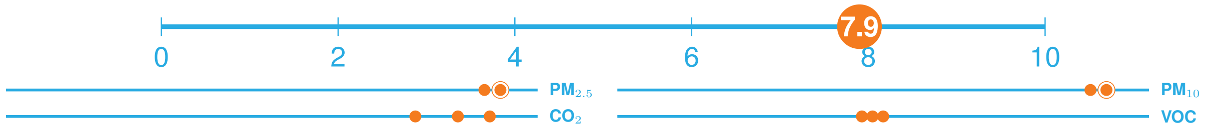
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
☑ Acoustic comfort
○ Anemometer

Data storage location : Europe

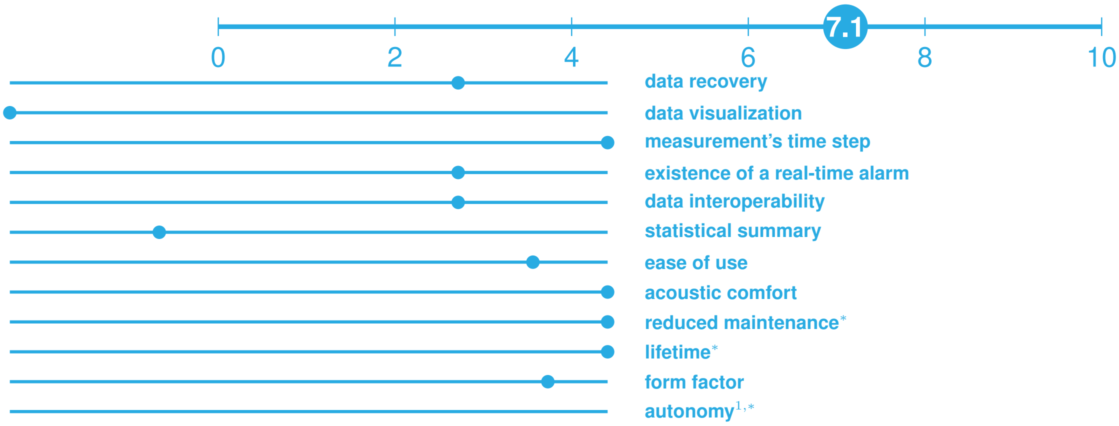
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

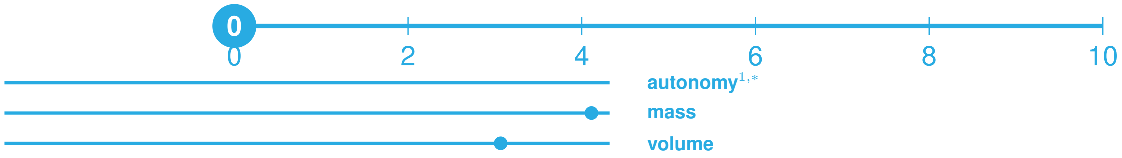


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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NANOSENSE QAA-RE

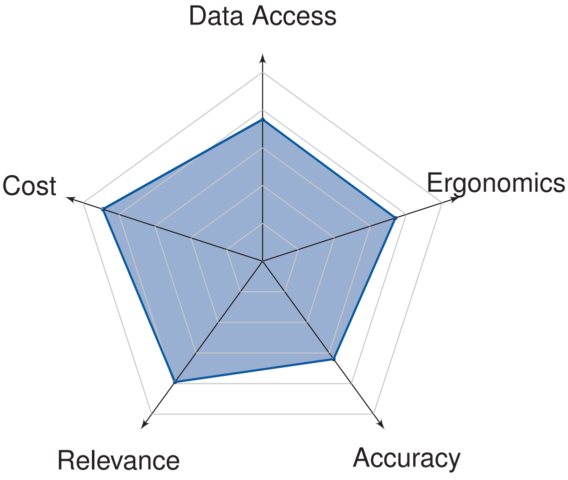
Use for which the evaluation was the best : Monitoring and awareness in outdoor air

Jury’s opinion

OA ★★★★☆

This device is designed to be used for measuring outdoor air quality to provide reference information to indoor air sensors. The quality of the measurement of $PM_{2.5}$ is good, but suffers from reproducibility issues for PM_{10}. In its basic version, no data visualization dashboard is available, however this is available as an option via a small annual subscription to a Pando2 service. In both cases the price of this solution remains very attractive. Its setup requires some specific technical skills and should be done by a professional. Upcoming versions are planned to include additional types of measured pollutants.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
○ CO
○ CO_2
○ VOC
○ H_2S
○ NH_3
○ NO
○ NO_2 (NO_x)
○ O_3
○ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

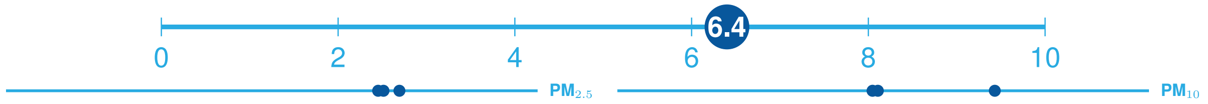
☑ Temperature
☑ Humidity
○ Odours
○ GPS
○ Atmospheric pressure
○ Luminosity
☑ Acoustic comfort
○ Anemometer

Data storage location : Europe

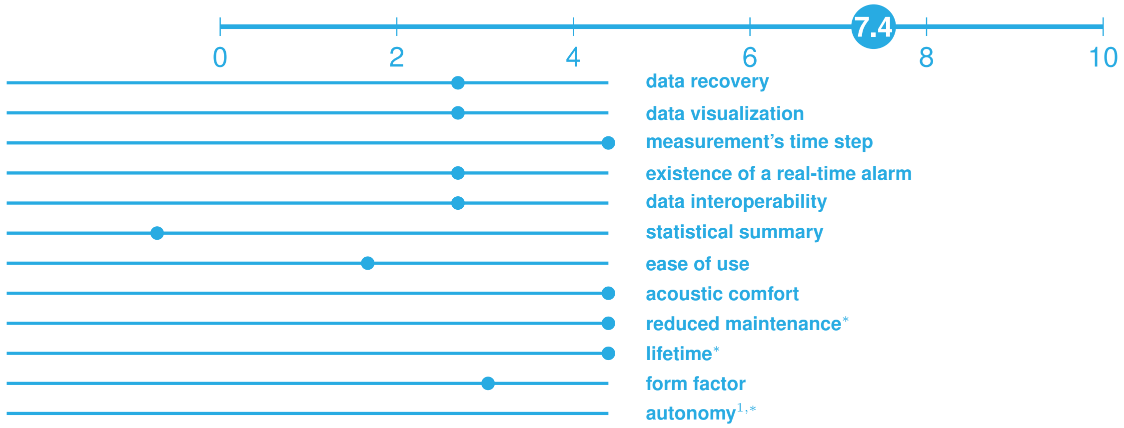
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

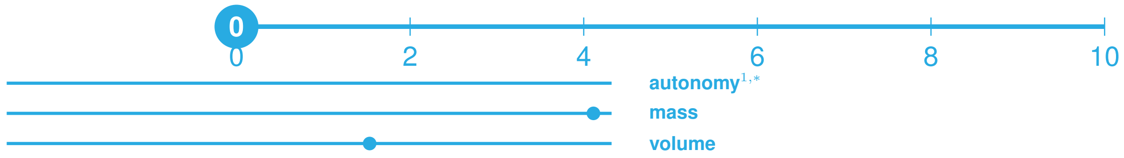


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M et **OA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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POLLUTRACK POLLUTRACK

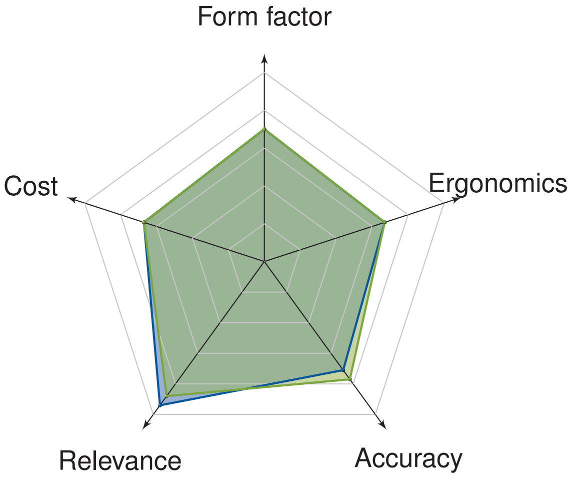
Use for which the evaluation was the best : All uses in outdoor air

OA ★★★½☆

Jury’s opinion

This device is designed to be attached to a vehicle for mobile outdoor $PM_{2.5}$ measurements. Its data quality is good, especially when mobile. Data recovery can be done through an API, which we have tested. No data visualization tool was provided for our evaluation. Although designed for vehicle applications, no specific mounting points or mechanism is included in the design. Its price is competitive relatively to other similar solutions.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ○ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ☑ $PM_{2,5}$
- ○ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

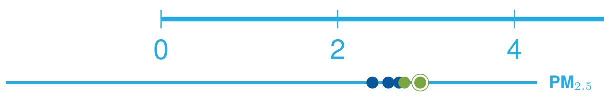
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ○ Atmospheric pressure
- ○ Luminosity
- ○ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

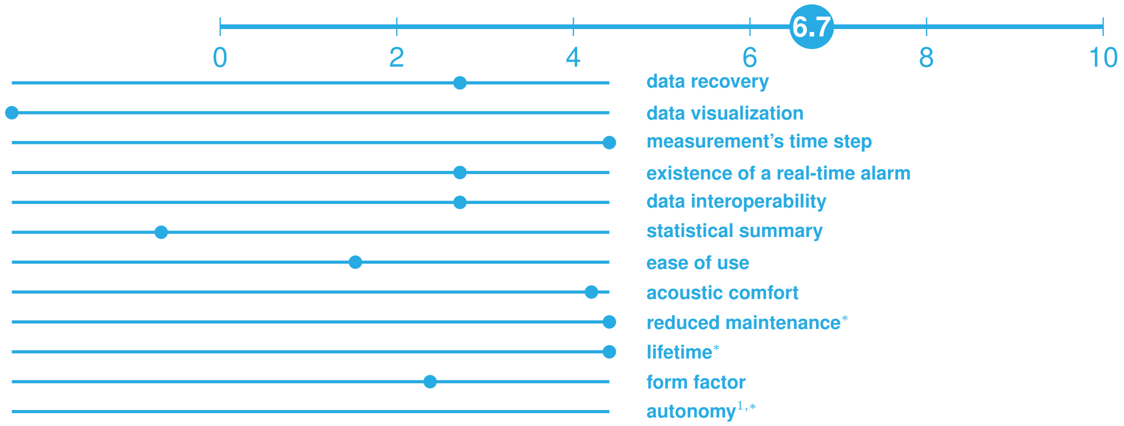
Detailed test results

Evaluated uses :
● outdoor air
● indoor air
● mobility
● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

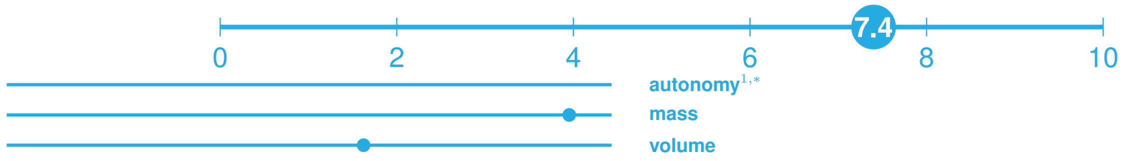


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M, **OA-A** and **OA-V**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

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[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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Entreprise/Company

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AIRLAB

MICROSENSORS CHALLENGE

2019

RUBIX POD

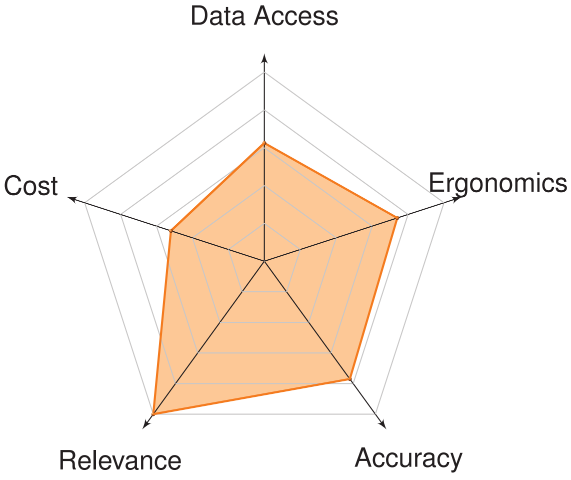
Use for which the evaluation was the best : Indoor air monitoring

Jury's opinion

This device is designed for use in indoor air quality monitoring. It provides CO_2 and $PM_{2.5}$ measurements, with very good data quality for the former and a good performance for the latter. It has a pleasing esthetic design and high quality cloud services and API. However, this is a relatively expensive solution for the targeted application.

IA-M ★★★★☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ☐ CH_2O
- ☐ CO
- ☑ CO_2
- ☐ VOC
- ☐ H_2S
- ☐ NH_3
- ☐ NO
- ☐ NO_2 (NO_x)
- ☐ O_3
- ☐ PM_1
- ☑ $PM_{2,5}$
- ☐ PM_{10}
- ☐ SO_2
- ☐ Particle number (concentration)

Other measurements

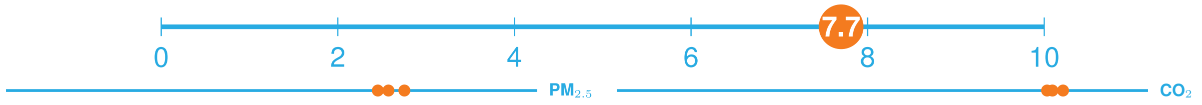
- ☑ Temperature
- ☑ Humidity
- ☑ Odours
- ☐ GPS
- ☑ Atmospheric pressure
- ☐ Luminosity
- ☐ Acoustic comfort
- ☐ Anemometer

Data storage location : Europe

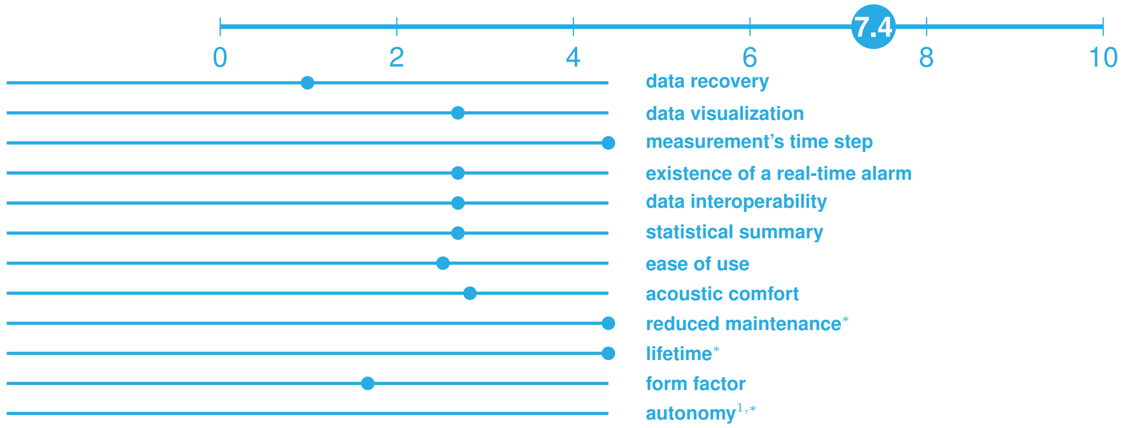
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

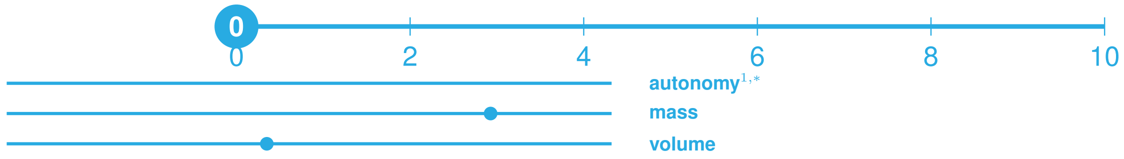


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

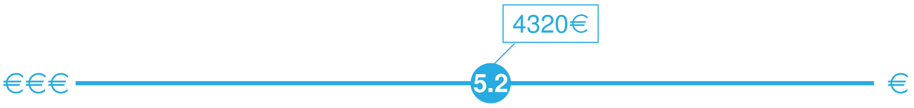


RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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RUBIX WT1

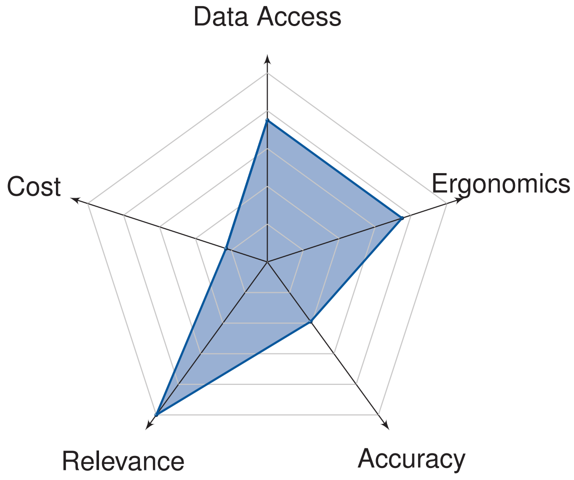
Use for which the evaluation was the best : Outdoor air monitoring

OA-M ★★★☆☆

Jury's opinion

This device is designed for use in outdoor air quality monitoring. It provides NO_2, $PM_{2.5}$ and PM_{10} measurements, with a good data quality for NO_2, but very poor for particulate matter. It has a pleasing esthetic design and high quality cloud services and API. However, this is an expensive solution for the targeted application.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ○ CO_2
- ○ VOC
- ○ H_2S
- ○ NH_3
- ○ NO
- ✓ NO_2 (NO_x)
- ○ O_3
- ○ PM_1
- ✓ $PM_{2,5}$
- ✓ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

- ✓ Temperature
- ✓ Humidity
- ○ Odours
- ○ GPS
- ✓ Atmospheric pressure
- ○ Luminosity
- ✓ Acoustic comfort
- ○ Anemometer

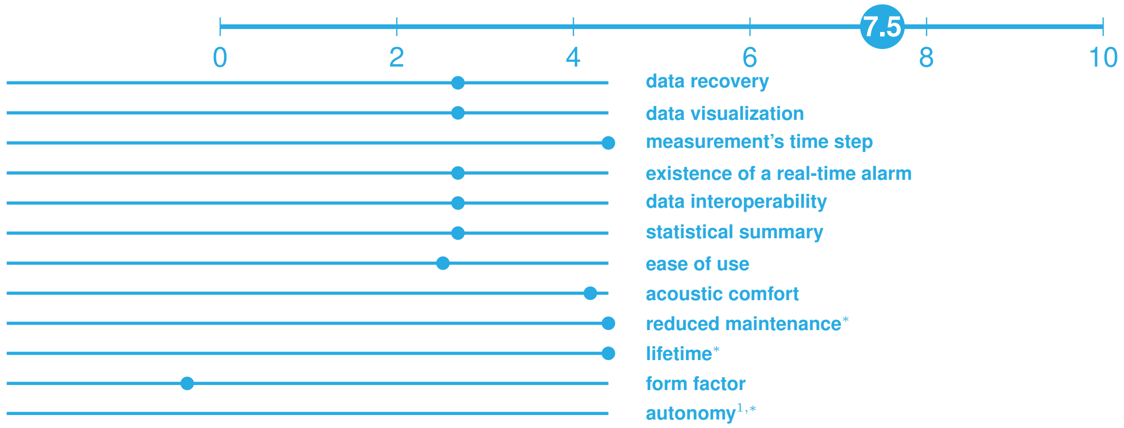
Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

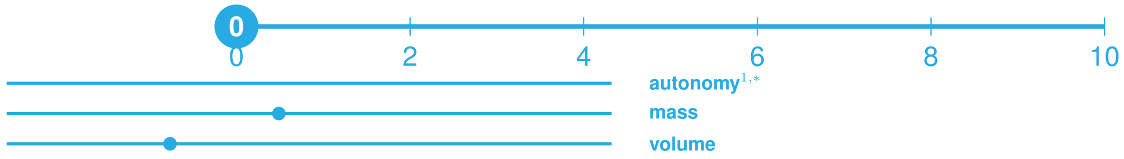
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)



RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

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Qi² Réseau de recherche Qualité de l'air en Ile-de-France
Observatoire de la qualité de l'air intérieur
VEOLIA
WORLD METEOROLOGICAL ORGANIZATION

SIM ENGINEERING SIM-MONI

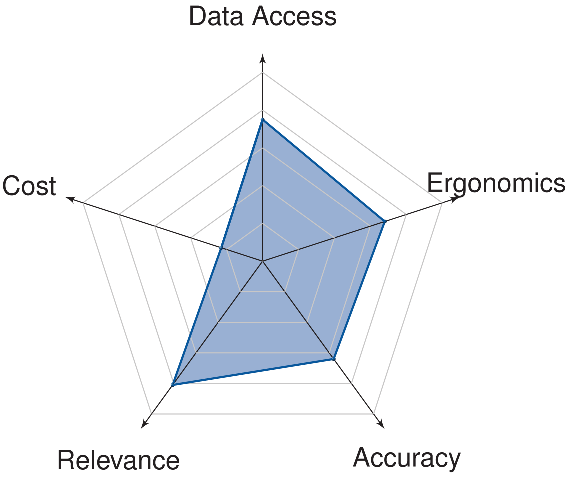
Use for which the evaluation was the best : Outdoor air monitoring

OA-M ★★★☆☆

Jury's opinion

This multi-pollutant device is designed for use in outdoor air quality monitoring. Although still in a prototype phase (TRL 7), it is a relatively mature platform with a professional look and feel. It provides a large array of measured pollutants and ambient parameters. The data quality is very good for NO_2 and O_3, but poor for particulate matter, except for PM_1. It is an expensive solution for the targeted application.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

- ○ CH_2O
- ○ CO
- ☑ CO_2
- ☑ VOC
- ☑ H_2S
- ○ NH_3
- ○ NO
- ☑ NO_2 (NO_x)
- ☑ O_3
- ☑ PM_1
- ☑ $PM_{2,5}$
- ☑ PM_{10}
- ○ SO_2
- ○ Particle number (concentration)

Other measurements

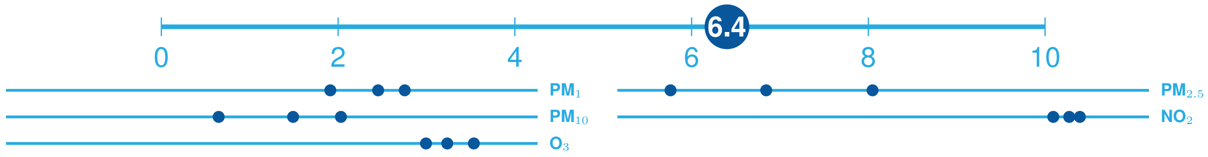
- ☑ Temperature
- ☑ Humidity
- ○ Odours
- ○ GPS
- ☑ Atmospheric pressure
- ○ Luminosity
- ☑ Acoustic comfort
- ○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

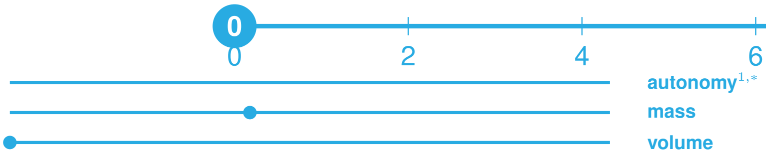
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**OA-M**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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Partenaires du challenge/Challenge's partners

VAISALA SAS AQT410

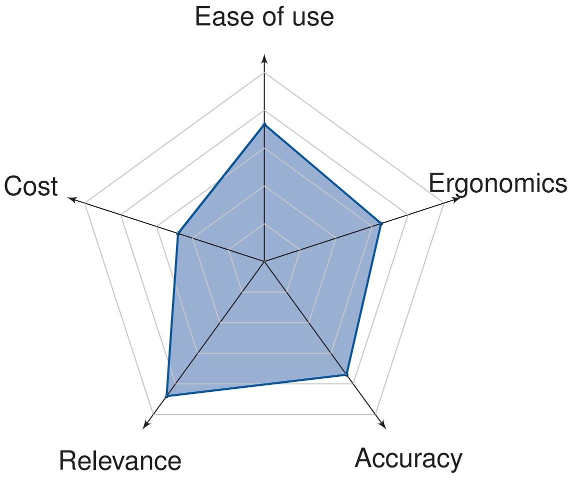
Use for which the evaluation was the best : Monitoring and awareness in outdoor air

Jury's opinion

This device is intended for measuring outdoor air. It is easy to install despite the need to separate the measurement module from the communication module. Its data quality is very good for NO and NO_2 and average for O_3. The inclusion of particulate matter measurements would be very welcomed, especially considering the price of the station.

OA ★★★⯪☆

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

☐ CH_2O
☑ CO
☐ CO_2
☐ VOC
☐ H_2S
☐ NH_3
☑ NO

☑ NO_2 (NO_x)
☑ O_3
☐ PM_1
☐ $PM_{2,5}$
☐ PM_{10}
☐ SO_2
☐ Particle number (concentration)

Other measurements

☑ Temperature
☑ Humidity
☐ Odours
☐ GPS

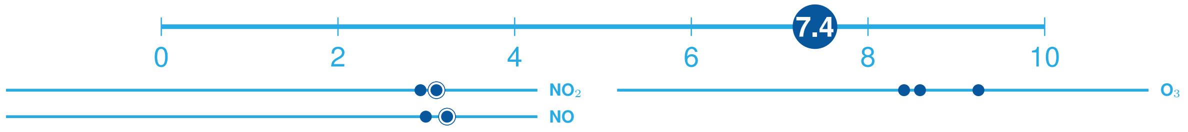
☐ Atmospheric pressure
☐ Luminosity
☐ Acoustic comfort
☐ Anemometer

Data storage location : Europe

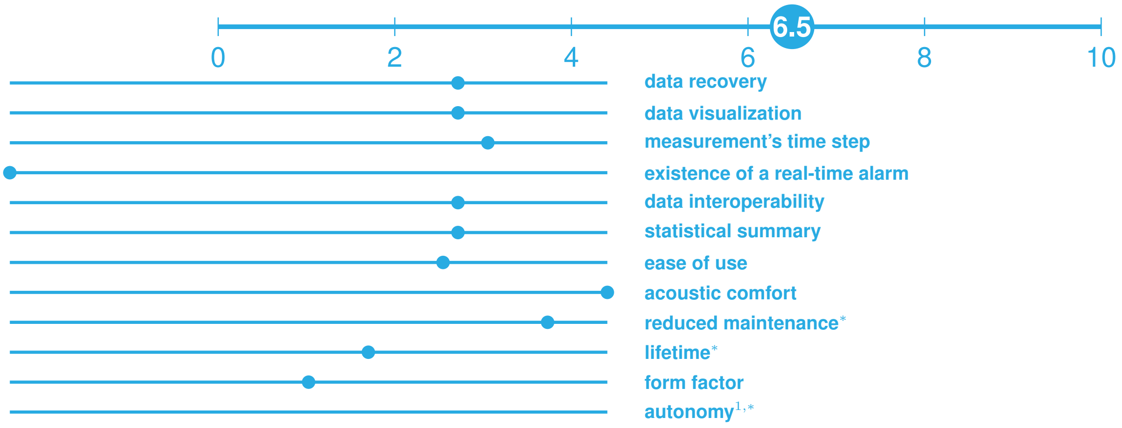
Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)

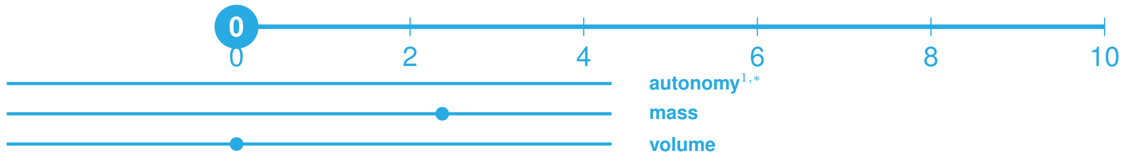


ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

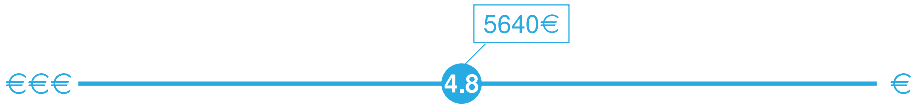


RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (OA-M and **OA-A**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years



[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

* This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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Partenaires du challenge/Challenge's partners

ZAACK ZAACK QAI

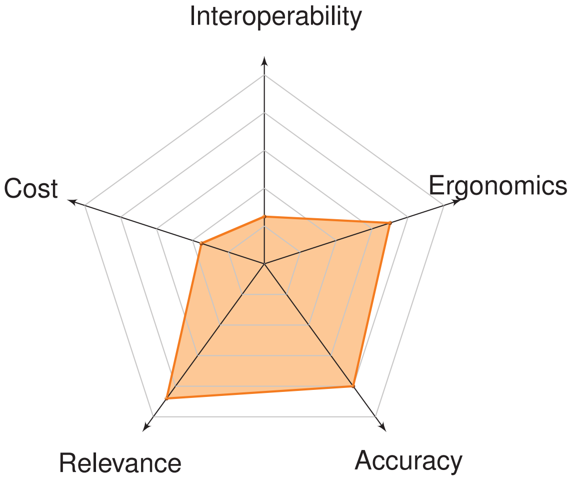
Use for which the evaluation was the best : Indoor air piloting

IA-P ★★★⯪☆

Jury's opinion

This multi-pollutant device is designed for use in measuring indoor air quality for raising awareness and piloting. It provides a large array of measured pollutants and achieves excellent data quality for CO_2, very good for particulate matter (PM_1, $PM_{2.5}$ and PM_{10}), good for NO_2, but poor for total VOCs. Installation and interfacing with other devices are handled directly by the manufacturer, with no direct access for the user to an API for data recovery. While live data visualization is free of charge, data access is billed per extraction. Its price tag is high for the targeted applications.

Evaluation



Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility

Measured pollutants

○ CH_2O
☑ CO
☑ CO_2
☑ VOC
○ H_2S
○ NH_3
○ NO
☑ NO_2 (NO_x)
☑ O_3
☑ PM_1
☑ $PM_{2,5}$
☑ PM_{10}
○ SO_2
○ Particle number (concentration)

Other measurements

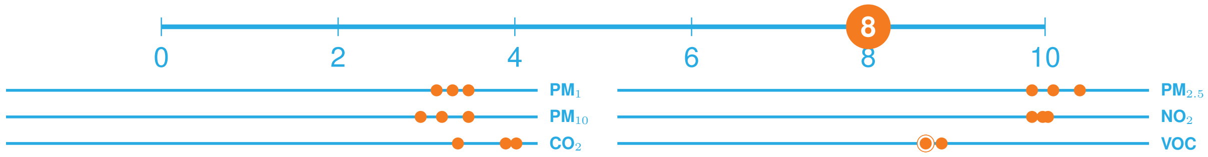
☑ Temperature
☑ Humidity
○ Odours
○ GPS
☑ Atmospheric pressure
○ Luminosity
○ Acoustic comfort
○ Anemometer

Data storage location : Europe

Detailed test results

Evaluated uses :
- ● outdoor air
- ● indoor air
- ● mobility
- ● all uses

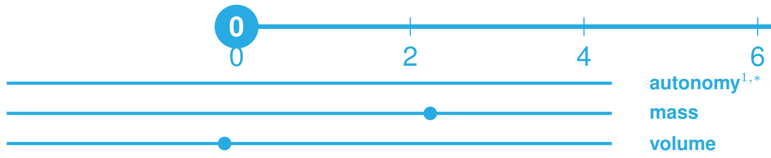
ACCURACY on 3 microsensors based on the SET method (Fishbain & al. 2017)



ERGONOMICS based on several sub-criteria (data vizualisation, ease of use, autonomy, ...)

RELEVANCE of the measured pollutants : number and stake of the sensor's measured pollutants in view of its competing categories (**IA-A** and **IA-P**)[2]

PORTABILITY[1,*]



COST investment and running costs over 3 years

[1] Regarding mains-operated sensors, autonomy is **only** taken into account for portability

[2] The values on the graph correspond to the categories marked in bold

[*] This parameter was not directly evaluated : it was graded based on the manufacturer declaration

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Challenge Microcapteurs 2019

This Challenge is part of the activities of AIRLAB, accelerator of technological or behavioural solutions to improve the air quality.

The AIRLAB ecosystem brings together a community committed to improving the air quality: large companies, SMEs and start-ups, institutions and communities, research institutes, NGOs... AIRLAB aims at identifying and stimulating new levers to go further and faster in reducing pollution in Paris and in the Île-de-France Region, whatever the sources. And evaluate their performance to inform decision-makers and users.

AIRLAB was created by Airparif and its founding partners in September 2017, after a prefiguration mission funded by the Île-de-France Region.

More information on www.airlab.solutions

ERRATA

1. In the first published version of this document a product from manufacturer Airthinx was erroneously included in tables “Indoor Air – Monitoring (IA-M)” (page 8) and “In indoor air (IA) >> PM2.5” (page 11). This was due to an editing error on the document and the values indicated in the aforementioned version do not in any way reflect an evaluation of the performance of a product from this manufacturer.

2. On page 57, the data storage location for the Meo sensor was corrected to “Europe” (it previously erroneously indicated “Asia”).

3. On page 58, the logo for manufacturer Meo was updated from its 2018 version to the current form.

4. On page 14, the calculated cost for Atmotrack has been corrected to 5280 €. The previously stated value was 8710 €, due to a filling error in the candidate submission form.

5. On pages 37 and 38, the Jury’s opinion text has been corrected to indicate the availability of an API service for the devices from Ecomesure (it previously stated that this was not available).

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