Future Electronics Grand Rapids Tech Day 2019
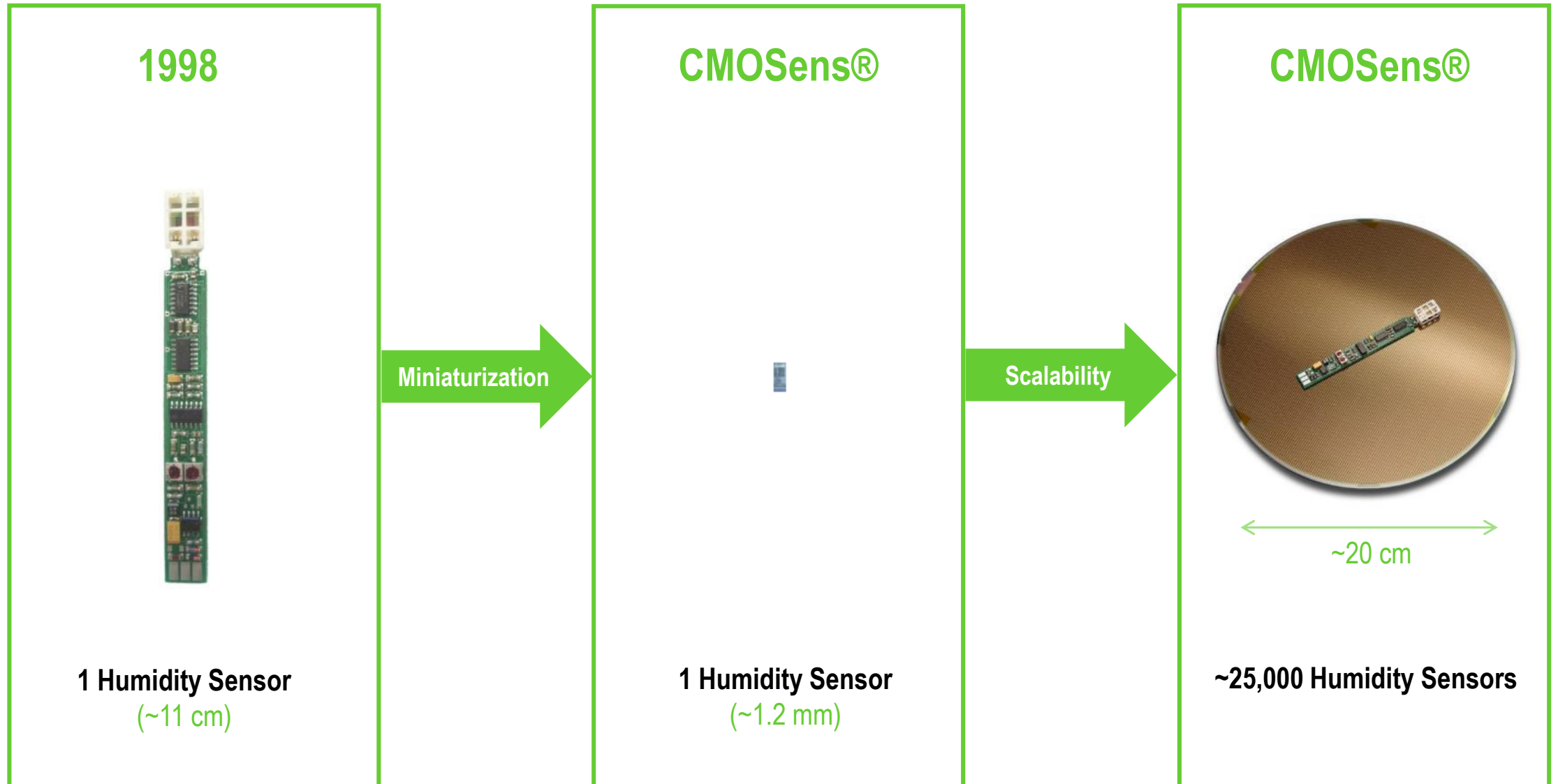
Zikomo Smith : Area Sales Manager
Angela Mercurio: Area Sales Manager
Allied Enterprises
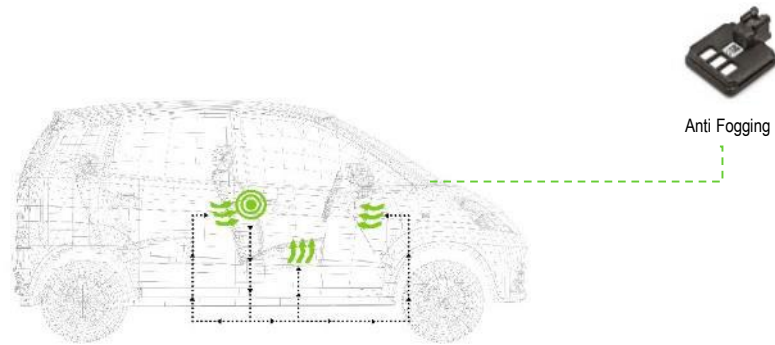
Pioneers in Sensor Technology
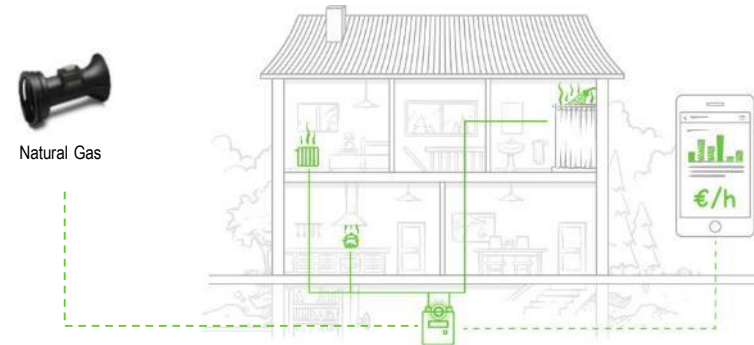
1998

1 Humidity Sensor
(~11 cm)

Miniaturization

CMOSens®

1 Humidity Sensor
(~1.2 mm)

Scalability

CMOSens®

~20 cm

~25,000 Humidity Sensors

Confidential
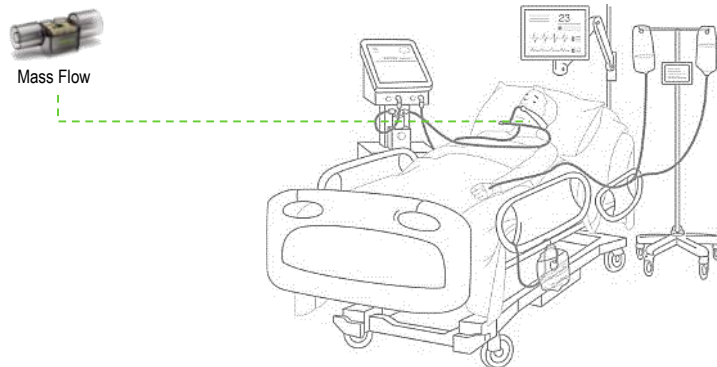
SENSIRION
THE SENSOR COMPANY

Solving Complex Problems Everywhere

Anti Fogging

Providing antifogging, engine and climate control to approximately **one in three cars** manufactured worldwide.

Natural Gas

Reliable real-time monitoring of gas consumption for **more than 1 million** households.

Mass Flow

Monitoring the breathing of **more than 10 million** patients in hospitals and at home.

Humidity & Temperature
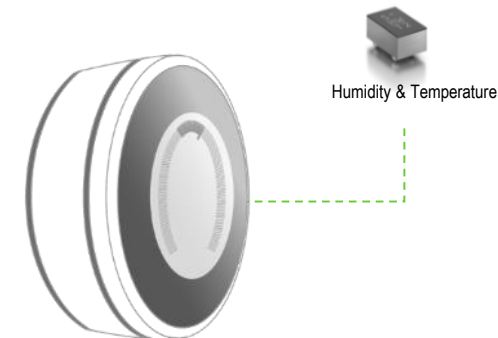
High precision monitoring of temperature and air quality for **millions** of households.

SENSIRION
THE SENSOR COMPANY

Our Growth Drivers

Energy Efficiency

- Scarcity of resources
- Governmental and societal initiatives

Quality of Life & Healthcare

- Economic development
- Increasing awareness around health, safety, comfort

Digitalization, Automation, Productivity Increase

- Digitalization and automation
- Technological advancements
- Connectivity, IoT

| Automotive 🚗 | Medical ❤ | Industrial 🏢 | Consumer 📱 |

Sensirion's sensor solutions are critical for many applications across these growth drivers.

Source: Gartner

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SENSIRION
THE SENSOR COMPANY

Our Success

Innovation Leader
In Flow and Environmental Sensing

> 50%[1]
Of the Global Humidity Sensor Share

~ 1 in 3[1]
Cars

> 90%[1]
Of all CPAP[2] Devices

> 600M
Sensors Sold

1) Based on internal estimates
2) Continuous positive airway pressure

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Our Markets at a Glance

Automotive

Industrial
Appliances / HVAC / Smart Energy

Medical

Consumer

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SENSIRION
THE SENSOR COMPANY

Our Solutions and Applications Across Our Markets

	Automotive 🚗	Medical 💓	Industrial 🏢	Consumer 📱
Environmental Sensors	✓	✓	✓	✓
Flow Sensors	✓	✓	✓	✗
Key Applications	▪ Auto defogging ▪ Climate control ▪ Engine control	▪ CPAP ▪ Ventilators ▪ Anesthesia	▪ Appliances ▪ Gas metering ▪ HVAC	▪ IP-Cams ▪ Gadgets ▪ Thermostats
% of Revenues in 2018	31%	22%	39%	8%

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Facts & Figures

1998 Founded
2018 Public

783 [1)]
Full Time Equivalents
(FTEs)

175M CHF [2)]
Revenue

~ 180
Patent Families
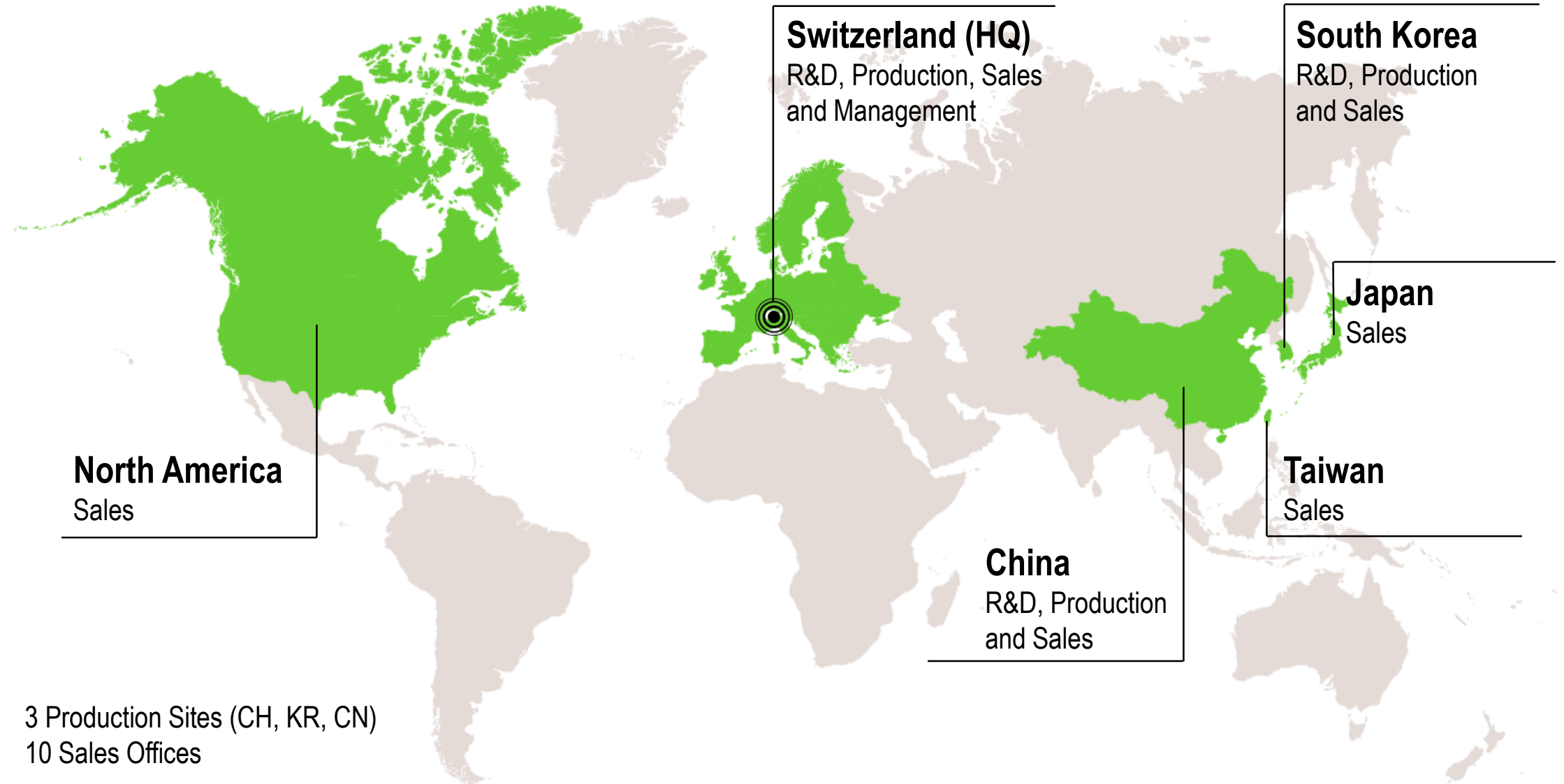
15% [3)]
CAGR [4)] over the
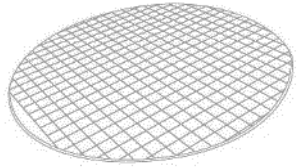Last 3 Years

21% [2)]
Of Revenue Invested in
R&D

1) As of 31st December 2018
2) 2018
3) 2016 – 2018
4) Compound annual growth rate

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SENSIRION
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Global Presence

Switzerland (HQ)
R&D, Production, Sales and Management

South Korea
R&D, Production and Sales

Japan
Sales

North America
Sales

Taiwan
Sales

China
R&D, Production and Sales

3 Production Sites (CH, KR, CN)
10 Sales Offices

SENSIRION
THE SENSOR COMPANY

Our Core Competencies
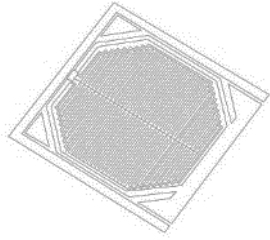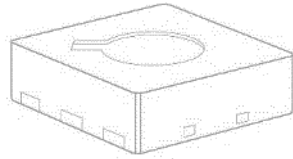
| ASIC | MEMS | Packaging | Calibration | Sensor Solutions | Applications |
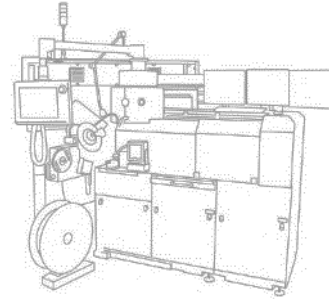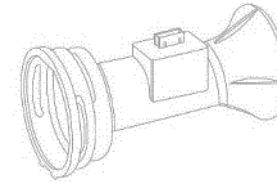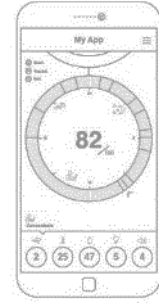
Innovation is at the core of our business - across all relevant fields of the technology chain.

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Sensirion Product Lines

Environmental Sensors and Modules
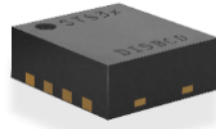
Humidity & Temperature   **Temperature**   **Gas**   **Carbon Dioxide**   **Particulate Matter**
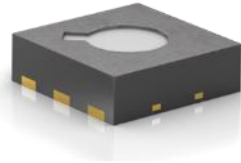
Flow Sensors and Modules

Natural Gas   **Differential Pressure**   **Liquid Flow**   **Mass Flow**

Sensirion Automotive Solutions Product Lines

Automotive Sensors

Particulate Matter Sensor

Air Quality Sensor
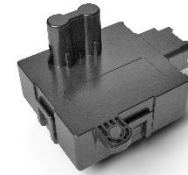
Ionizer

Cabin Air Temperature Sensor

Anti-Fogging/Auto-Defrost Sensor

Dew Point Sensor

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Sensirion RH/T Sensor Portfolio

SHTC3

- Low-power, battery driven device

- SHTC1 Customer uses LDO & level-shifter (cost saving of 10-20 cent)

- High price pressure on SHT30

- @ 1.8V: Higher accuracy
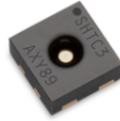
SHTC1

- Customer needs 1.8 V and does not higher accuracy (there is no EOL planned for the SHTC1)
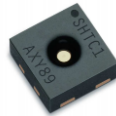
SHTW2

- Customer needs 1.8 V and needs/is able to handle the very small size

- Extreme price pressure

SHT3x

- Customer needs more features or filter membrane/protective cover

- Customer needs >3.6V

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3rd Generation RH/T Product Portfolio

Markets / Applications

High-end   Industrial   HVAC   Medical   Data Loggers   HDD   Mobile Devices

Measurement&Test   Automotive   Home Appliances   IoT   Consumer Electronics

Product Lines

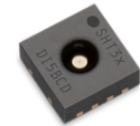| SHT85	SHT3x / STS3x	SHTC3	SHTC1/W2
2.4 – 5.5 V I2C ~19.5 x 5.5 x 2.2-3.5 mm^3	2.4 – 5.5 V I2C, analog voltage 2.5 x 2.5 x 0.9 mm^3	1.6 – 3.6 V I2C 2 x 2 x 0.75 mm^3	1.8 V I2C 2 x 2 x 0.75 mm^3 1.3 x 0.7 x 075 mm^3

Sensor Products (accuracy)

advanced   standard   basic

SHT85	SHT35 / STS35		
	SHT31 / STS31		
	SHT30 / STS30	SHTC3	SHTC1/W2

Protection Options

Membrane   SF2 / Opt. Prot. Cover / Opt. Membrane

Evaluation Kits

SEK-Environmental Sensors

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Question 1

What year was Sensirion founded ?

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Indoor Air Quality: Source and Impact of CO_2

Humans increase CO2 concentration in confined spaces

O=C=O
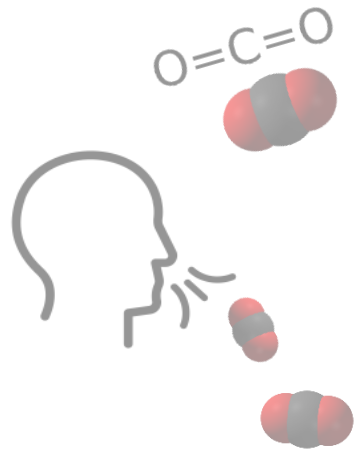
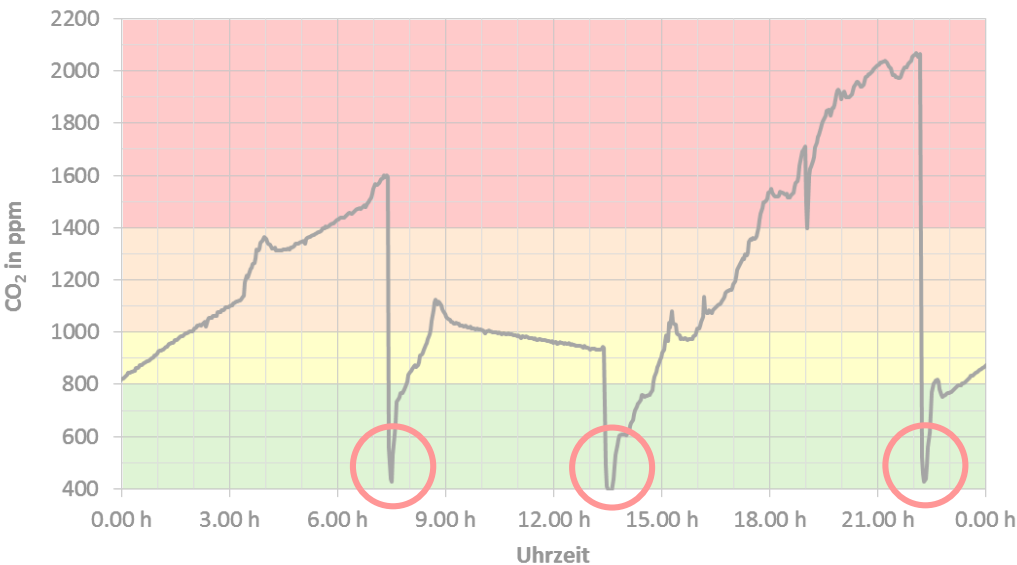**Indoor Air Quality strongly correlates with CO_2 concentration**

1'000 ppm

600 ppm

2'000 ppm

400 ppm
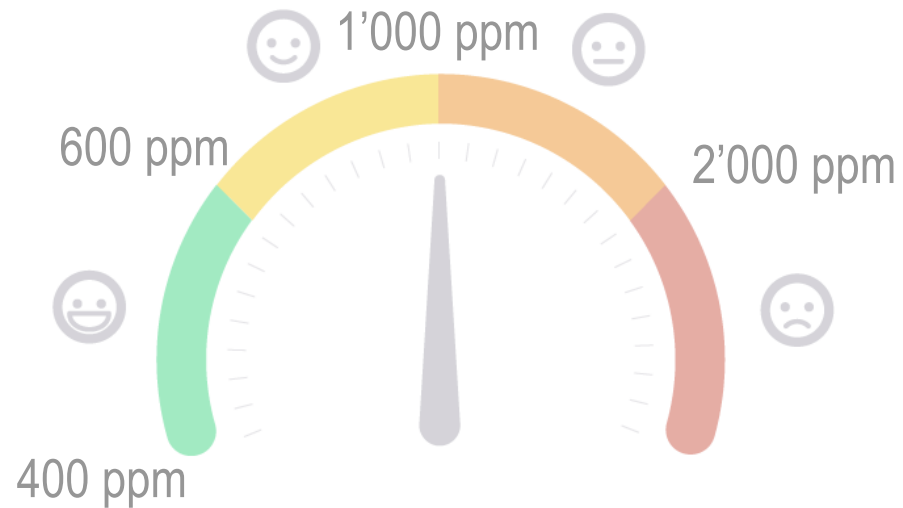
High CO_2 levels cause drowsiness, reduced concentrations and headaches

Zzz

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Typical CO_2 Concentration and Policy Standards

CO_2 concentration profile in an occupied room
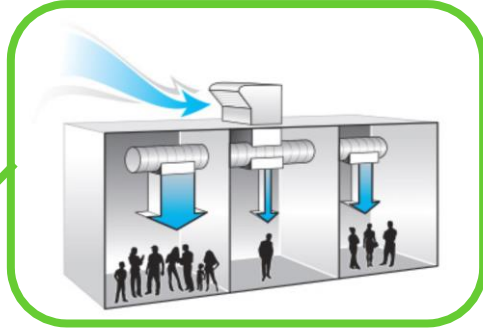

Ventilation Event

2007 European Standard EN 13779

Indoor air quality can be categorised by CO_2 concentration. CO_2 is a good indicator for the emission of human bioeffluents (…) for occupied rooms, where smoking is not allowed and pollution is caused mainly by human metabolism.

Indoor air quality Category	Description	CO_2-level above level of outdoor air [ppm]
IDA 1	High indoor air quality	< 400
IDA 2	Medium indoor air quality	400 – 600
IDA 3	Moderate indoor air quality	600 – 1000
IDA 4	Low indoor air quality	> 1000

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Indoor CO$_2$ Sensing: Motivation
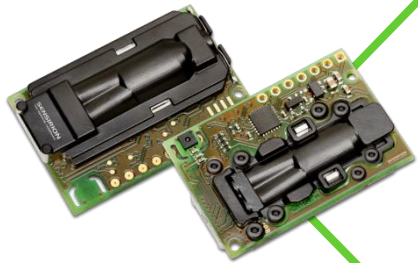
Demand Controlled Ventilation (DCV)
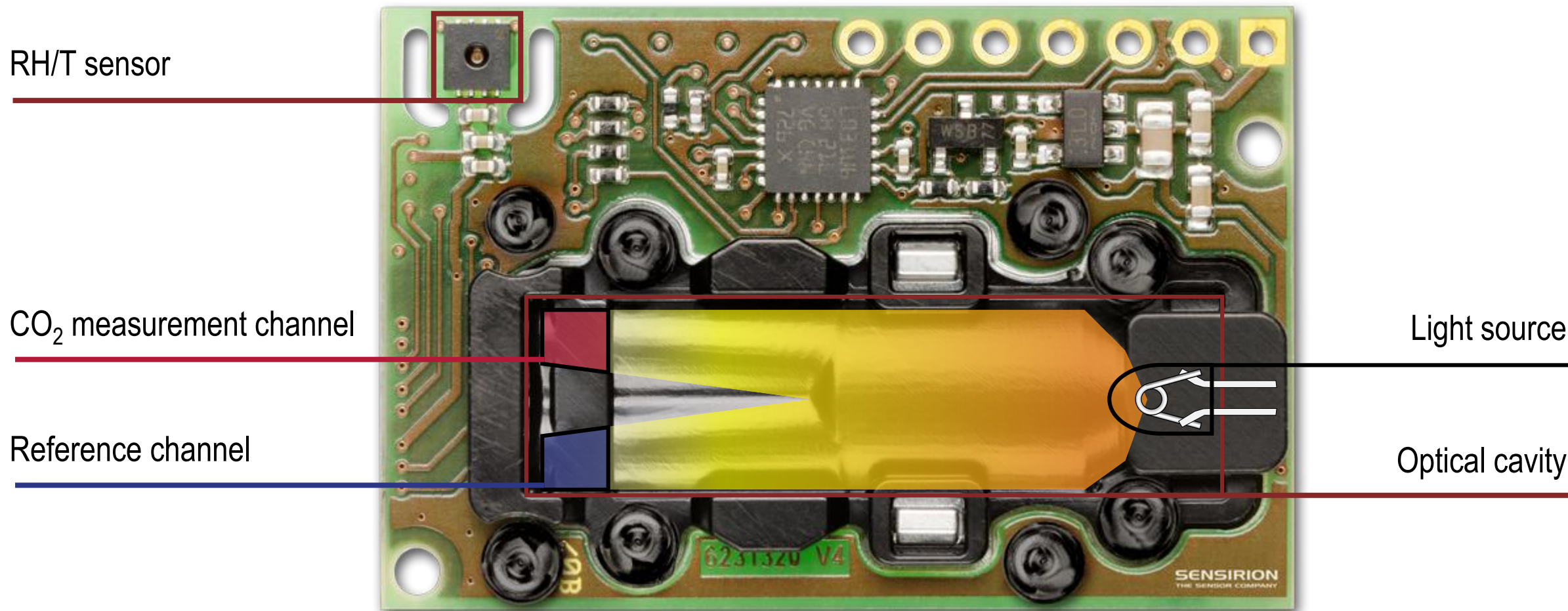- Use CO2 sensor as a trigger to activate ventilation
- Ensure well-being, health and productivity
- Increase energy efficiency of buildings

Indoor Air Quality Monitoring (IAQ)
- Monitoring of CO2 in indoor environments
- Show the customer that air quality is good
- Educate the customer to open a window in case of high CO2 concentrations

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Sensirion SCD30 - New NDIR combo sensor: CO_2 + RH + Temp

RH/T sensor

CO_2 measurement channel

Reference channel

Light source
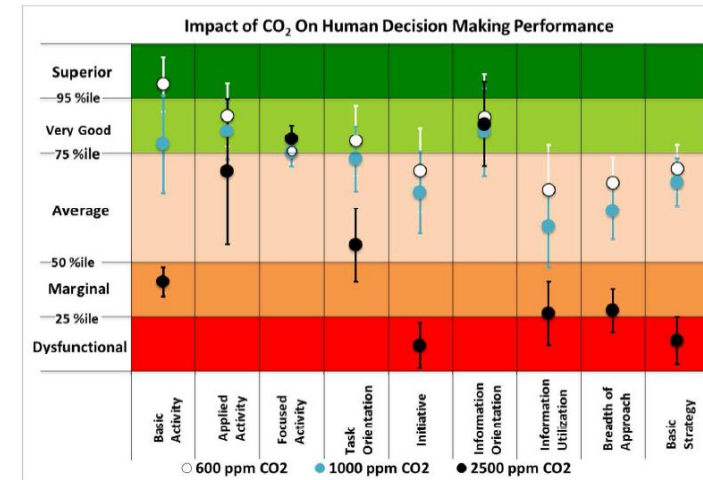
Optical cavity

SENSIRION
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Sensirion SCD30 - New combo sensor: CO_2 + RH + Temp
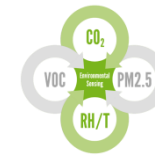
Effects on Humans -

- Mood swings and anxiety

- Nausea

- Headache

- Lathargy and drowsiness

- Decreased cognitive abilities from Workers in Office Buildings @ CO2 concentrations >750ppm

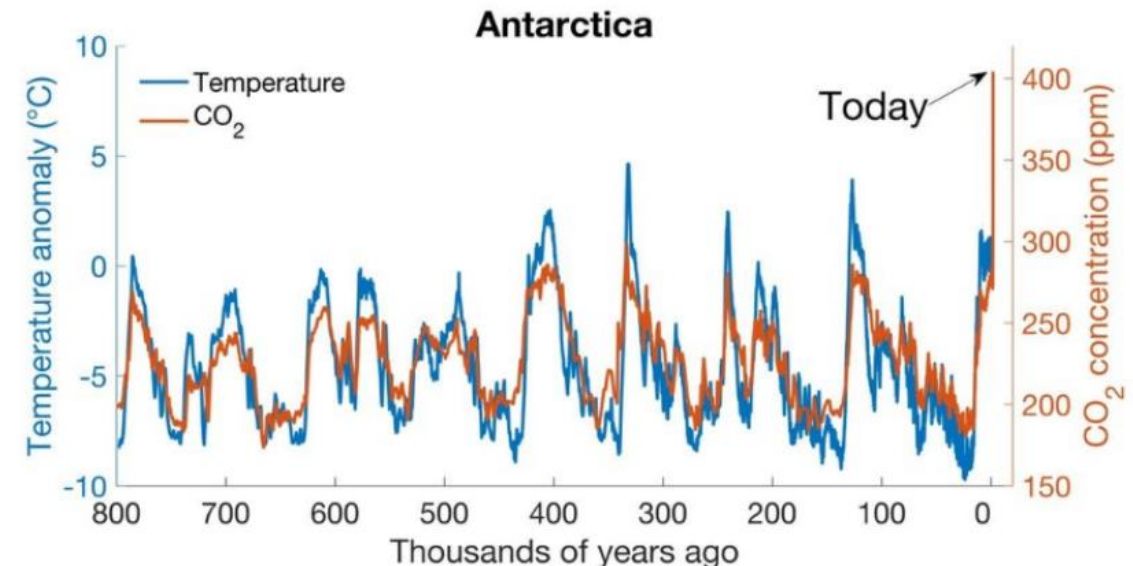*Publications and Regulations*

- *California Title 24 – Demand controlled ventilation to maintain CO2 <600ppm*

  http://www.energy.ca.gov/2015publications/CEC-400-2015-037/CEC-400-2015-037-CMF.pdf

- Environmental Heath Perspectives

  https://ehp.niehs.nih.gov/15-10037/

Impact of CO_2 On Human Decision Making Performance

Antarctica

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SCD30 – NDIR based CO2 sensor with RH + T on board

- Fully calibrated digital sensor > Minimize design efforts, allow fast design cycles

- Low power > Energy efficient

  75mA when the light source is turned on [20% duty cycle for 2s sampling]

  Avg. power consumption: 17.5mA for 0.5Hz; 10mA for 0.1Hz.

- Accurate for 0-10,000ppm. > Reliability

  30ppm + 3% relative error

- Integrated RH and T. Active temperature compensation. > Complete and robust solution for HVAC and building control

- Dual channel principle to offset aging/drift affects of the light source > Long term stability 15 years

- Field calibration FRC + ASC > Very low device to device variation

- Thinnest package > Attractive for wall mounts and other IAQ applications

- CMOSense technology > repeatable and low cost

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Sensirion SPS30

## Particulate Matter (PM) Sensor Module for Air Quality Monitoring Applications

- Particle size mass concentration: *PM1, PM2.5, PM4, PM10*

- Particle size number concentration: *PM0.5, PM1, PM2.5, PM4, PM10*

- Mass concentration range: 0-1000 µg/m3

- Resolution: 1 µg/m3

- Accuracy: ±10 µg/m3 @ 0 to 100 µg/m^3

  ±10 % @ 100 to 1000 µg/m^3

- Supply voltage: 5 V

- Interface: UART, I^{2}C

- Operating temperature: -10 to 60 °C

- Dimensions: 40.6 x 40.6 x 12.2 mm^3

- Lifetime and long-term stability: *> 8 years @ 24h/day operation*
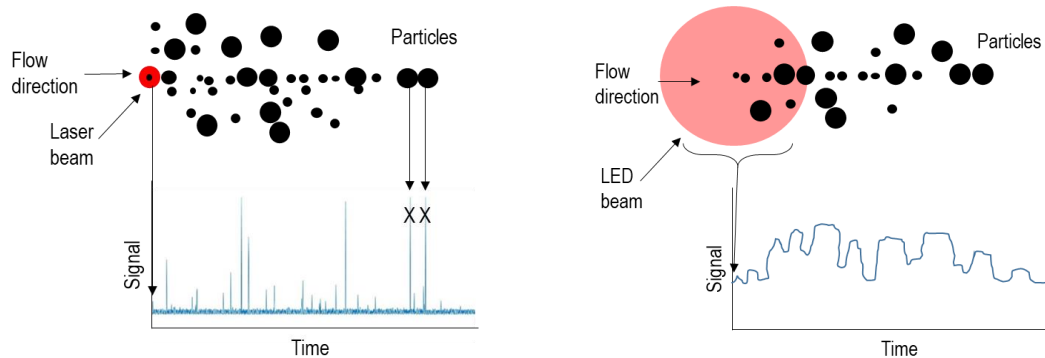

SPS Video

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What are the important features of Sensirion's SPS30?

- **Reliability – Long term stability**
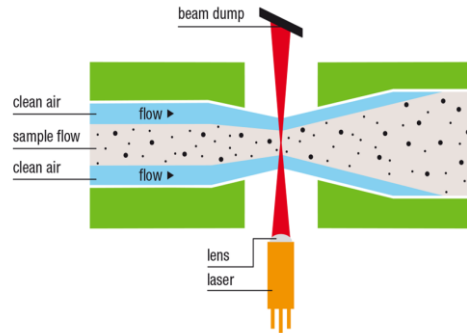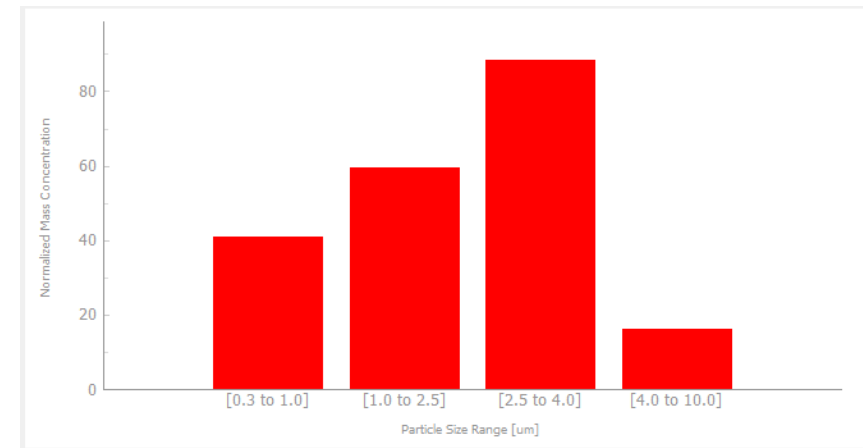

- **Binning – Particle distribution**

Laser vs. LED

- **Applications**
  - **Air purifiers**
  - **HVAC equipment**
  - **Air conditioners**
  - **Air exchangers**
  - **IAQ devices/monitors**
  - **Smoke/fire detection**
  - **Dust monitoring**

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Thermal Flow Measurement

- Highest product performance in terms of speed, reliability and accuracy

- Market leader in medical applications
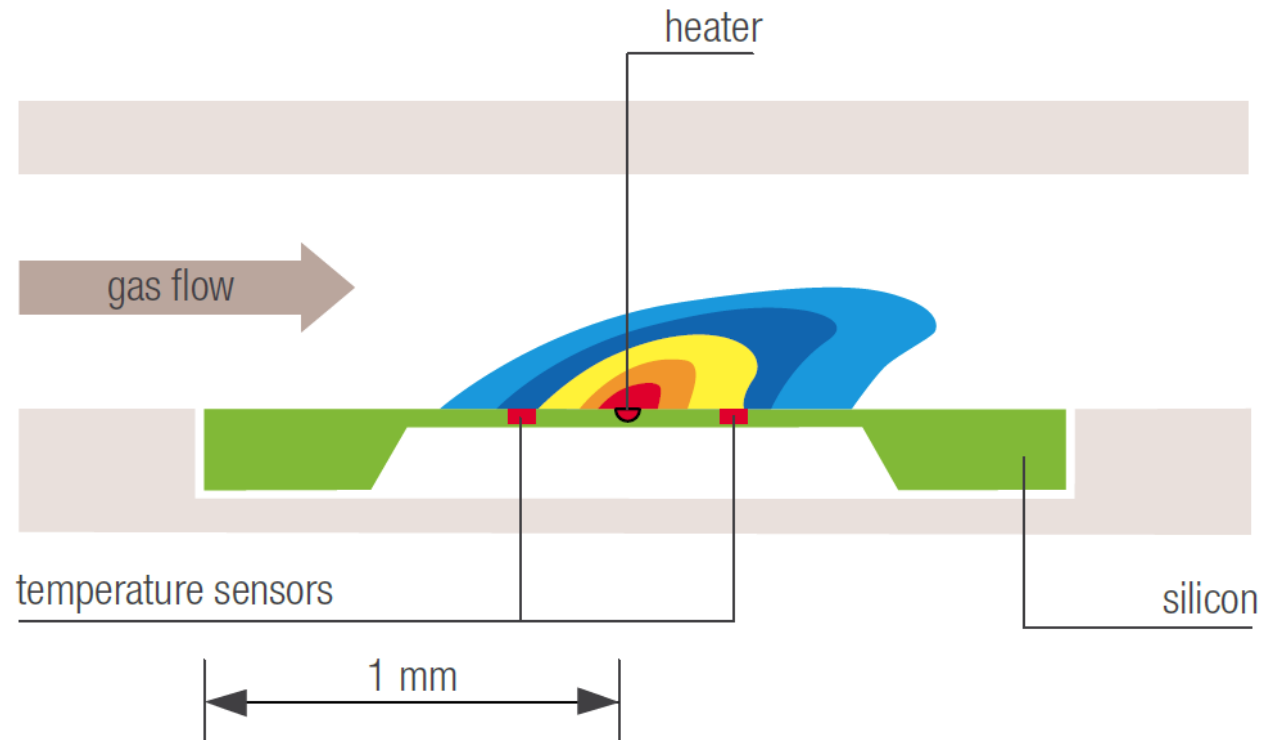
Flow Sensors

- Excellent reliability, accuracy and long term stability

- Fast response time

- Fully calibrated flow measurement

- Autoclavable and disposable sensor solutions

- Customization for high volume applications

Flow Sensors for Ventilation and Anesthesia

Inspiratory	SFM3000	SFM3100	SFM3200

Expiratory	SFM3200-AW Washable / Autoclavable		

Adult   **Infant/Neonate**

Proximal Flow Autoclavable/Washable Single use	SFM3300-AW	SFM3300-D	SFM3400-AW	SFM3400-D

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Flow Sensors vs Differential Pressure Sensors

Volume

High

Never Worked with
Flow Measurement
Before

considerable options	DP Sensors
Flow Sensors	considerable options

Flow Expert

Low

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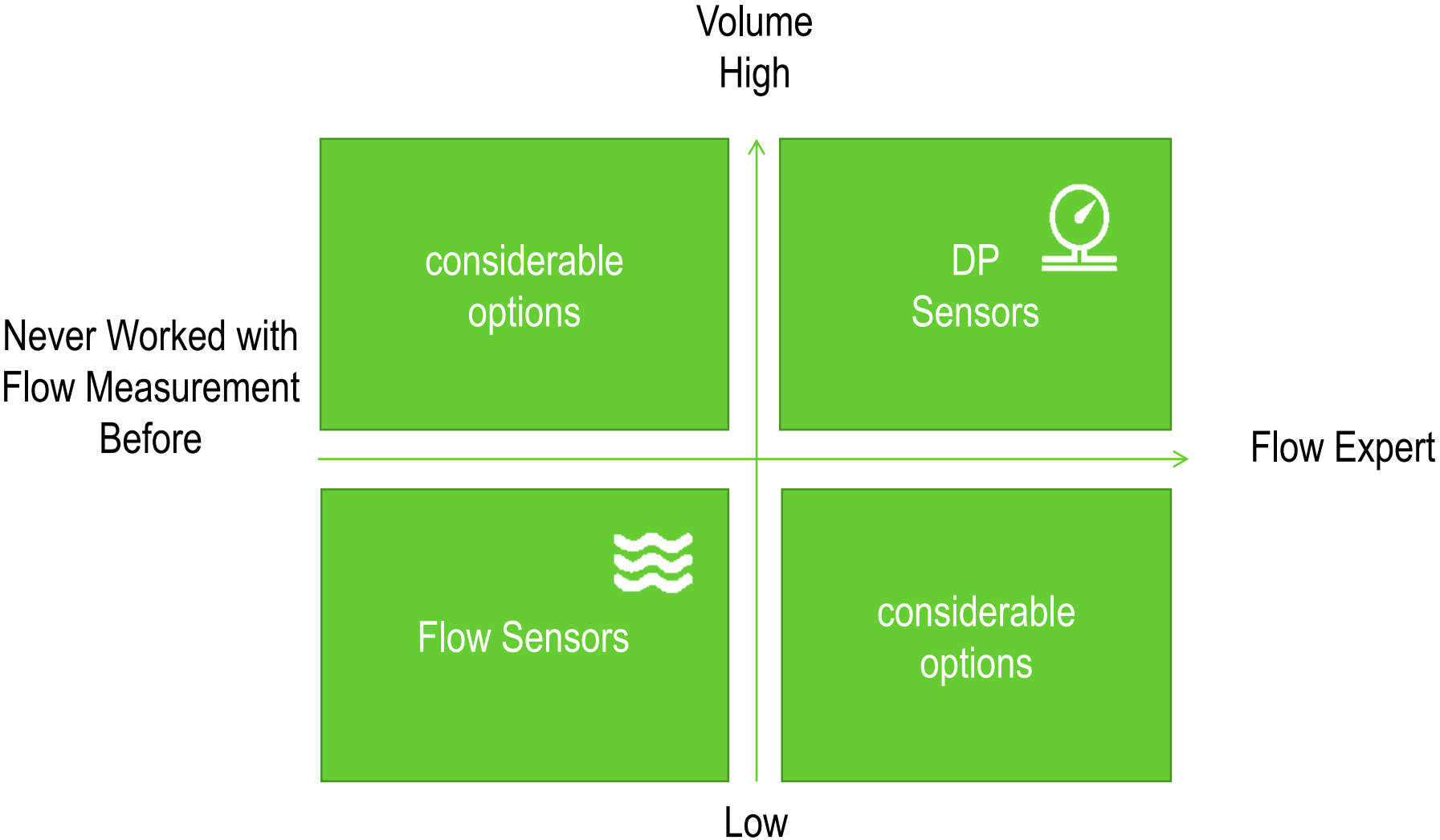
Question 2

What light technology does our CO2 sensor and Particulate Matter sensor use?

Hint
-2 unique light technologies

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Sensirion Focus Applications

RH/T, VOC

Thermostats

Gas Flow, DP, RH/T

Portable Ventilators

RH/T, VOC, CO2

Demand Controlled Ventilation
Improved living with quality air

Demand Controlled Ventilation

RH/T, VOC, CO2, PM2.5

Data-Logger / Cold Chain

RH/T, VOC, PM2.5, CO2

Personal Air Purifiers
For spaces up to 600 square feet

Commercial Air Purifiers
For commercial up to 1400 square feet
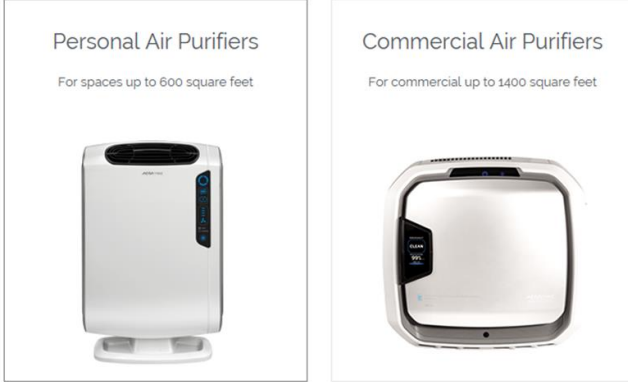
Air Purifiers

RH/T, VOC, SDP

Appliances

RH/T, VOC, CO2

Smart Farming

?

New IoT Applications

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Thermostats –R/HT

Which Sensirion product fits best and why?

Customer Benefit	Enabled by	Our USPs
Easy adaption to changing customer needs		Flexible SHT platform
Best performance of your product (e.g. independent of self-heating by WiFi capability, large displays, etc.)		Temperature Compensation Engine
Lowest Total Cost		Highest volume in the market One Stop Sensor Shop Versatile Solutions
WYSIWYG What you see is what you get		We really fulfil our specifications We do 100% end test (a lot of competitors do neither)

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Thermostats – CO_2

Which Sensirion product fits best and why?
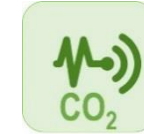
	Customer Benefit	Enabled by	Our USPs
	No customer complaints		Exceptional long term stability by dual channel design
	Lowest integration and product costs		Integrated RHT sensor
	Greater freedom of design		Small form factor (35x23.5x7 mm^3)
	Enables use in battery driven devices		Low power consumption
	Highest performance for advanced HVAC control		Best price/performance ratio

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Demand Control Ventilation – Differential Pressure /Mass Flow

Which Sensirion product fits best and why?

	Customer Benefit	Enabled by	USP
	No (re)calibration required		No drift, no offset (excellent repeatability)
	Highest energy efficiency and reduced emissions (minimized energy losses due to lowest pressure drops)		Highest accuracy at low flows enables precise control
	Lowest Total Cost		Economies of scale One Stop Sensor Shop
	No customer complaints and best customer experience		Return rate of < 50 ppm with multimillion sensors in the field

Demand Control Ventilation – CO_2

Which Sensirion product fits best and why?
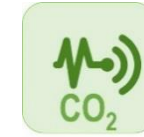
Customer Benefit	Enabled by	USP
Lowest product life time costs		Exceptional long term stability by dual channel design
Lowest integration and product costs		Integrated RHT sensor
Greater freedom of design		Small form factor (35x23.5x7 mm^3)
Enables use in battery driven devices		Low power consumption
Highest performance for advanced HVAC control		Best price/performance ratio

SENSIRION
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Refrigerators

Our humidity and temperature sensors increase energy efficiency and help to keep food fresh longer

- Mullion heater control (67%* global market share): is used to avoid condensation. It is only switched on if humidity is high.

- Compartment control: Fruit, vegetables and meat need different humidity levels to stay fresh.

Reason for Success

- High accuracy & long-term stability

- Tailor-made analog interface

- 1st class technical support

*as per December 2017

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SENSIRION
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Air Purifiers / Humidifiers

Our innovative sensor solutions extend product lifetime and increase accuracy

- Air Purification: Removal of VOCs and particle matter to improve comfort and well-being

- Humidification (60% global market share for RH sensors*): to stay in the comfort zone

Reasons for Success

- IAQ sensor: excellent long-term stability thanks to siloxane resistance

- PM2.5 sensor: excellent long-term stability thanks to dust resistance

- Humidity & temperature sensor: best cost/performance ratio

*as per December 2017

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Indoor CO$_2$ Sensing: Applications

Commercial HVAC

Mobile & Consumer Electronics

Residential HVAC & Appliances

Automotive

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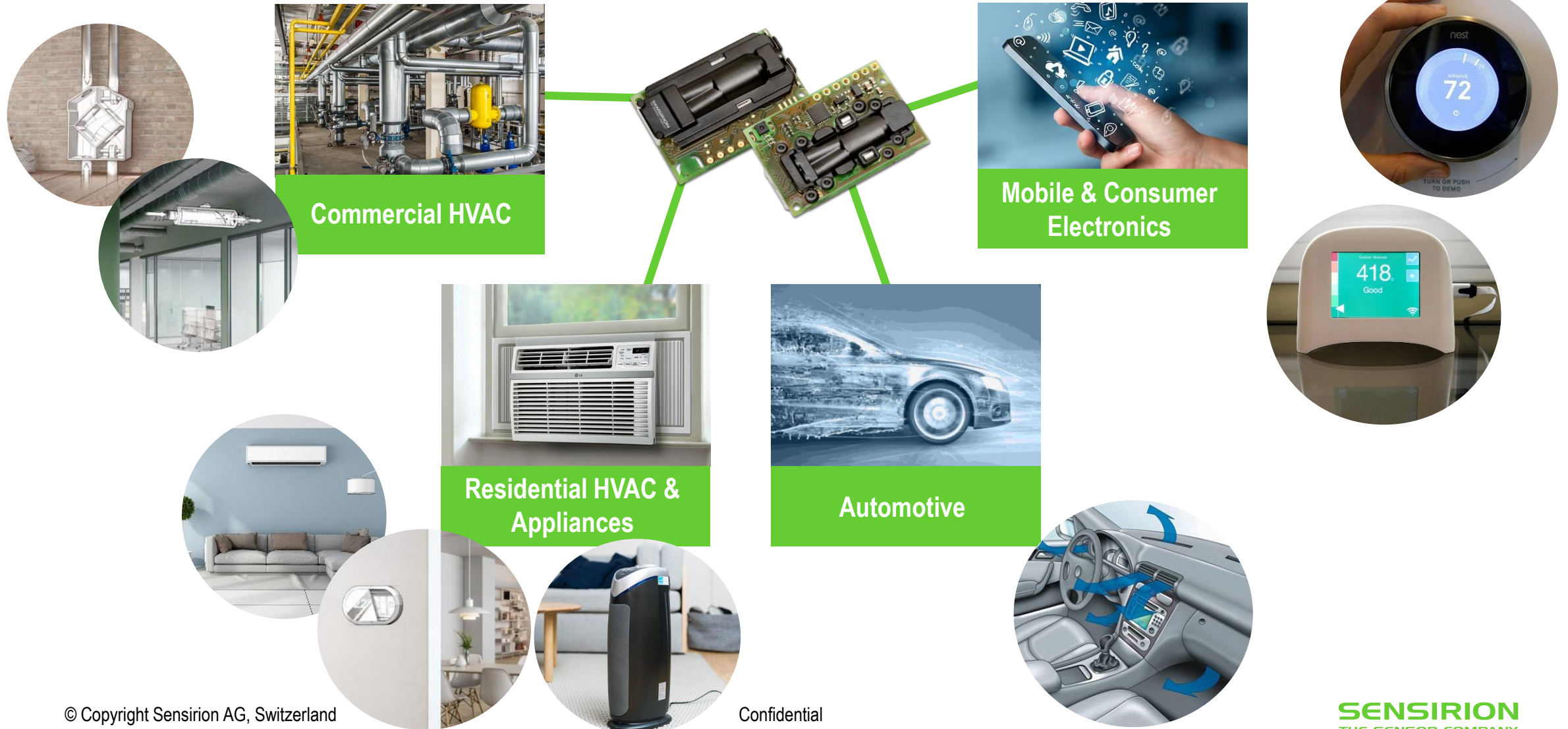
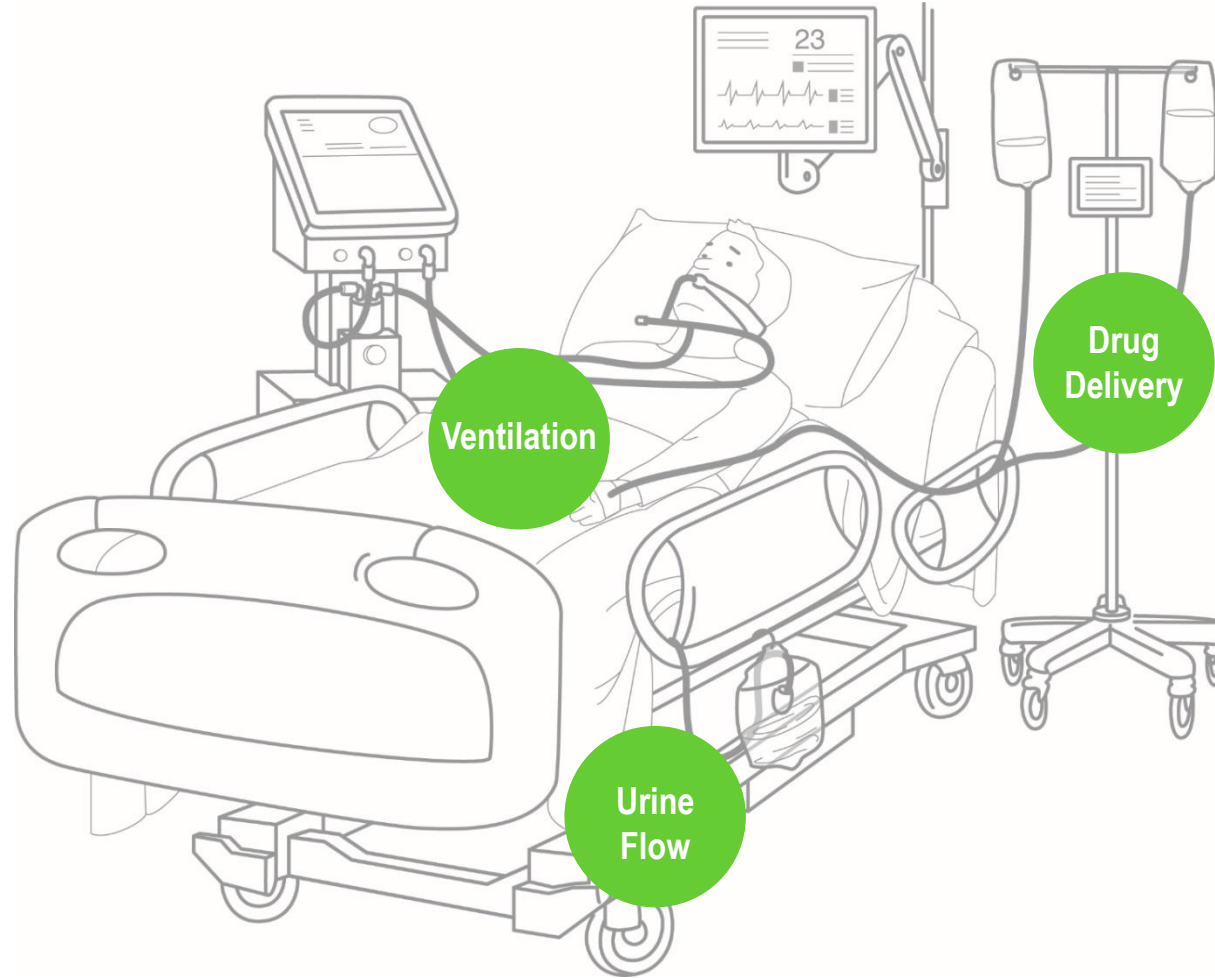# Medical Applications

CPAP

E-Health

Ventilation

Drug Delivery

Urine Flow

Anesthesia

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Ventilation & Anesthesia

Our proven sensor solutions make intensive and home care ventilation applications safer, more reliable and more convenient

- Patient centric ventilation in hospitals, homes and on the go with portable devices

- Precise anesthesia and gas mixing (CO_2, N_2O, Xenon, O_2, Air)

- Broad portfolio of flow sensor solutions (adult, neonate, re-usable, single-use, proximal, expiratory, …) provide easy to integrate solutions with a competitive advantage towards other technologies: No offset, no drift, readily calibrated, highly sensitive in all flow regimes and attractive volume pricing.

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SENSIRION
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Ventilation & CPAP

Our leading air-flow solutions for CPAPs help treat sleep apnea

- More than 10 million patients rely on our sensors every day and night

- Customer's peace of mind by using more than 10 years proven technology.

- 9 out of 10 customers choose Sensirion's sensor solution

- Patient's comfort by keeping device and patient's breathing synchronized

SENSIRION
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Automotive Market - Key Applications
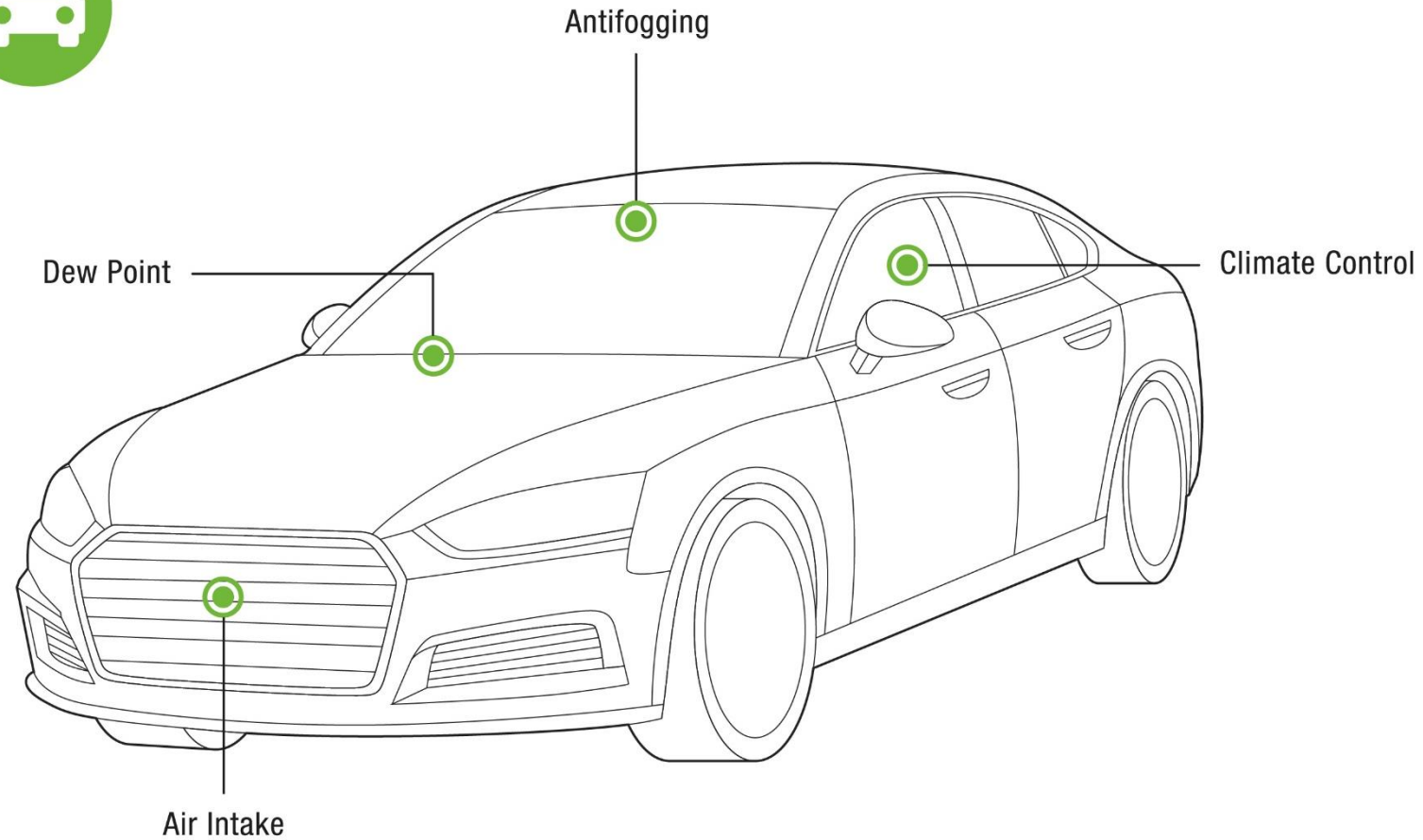
Climate Control (Antifogging & Climate Control)

Our humidity and temperature sensors optimize overall energy efficiency, safety and driver comfort

- Enable prevention of windshield fogging

- Allow automatic control of the AC system

- Increase passenger comfort and reduce energy consumption

- Enables safe engine Start / Stop function

SENSIRION
THE SENSOR COMPANY

Air Intake

Our sensor solutions contribute to a reduction in fuel consumption

- Better combustion control

- Fuel economy

- Reduction of NO_x level

- Reduction of particle level (especially for diesel)

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SENSIRION
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Live Demos and Wrap up

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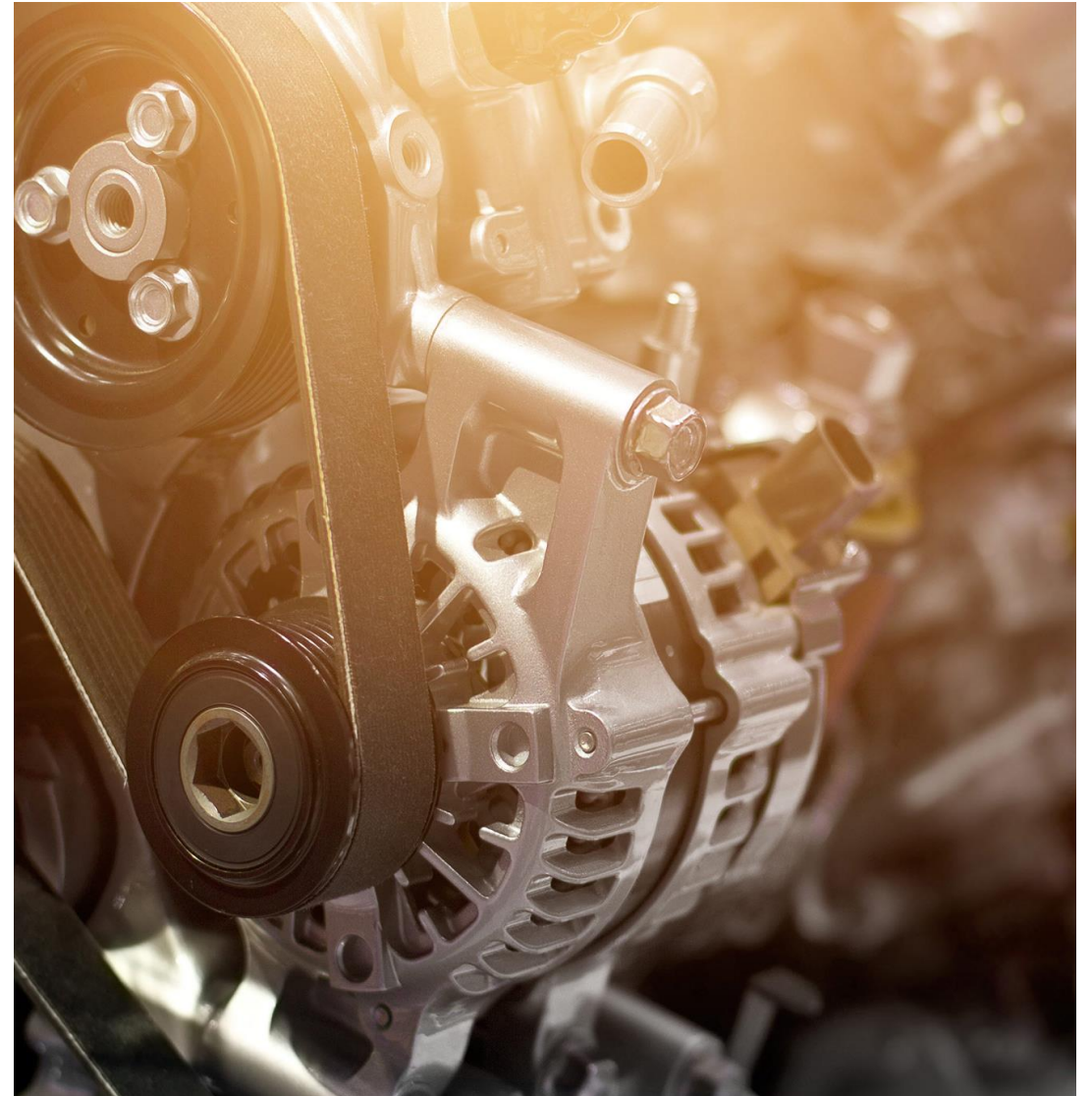
SENSIRION
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Question 3

What are 3 key applications that Sensirion is successful at ?

Hint
-industrial application , medical , automot

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www.sensirion.com