Sensor Market 2025-2035: Technologies, Trends, Players, Forecasts

Global sensor market including future mobility, LiDAR, radar, cameras, IR; IoT; wearables; edge sensing; quantum sensors; printed and flexible sensors; environmental gas sensors; silicon photonics; emerging image sensors, including ten-year forecasts

Dr Tess Skyrme; Dr Jack Howley; Dr Xiaoxi He; Dr Conor O’Brien; Dr James Jeffs; Yulin Wang; John Li; Dr Nadia Tsao; Sam Dale

IDTechEx SAMPLE PAGES

IDTechEx provides clarity on technology innovation

Since 1999 IDTechEx has provided independent market research, consultancy and subscriptions on emerging technology to clients in over 80 countries.

- Technology assessment
- Technology scouting
- Company profiling
- Market sizing
- Market forecasts
- Strategic advice

Reports | Subscriptions | Consulting | Journals | Webinars

IDTechEx

Report Overview

Slides:	483
Forecasts to:	2035

www.IDTechEx.com/**SensorMarket**

The global sensor market is forecast to grow with a CAGR of 6% to US$253 billion by 2035

Sensor Market 2025-2035: Technologies, Trends, Players, Forecasts

The latest report from IDTechEx on the Sensor Market 2025-2035 characterizes innovations in sensor technology and emerging sensor application markets, including future mobility, IoT, wearable technology, and edge sensing. IDTechEx forecasts that global sensor revenue will grow at a conservative 6% CAGR by 2035. This report is IDTechEx's most comprehensive study on the sensor market, drawing on expertise from more multiple analysts and contributing reports within the sensor market portfolio.

- A comprehensive overview of the global sensor technology market, drawn from 14 IDTechEx reports covering sensor technology.
- Sensor technology benchmarking, critical evaluation and comparison.
- Sensor technology innovations, including sensor trends in imaging, printed electronics, silicon photonics, quantum sensing, biosensors and emerging sensor materials and designs.
- Identification and appraisal of emerging sensor applications across automotive, aerospace, industrial, consumer, healthcare, environmental markets.
- Overview of wearable sensors and key applications in wearables and healthcare.
- Extensive characterization of sensors for future mobility, including electric vehicles, autonomous vehicles, in-cabin monitoring, connected and software defined vehicles.
- Overview of the IoT market, emerging IoT sensor technology and applications in industrial IoT, environmental IoT and consumer IoT.
- Identification of key sensor manufacturers and associated value chain mapping.
- Over 50 company profiles including interviews with key sensor manufacturers and sensor industry players.
- Granular ten-year forecasts, broken down by sensor technology.

Access more with an IDTechEx subscription

An annual Market Intelligence Subscription from IDTechEx offers you:

- On-demand access to extensive independent data and analysis on technology innovation
- A choice of in-depth market and technology research reports
- Dedicated time with technical industry experts

Schedule a demo:
research@IDTechEx.com

Find out more:
www.IDTechEx.com/Subscriptions

Subscription Portal
Frequently updated analysis and data on emerging technologies

Research Reports
Complete appraisal of a technology or market

Analyst Time
Technology and market experts address your challenges

A subscription can help you to...

- Scout the technology innovation space
- Identify and assess market opportunities
- Keep up-to-date with technology, industry and regulatory trends
- Appraise new technologies
- Track the competition
- Save time and resources

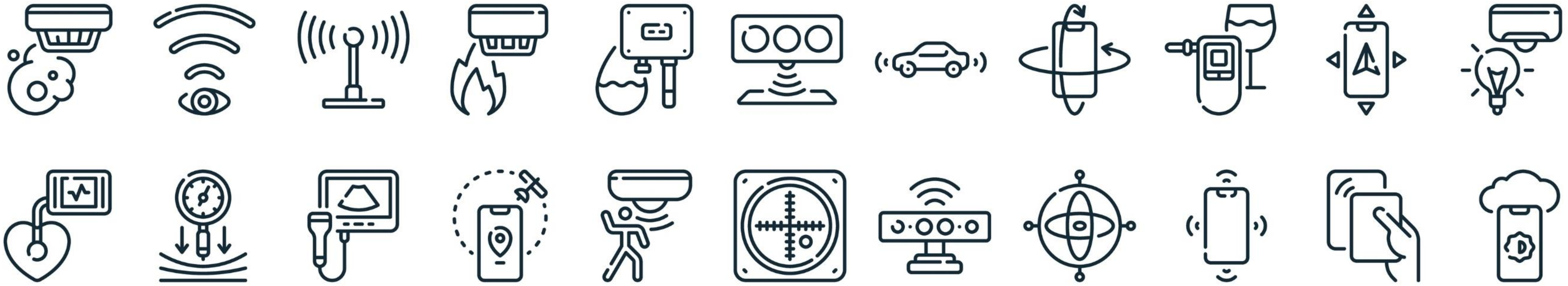
IDTechEx

Table of Contents

Introduction to sensor technology

Sensors are sources of data. Typically housing a transducer to convert a given stimuli into a measurable electrical output. Or, in some instances, a colorimetric response (for example, the biosensors within lateral flow tests). The primary focus of this report are sensors which produce an electrical output, however given the widespread adoption of biosensors during the COVID19 pandemic, a dedicated chapter on trends in this form of sensor is included.

Sensors enable us to understand more about ourselves and the environment. This data can then be used to for automation, diagnosis, continuous monitoring, machine interfacing and much more. There are a huge variety of sensor technologies, metrics of interest, sensor enabled devices and commercial applications.



Note, images shown reflect the wide array of sensor technology categories and is not a direct reflection on the trends covered in this report.

Overview of major sensor technology markets

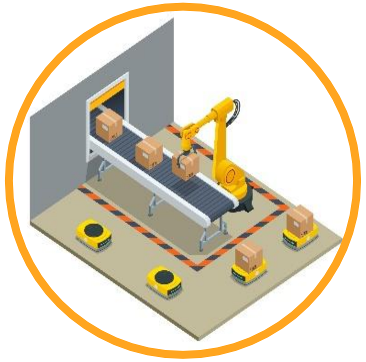
Automotive

- Fuel-air levels
- Engine oil levels
- Pressure
- Temperature
- Speed
- Parking
- Autonomy (ADAS)
- ‘Mobility electronics’

Aerospace

- Navigational
- Speed
- Pressure
- Altitude
- Angle of attack
- Fuel temperature
- ‘Avionics’

Industrial

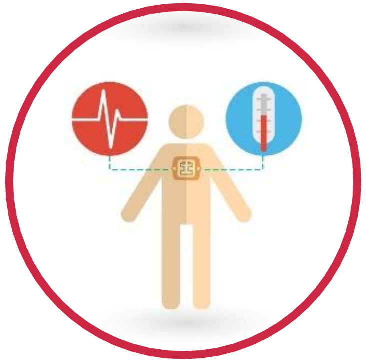


- Fire Safety
- Temperature
- Humidity
- Gas safety
- Automation
- Inventory Management
- ‘Industrial IoT’

Consumer

- Motion (IMUs)
- Touch control
- Microphones
- Cameras
- Eye/Hand tracking
- Fitness/Heart rate

Healthcare



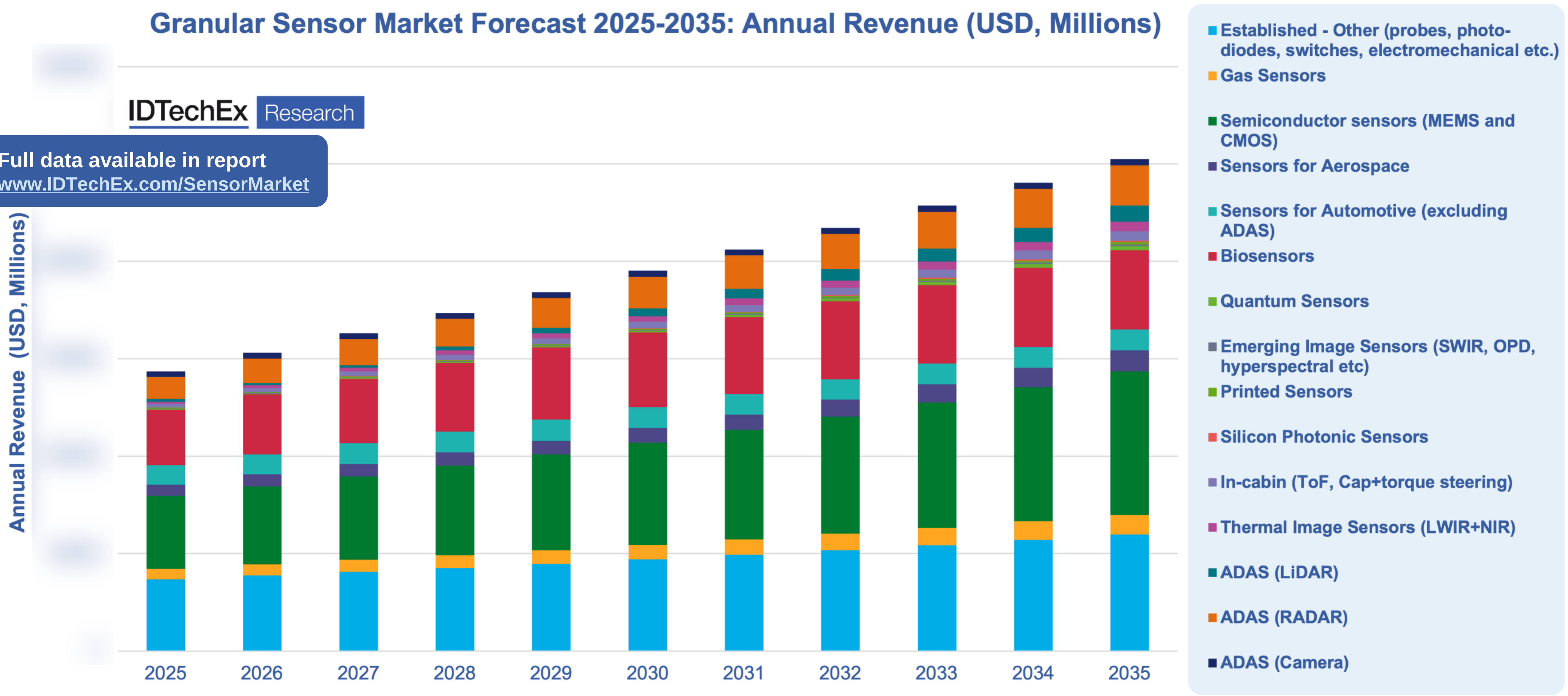
- Heart-rate
- Blood oxygen
- Blood pressure
- Glucose
- Hydration

Environmental

- Indoor air quality
- Carbon dioxide
- Particulate matter
- VOCs
- Pollution
- Water monitoring
- Soil Monitoring

**Sensors described are examples of product lines within each industry, and not an exhaustive list;*

Total sensor market 2025-2035: Annual revenue (USD, millions) – granular breakdown



Full data available in report
www.IDTechEx.com/SensorMarket

IDTechEx

Key drivers and global-trends impacting the sensor market

Energy Uncertainty / High Energy Costs	Lower power, energy harvesting, and resource optimization solutions valued	Demand for **more efficient sensor hardware** and **more effective sensor enabled IIoT solutions**
Human safety and well-being	Value in autonomous and electric vehicles to road accidents or battery fires. Value also in healthcare sensors for personalized health and remote monitoring to better manage aging populations and chronic disease.	Demand for **higher performance sensors** for better quality and **new data** sources for future mobility and med-tech markets
Global Security Concerns	Data security and solutions for enhanced national/cyber/sensor security valued	More demand for **edge sensing** vs. cloud dependent solutions. Greater efforts to secure supply chains.
Climate Change	Value in solutions which improve sustainability as well as weather forecasting and natural disaster alerts.	Demand for more sustainable supply chains, and **sensors within resource optimization** solutions. Continued need for improved monitoring networks indoor, and outdoor and space-based.
Digitalization and AI	The value of data continues to rise, especially given the potential of sensor processing becoming available with high performance and next generation computing.	More data needs **more sensors, better sensors, and improved sensor networks**

IDTechEx

Overview of key sensor technology innovations and applications for future markets

Here IDTechEx highlights some of the most important ‘emerging’ sensor technology categories anticipated to contribute to market growth in the next ten years. In each instance some of the key reasons these categories have disruptive potential are highlighted. This alongside broader sensor markets/applications expected to be impactful.

Technology Categories

Image Sensors
Next generations of image sensors can offer broader wavelengths detection or greater resolution.

Gas Sensors
Gas sensor innovations expand upon analyte range and detection limits.

Printed Sensors
Printing enables sensors to be very small, low cost and flexible – as well as integrated across large areas.

Silicon Photonics
Photonics circuits manufactured in silicon can miniaturized advanced imaging methods, e.g. spectroscopy.

Quantum Sensors
Quantum mechanics offers orders of magnitude improvements in sensitivity across multiple metrics.

Biosensors
Biosensor innovations point of care testing could play a key role in the future of remote patient monitoring and diagnostics.

2D Materials
Materials such as graphene or CNTs can significantly improve the performance of sensors, e.g. through greater conductivities.

Application Categories

Future Mobility
Electrification, autonomy, connected vehicles and driver monitoring trends are all driving sensor innovations

Industrial IoT
Sensor networks within industry are of growing interest for automation, safety and digitization purposes.

Environmental IoT
Networks of sensors for pollution and air quality monitoring are of growing importance as the climate changes.

Consumer IoT
The evolution of consumer engagement with personal electronics and smart home product is a driver for sensor innovation.

Wearables + Healthcare
Wearables for more advanced healthcare monitoring will depend on novel sensors for use within remote monitoring and personalized healthcare.

6G
The commercialization of higher-frequency bad tech for 6G is a driver for THz sensing innovations.

IDTechEx Research

IDTechEx

Sensor Market Categories included in these forecasts

This report focuses on annual revenues, with 15 distinct forecast lines as detailed opposite. In most instances IDTechEx offers more detailed reports into these markets offering further granularity and breakdown by sales volumes and prices. This information is also available via an IDTechEx subscription.

IDTechEx Research	Forecast Line	Related IDTechEx Reports/Forecasts
Established Sensor Categories	Gas sensors	Environmental Gas Sensor Market
	Semiconductor sensors (MEMS and CMOS)	Wearable Sensors; Advanced Semiconductor Packaging;
	Sensors for Aerospace	
	Sensors for Automotive (excluding ADAS)	Li-ion Batteries and Battery Management Systems
	Biosensors	Biosensors for Point of Care Diagnostics
	Other (probes, photo-diodes, switches, electromechanical etc.)	
Emerging Sensor Categories	Quantum Sensors	Quantum Sensors
	Emerging Image Sensors (SWIR and OPD)	Emerging Image Sensors
	Printed Sensors	Printed and Flexible Sensors
	Silicon Photonic Sensors	Silicon Photonics and Photonic Integrated Circuits
	In-cabin sensing (ToF, torque, steering)	In-Cabin Sensing
	Thermal Image Sensors (LWIR + NIR)	Infra-red Cameras for Automotive
	ADAS Sensors (LiDAR)	LIDAR; Autonomous Cars, Robotaxis, Sensors; Sensors for Robotic
	ADAS Sensors (RADAR)	LIDAR; Autonomous Cars, Robotaxis, Sensors; Sensors for Robotic
	ADAS Sensors (Camera)	LIDAR; Autonomous Cars, Robotaxis, Sensors; Sensors for Robotic

IDTechEx

General trends separating emerging and established sensor tech

Smaller

- Real-estate for space at the device level is constantly under pressure and manufacturers continue to seek innovations which make sensors smaller.

Lower Power

- Reduced power at the sensor level will always create a compelling value proposition if other qualities aren't compromised.

More Metrics

- Access to new metrics or data streams and/or data quality only currently available in a lab or with measurement equipment as opposed to miniaturized sensors.

Higher Performance

- More sensitive, accurate, reliable, better SNR, easier to calibrate. Ultimately looking to out-perform on key technical benchmarks compared with incumbents.

New Form-Factors

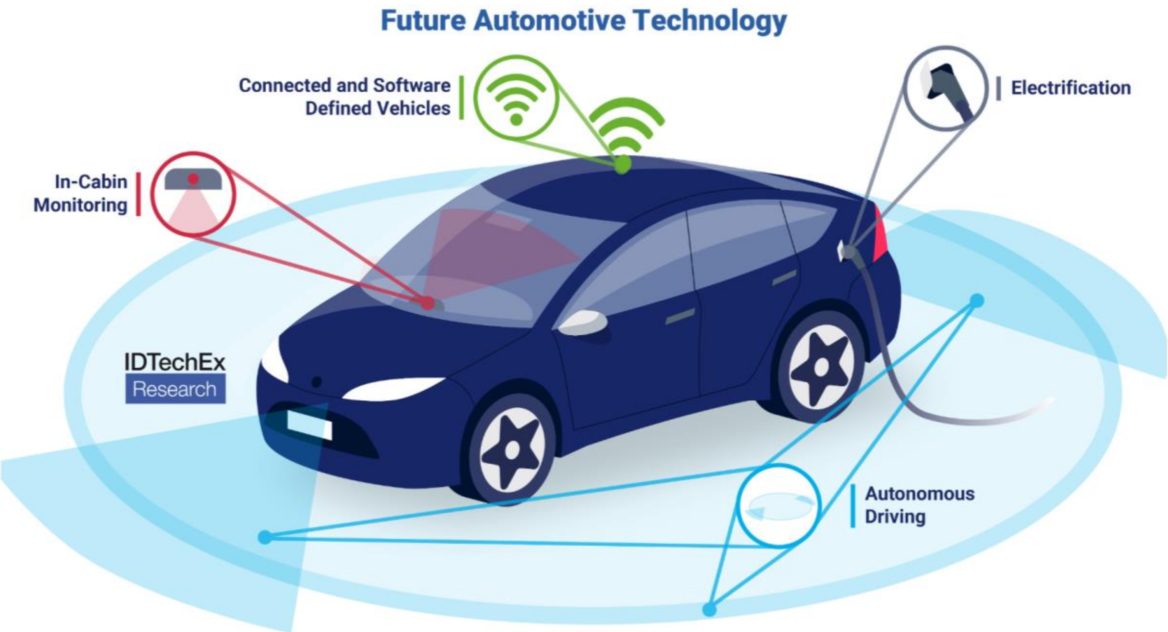
- New sensor designs are needed, for example offering flexibility, conformability or biocompatibility etc. Such technologies can enable next generation electronic device developers to utilize more innovative form-factors.

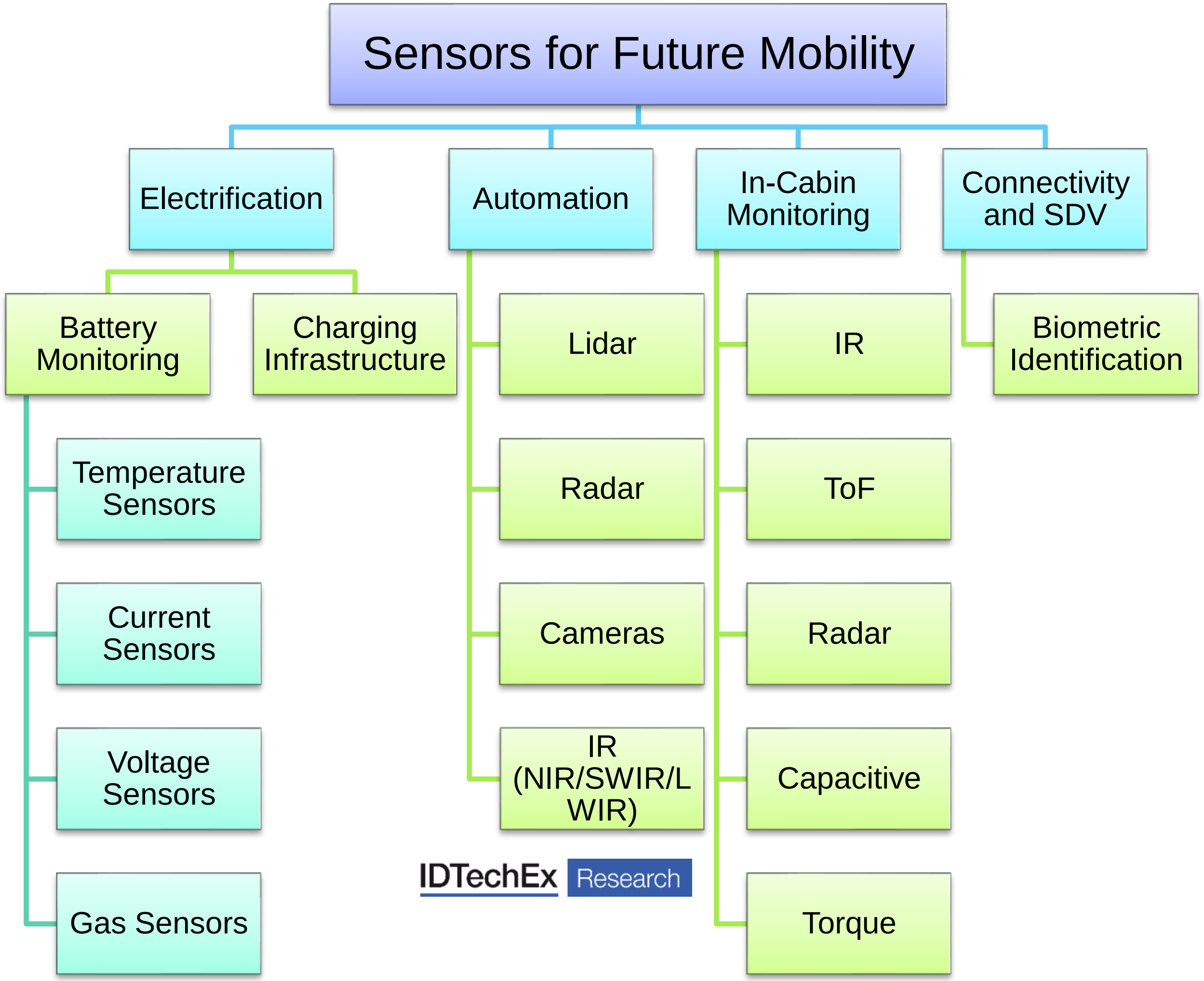
General trends in sensor technology innovation

IDTechEx Research

What is the role of sensors in future mobility technology?

Sensors will play a key role in enabling electrification, automation, in cabin monitoring and vehicle connectivity/SDV. Some major categories of interest are highlighted in the chart below.





IDTechEx

Near term IoT markets trends set to revolve around edge sensing as the industry shifts from the cloud to the edge

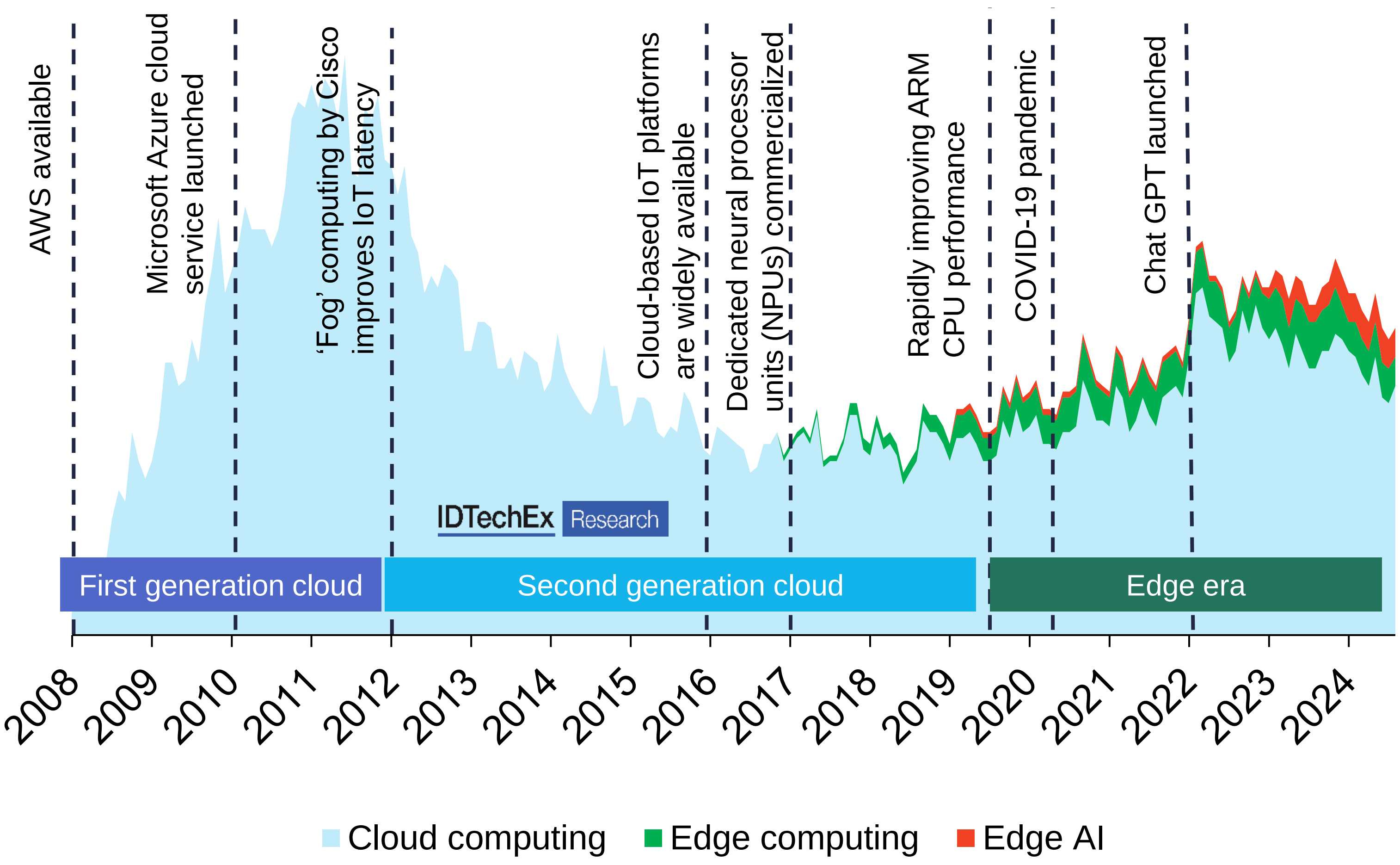
Edge sensing is marketed as the next evolution in the sensor-enabled insights.

The growth of cloud computing, where large volumes of sensor data is processed remotely, has enabled applications such as asset tracking and inventory management. However, key drawbacks remain data security concerns, latency in time-critical applications, and high energy consumption.

The recent commercialization and advancement of energy efficient, high-performance CPUs is driving computing towards the edge. With key performance metrics being met, edge sensing technologies that take advantage of local edge computing are emerging.

Progress in edge computing has also ushered the rapid emergence of edge AI technologies within endpoint devices. Edge sensing is increasingly being co-developed alongside edge AI technologies. Edge AI integration within sensors promises predictive and prescriptive functionality for greater automation in most application markets.

Search trends of key enabling technologies (Google Trends)



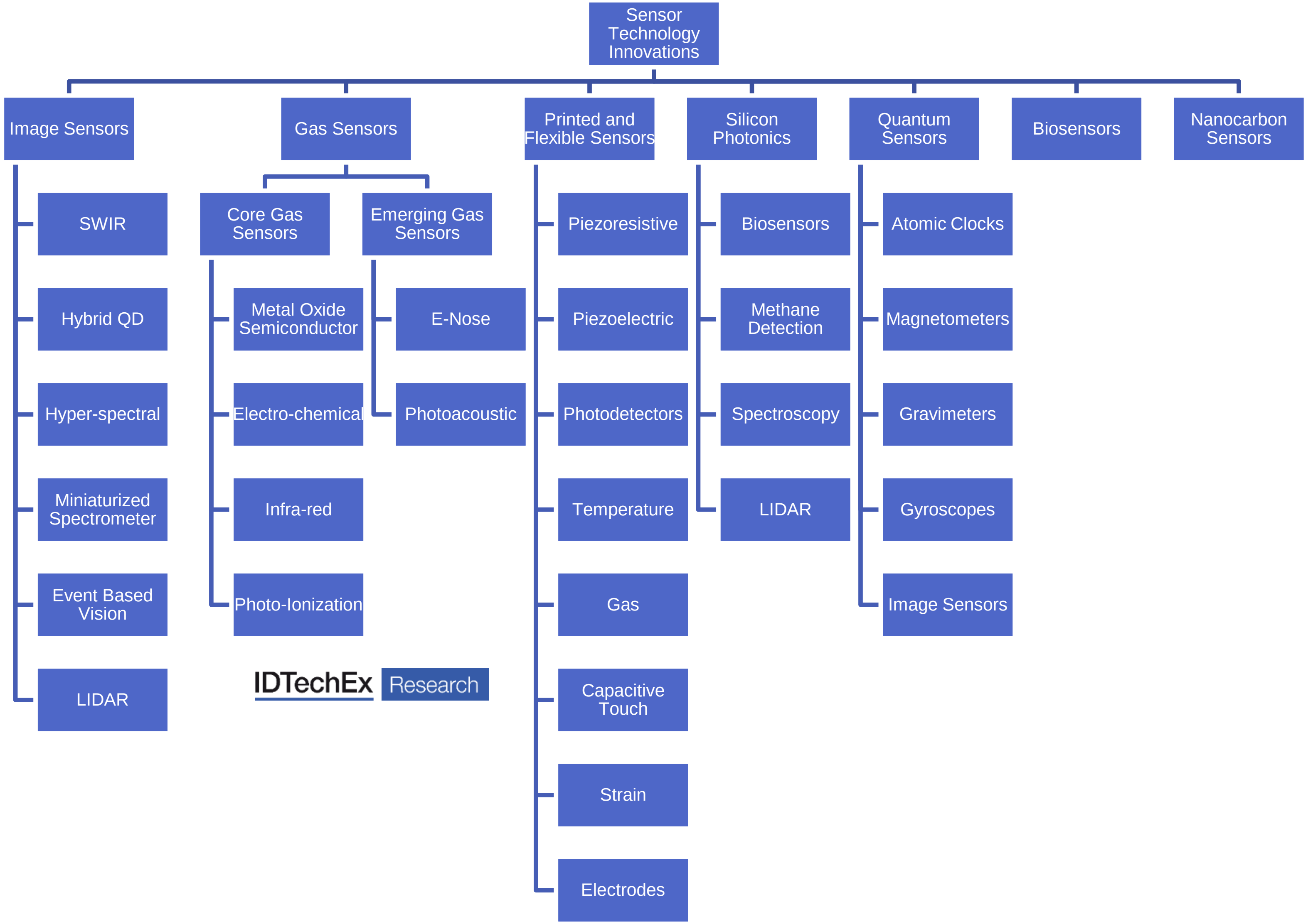
Chapter Overview and Related IDTechEx Reports

In this extensive chapter IDTechEx will provide a comprehensive overview of key sensor technology innovations impacting the market.

In each category the technology fundamentals are overviewed, outlook assessed, and key players identified.

Inevitably, in many instances there is some cross-over of technologies and applications across multiple categories listed, as well as other chapters of this report.

In many instances IDTechEx offers more detailed reports on each of the sectors listed. Please contact idtechex.com/research for more information.



IDTechEx

Edge sensing internet of things architecture

Data source

e.g., devices, machines, people, tools, cars, environment, buildings.

Conventional IoT Architecture

Sensors
- Data acquisition relating to function
- Temperature, vibration, current, gas, optical etc.

Internet gateways, data acquisition systems
- Data aggregation
- Analog-to-digital conversion
- Control data transfer

The Edge

Data processing, operations, and decision making do not occur at the sensor

IT
- Networking
- Analytics
- Data pre-processing

Data center / Cloud
- Analytics
- Management
- Data archiving

Edge sensing IoT Architecture

Sensors
- Data acquisition for processing on device

Edge compute
- Algorithms and analytics
- Realtime data processing
- Decision making

IT
- Data pre-processing
- Networking
- Machine-to-machine interaction

Storage
- Short term data storage

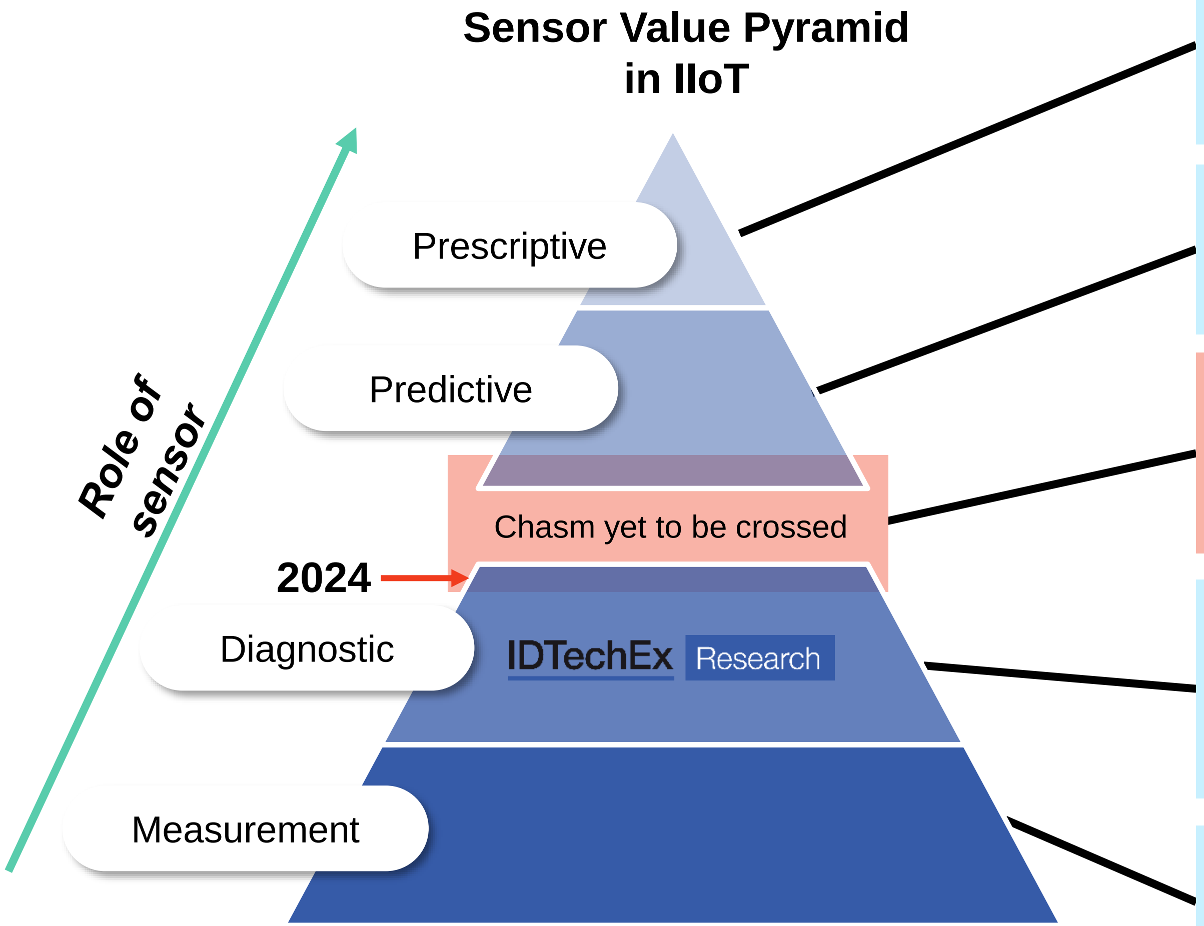
Security
- Data encryption

Edge sensing brings data and control closer to the data source to increase functionality and reduce latency

Data center / Cloud
- Remote data monitoring
- Update roll-out
- Long-term data storage and archiving

IDTechEx Research

Roadmap of the evolving role of sensors in industrial IoT



Using insight from predictive sensing to proactively prescribe action. This could include identifying failing equipment components, ordering more, and adjusting operation timetable to account for downtime. Greater industrial automation will rely on achieving near-human level insight from sensor technology. Edge AI and machine learning will play an important role in achieving automated decision making.

Insight from sensors modelled to predict future device, equipment, and system performance and maintenance. Sensor volume increase required to collect adequate relevant data. As data volume increases, economics of IIoT solutions must be considered. Technology enablers required are low-power sensors with edge compute.

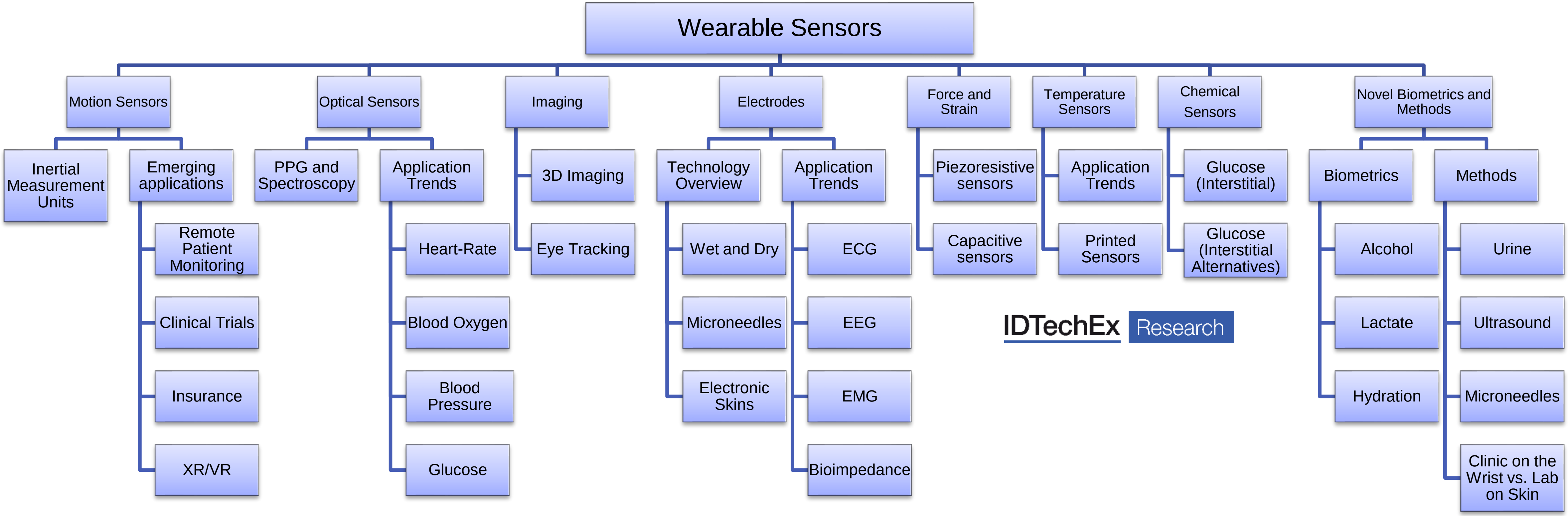
IoT prevalent in industry for measurement and diagnostics. Business models now need to adapt to offer new sensing solutions that provide greater value over existing solutions. Predictive maintenance solutions must demonstrate compelling, tangible improvements (e.g., equipment uptime, process throughput etc.) to customers.

Data from various sensors combined to provide insight beyond individual readings (e.g., equipment performance, asset tracking, hazard identification). Numerous sensors required measuring key metrics. Diagnostic sensing enabled by high-speed networking solutions for fast data transfer and processing technologies, including cloud compute.

Sensors measuring and reporting on individual parameters (temperature, vibration, position etc.). Requires strong and reliable performance. Ubiquitously applied for safety, positioning and actuation, storage, logistics and beyond.

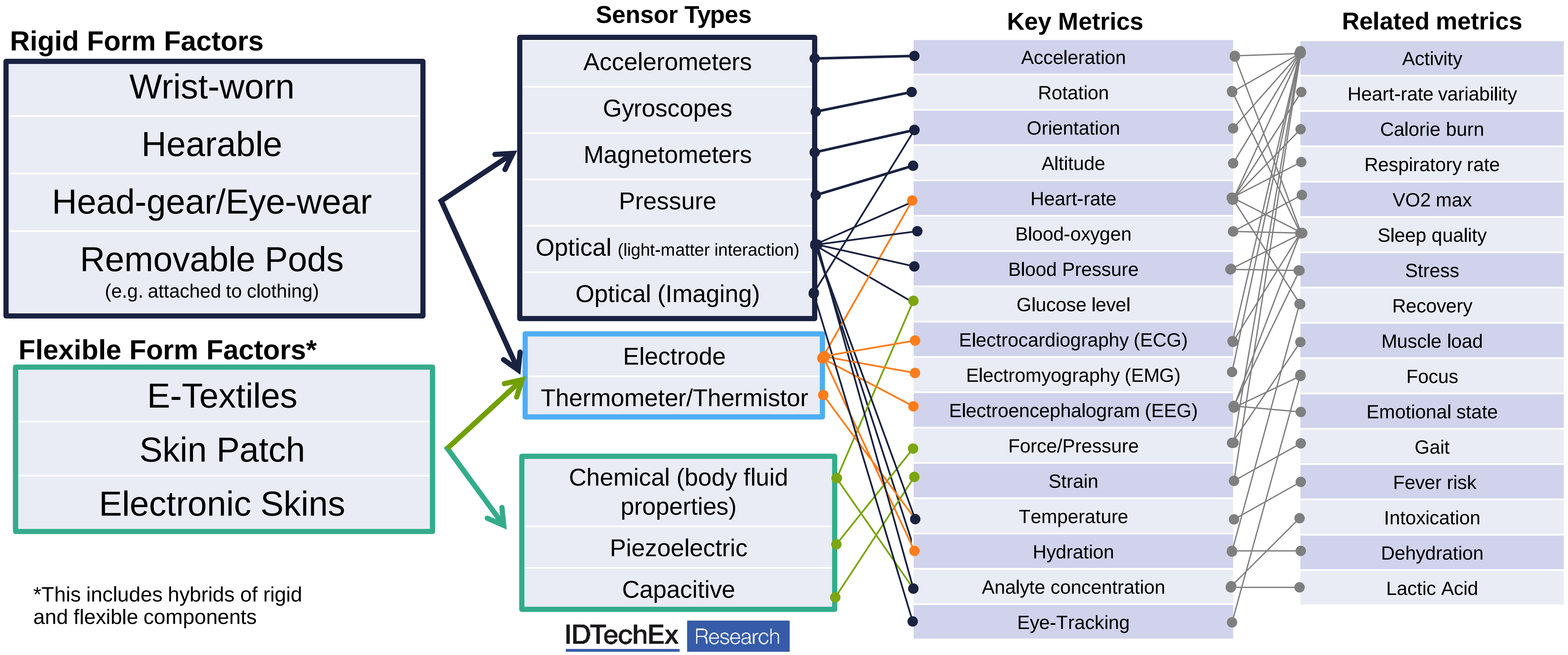
Overview of the wearable sensors section and technology landscape

The wearable sensor technology landscape covers a wide range of sensor types, which can be integrated into an array of wearable form-factors. Moreover, there is often overlap in the metrics these sensors are seeking to measure. In this section IDTechEx provides an overview of the fundamentals of many sensor technologies alongside key players and market trends. This section includes content on the categories outlined below.



Connecting form factors, wearable sensors and metrics

Wearable sensor technology is positioned within a complex eco-system of form-factors and biometrics. Furthermore, in some instances biometrics are processed to produce related metrics which use combinations of sensor inputs. To breakdown this network, and pick out the role of each sensor type, we have created a map of the wearable sensor sector – focusing on technology which measures properties of the user. This isn't exhaustive but includes those most relevant to growing markets.



*This includes hybrids of rigid and flexible components

IDTechEx

Controllers and sensing connect XR devices to the environment and the user

In order to show users a convincing virtual environment, XR devices must, to varying extents, be aware of the real environment and the positioning of the user's body. As XR content evolves past adapting content for "legacy devices" (smartphones, PCs, consoles etc), the level of information XR devices take in is increasing.

Growing immersion →

← Importance of information

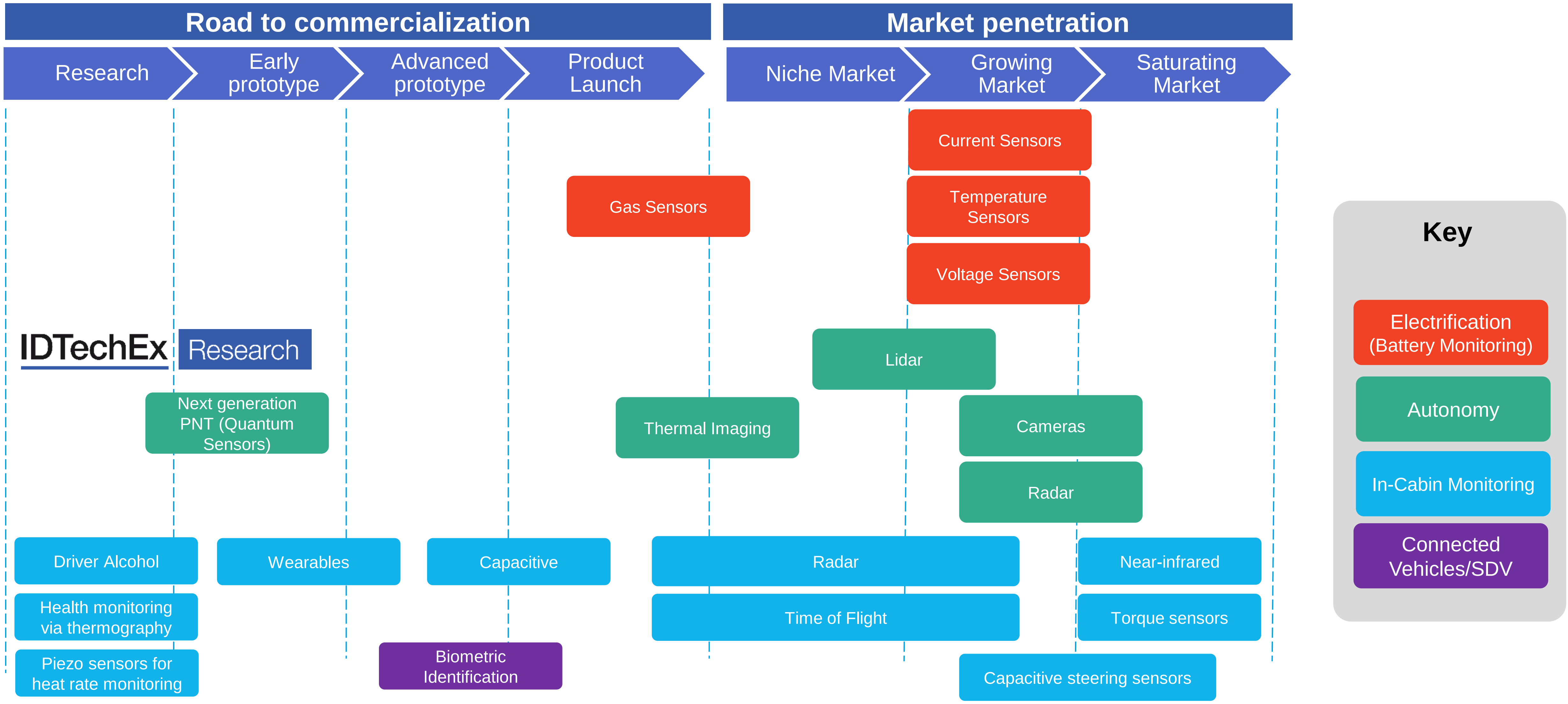
Head tracking: what direction is the user looking?	Tracking hand location/ direction: where is the user pointing?	Positional tracking: where is the user in the environment?	Full hand tracking: how are the user's hands interacting with the virtual environment?	Eye tracking: where exactly is the user looking?	Face tracking: what is the user's facial expression?	Full body tracking: how exactly is the user interacting with the environment?

Note that a key additional use of eye tracking is enabling foveated rendering.

IDTechEx Research

IDTechEx

Summary and outlook for sensors in future mobility applications



IDTechEx

Applications of Sensors in Robots

Sensors in robots can be used for a variety of tasks ranging from measuring force, detecting objects, navigation and localization, to collision detection and mapping. With recent advances in sensor technologies and software, many sensors can be used for multiple purposes. For instance, cameras together with computer vision systems can be used for collision detection as well as navigation and localization. The chart below summarizes the commonly used sensors by application split. This section splits the tasks into four main themes including navigation and localization, collision and proximity detection, force and torque measurement, and others.

This section mainly focuses on the sensors that are equipped directly on the robots and largely ignore the sensors used in the components (e.g., servo motors, controllers, etc.), such as current sensors, optical encoders, etc.

Type of robot	Relevant sensors covered in this section					
Industrial robotic arm	Camera	Force and torque sensor	Photoelectric sensor			
Automated Guided Vehicle (AGV) Autonomous Mobile Robot (AMR)	Camera	Ultrasonic sensor	IMU	LiDAR/radar		
Collaborative robot (Cobot)	Camera	Force/Torque sensor	Capacitive/tactile skin sensor			
Drone	Camera	Localization sensor (LiDAR, GPS and radar)	IMU	Altimeter	Ultrasonic sensor	Pressure sensor
Agricultural robot	Camera	Ultrasonic sensors	IMU	LiDAR/Laser scanner/radar		
Cleaning and disinfection robot	Camera	LiDAR/radar	Cliff sensor			
Social robot	Camera	Ultrasonic sensor	IMU			

Task themes

- Navigation and localization
- Collision and proximity detection – safety
- Force/torque measurement – safety
- Others (e.g., pressure measurement, etc.)

IDTechEx Research

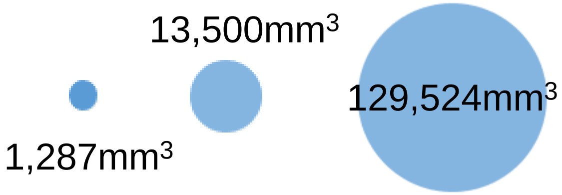
Source: IDTechEx

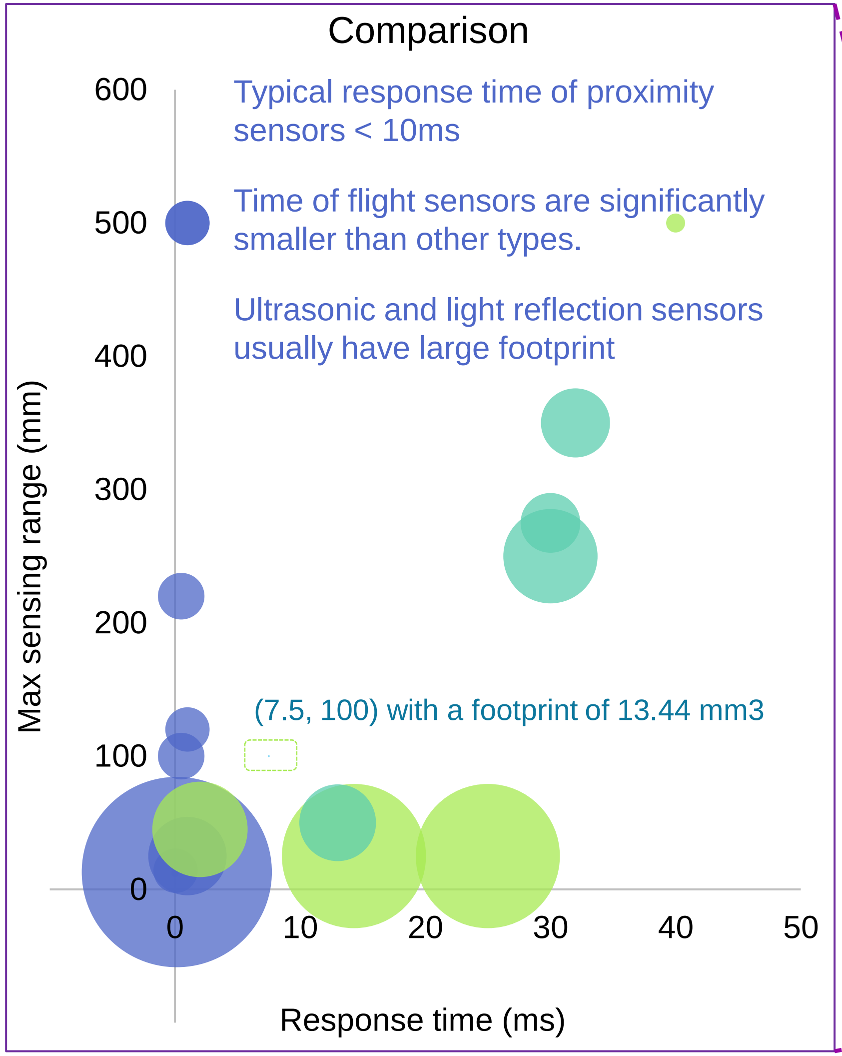
IDTechEx

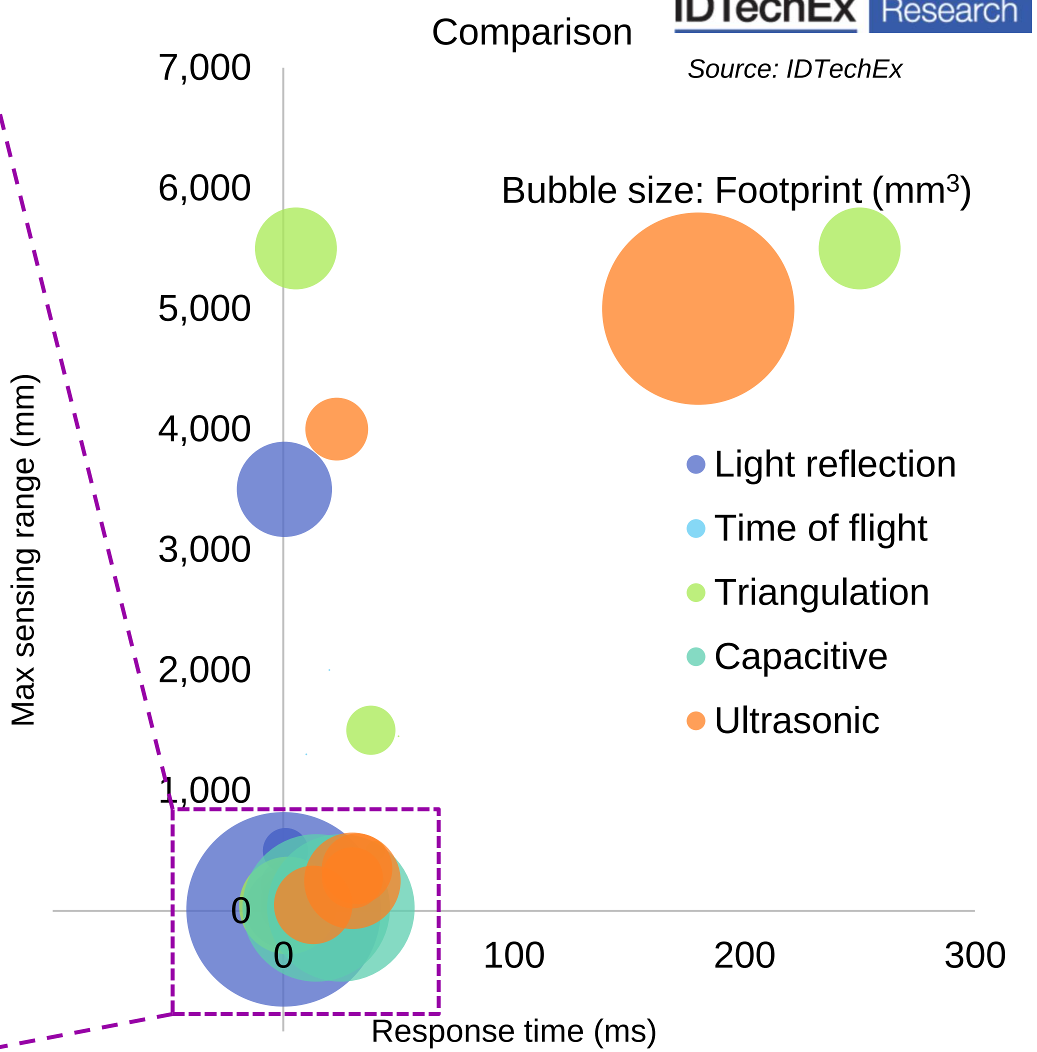
Comparison of proximity sensors

The diagram compares different proximity sensors. It is observable that most proximity sensors are relatively small (footprint smaller than 40,000 mm^3), with maximum sensing distances shorter than 2000mm (2 meters).

Ultrasonic sensors typically have the largest sensing distance compared to other proximity sensors, whereas capacitive proximity sensors have the shortest sensing distance. The correlation between footprint and max sensing distance determines the ideal application scenarios of these sensors. For instance, sensors with large sensing distances with a large footprint (e.g., ultrasonic sensors) can be widely used in tasks that need long-range detection, such as underwater robots. On the contrary, the sensors with relatively short detection distances and footprints would be more suitable for tasks in limited space, such as collaborative robots in production lines.







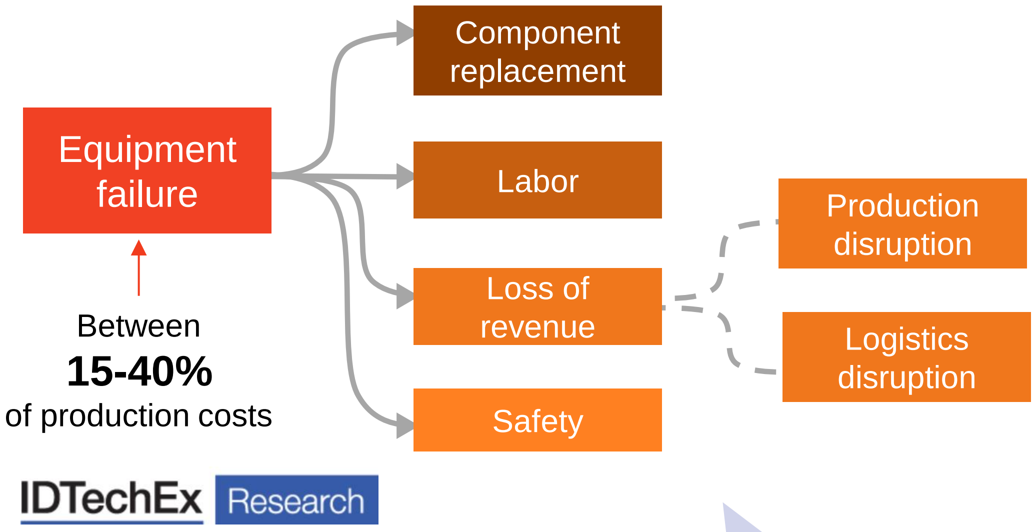
Sensors in machine health monitoring and predictive maintenance

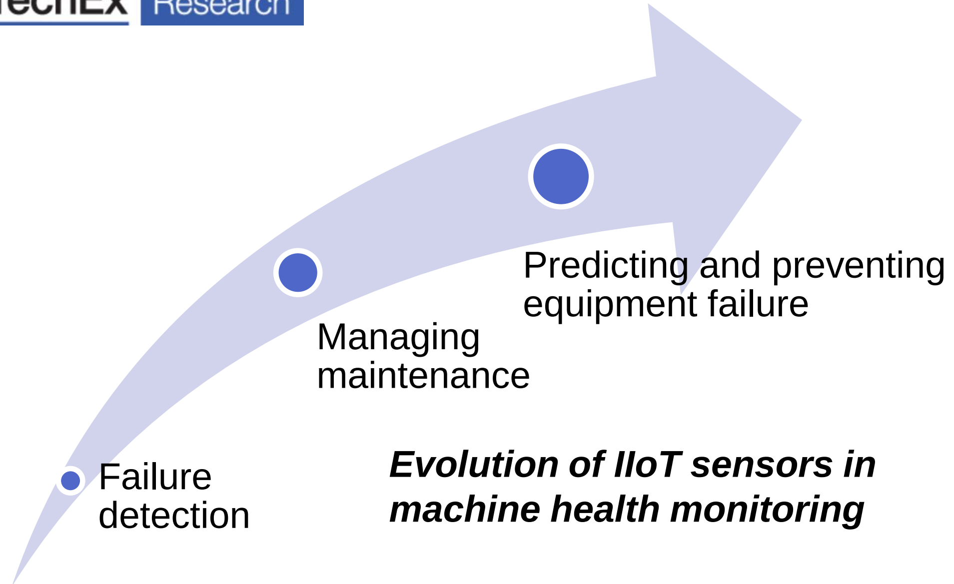
IIoT sensors are emerging for machine heath monitoring applications to optimize equipment maintenance and minimize operational downtime. Machine health monitoring is the use of sensors to monitor equipment operation and detect anomalous behaviour detection during operation. By digitalizing equipment operation, problems may be addressed proactively, reducing the risk to productivity and thus overall OpEx.

Cost savings are an important driver for the adoption of machine health monitoring technologies. Maintenance costs are estimated to range between 15% and 40% of total production costs in manufacturing industries. Costs imposed include component replacements, labour costs, loss of revenue during downtime, and potential related safety issues.

While the use of temperature and gas sensors are common for failure detection in IIoT, proactive and predictive sensing technologies offer greater cost saving potential. This is due to time being critical for machine health monitoring. A piece of equipment running up to the point of failure can cost up to 10 times as much as a regular maintenance as the risk to damage of auxiliary and peripheral equipment increases exponentially.

Related impact on costs





Evolution of IIoT sensors in machine health monitoring

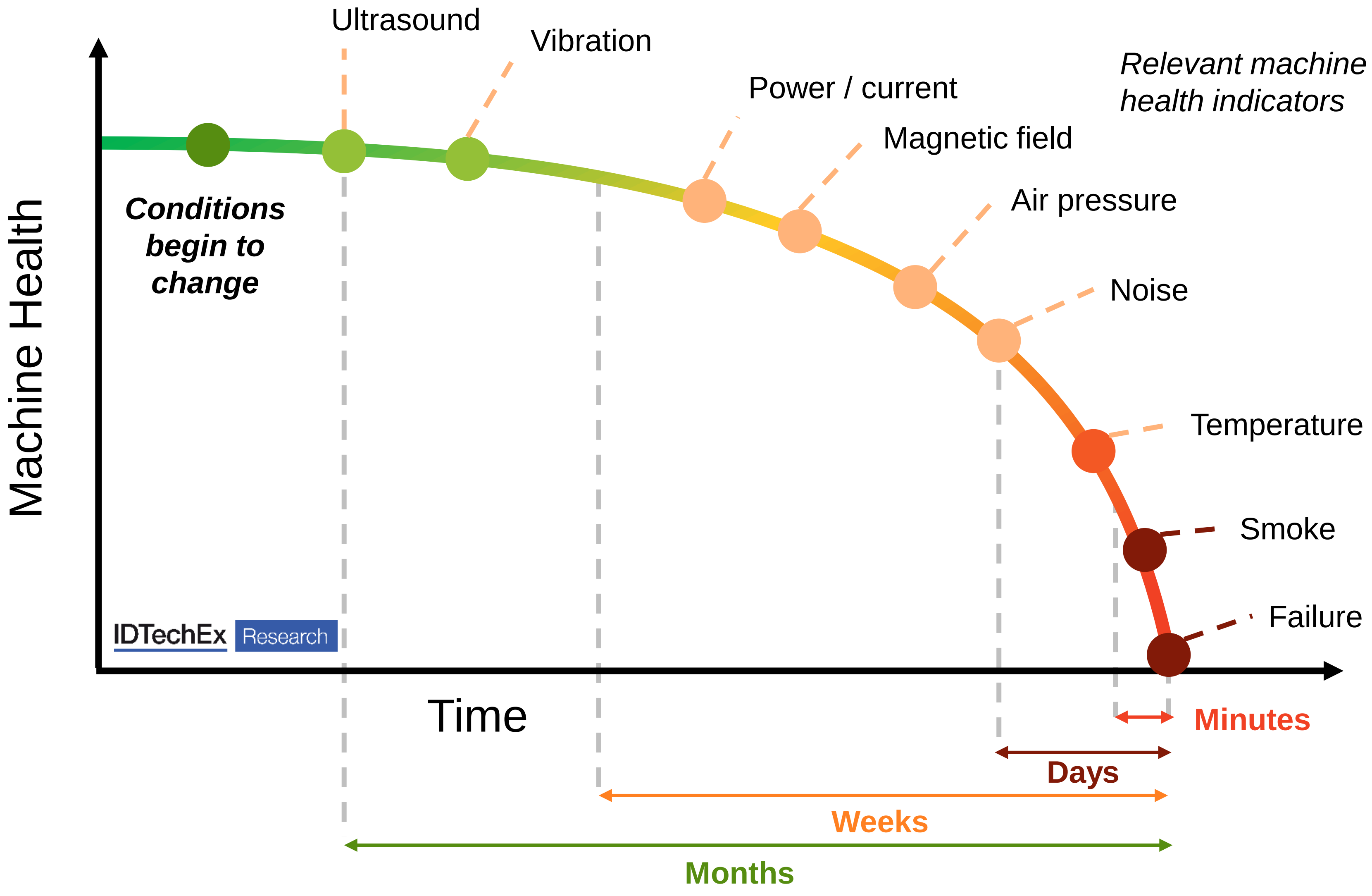
IDTechEx

Indicators for machine health monitoring

There are numerous indicators that may be used to monitor deterioration in machine health up to reaching the point of failure. Imminent equipment failure is often accompanied by heat, fire, smoke and gas emission.

Changes in acoustic profiles of equipment during operation are typically the indicators operators and users in close proximity notice in the lead up to failure.

While there are many indicators, changes in the vibrational profile of machines are amongst the earliest detectable indicators of machine health deterioration. Changes to vibrational profiles during machine operation display early enough that changes to operation can be made to prolong lifetime and manage issues without impacting operational productivity.



IDTechEx

Key miniaturized gas sensor technologies for outdoor pollution monitoring

There are multiple different principles and technologies available to detect gas. Each sensor type is characteristically different in terms of analytes detectable, sensitivity, cost and application. Whilst there is significant overlap in the use cases and principles of each, commonly used devices for outdoor pollution monitoring are optical particle counters, metal oxide sensors, electrochemical sensors, infra-red sensors, photo-ionization detectors and photoacoustic sensors. As an introduction to the relationship between technology and application, a popular use-case and advantage for each is summarized. The advantages for the market are in green, and disadvantages in red. The most commonly used, electrochemical, infra-red and optical particle counter, are highlighted.

Advantages
Disadvantages
Key Technologies
IDTechEx Research

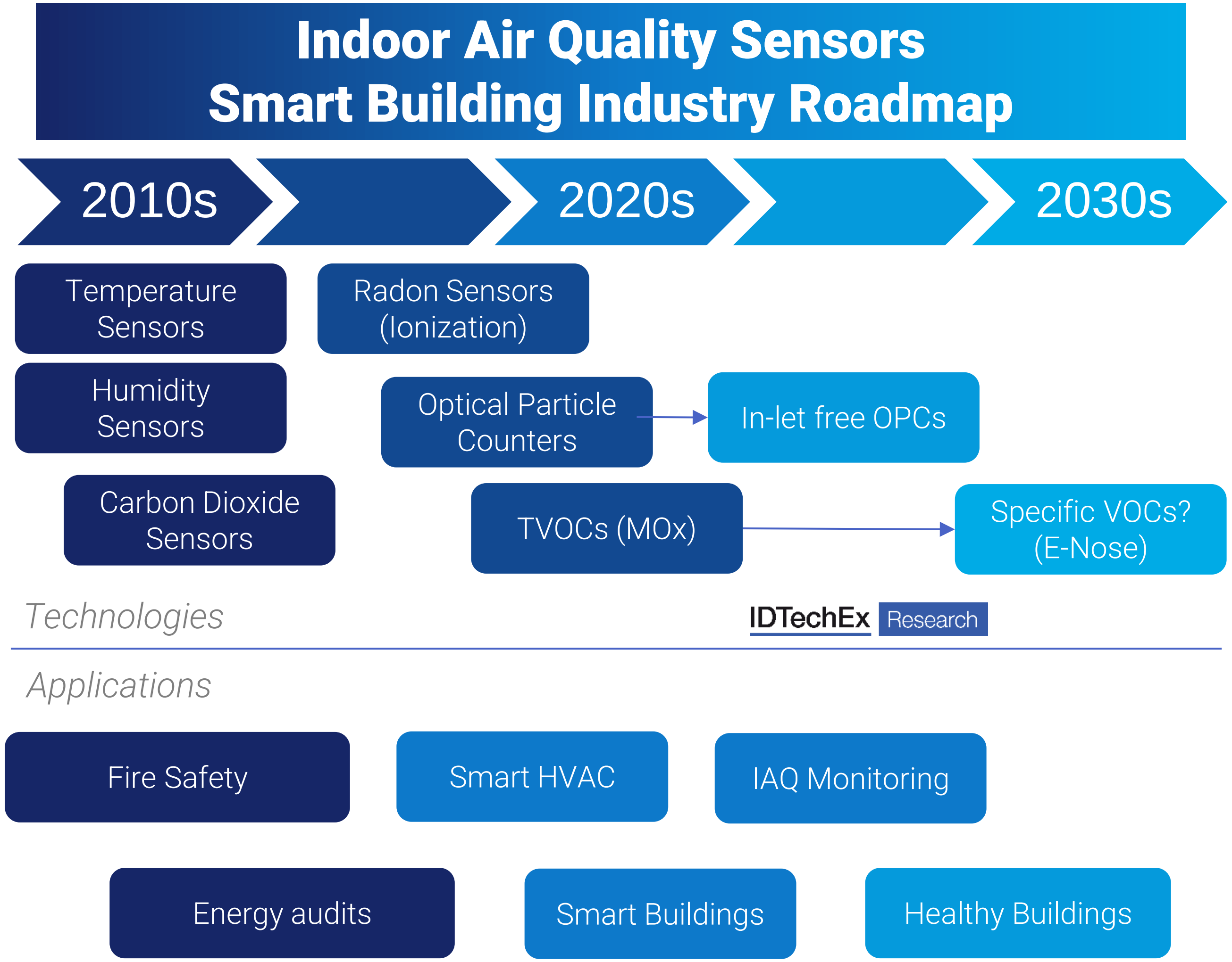
Metal Oxide Semiconductor	Electrochemical	Infrared	Photo Ionization Detectors	Optical Particle Counter	Photoacoustic
Non-specific VOC detection	Medium Cost	Small	VOCs	Particulate matter sensors	Low Power
Low Cost	Broad analyte range	Self-calibrating	Low concentrations	Sizing and counting	Highly miniaturized
Low Accuracy	Calibration Required	Limited analyte range	High Cost	Limited analyte range	Limited analyte range

IDTechEx

Miniaturized gas sensors for indoor monitoring in smart buildings: conclusions and outlook

Key Takeaways

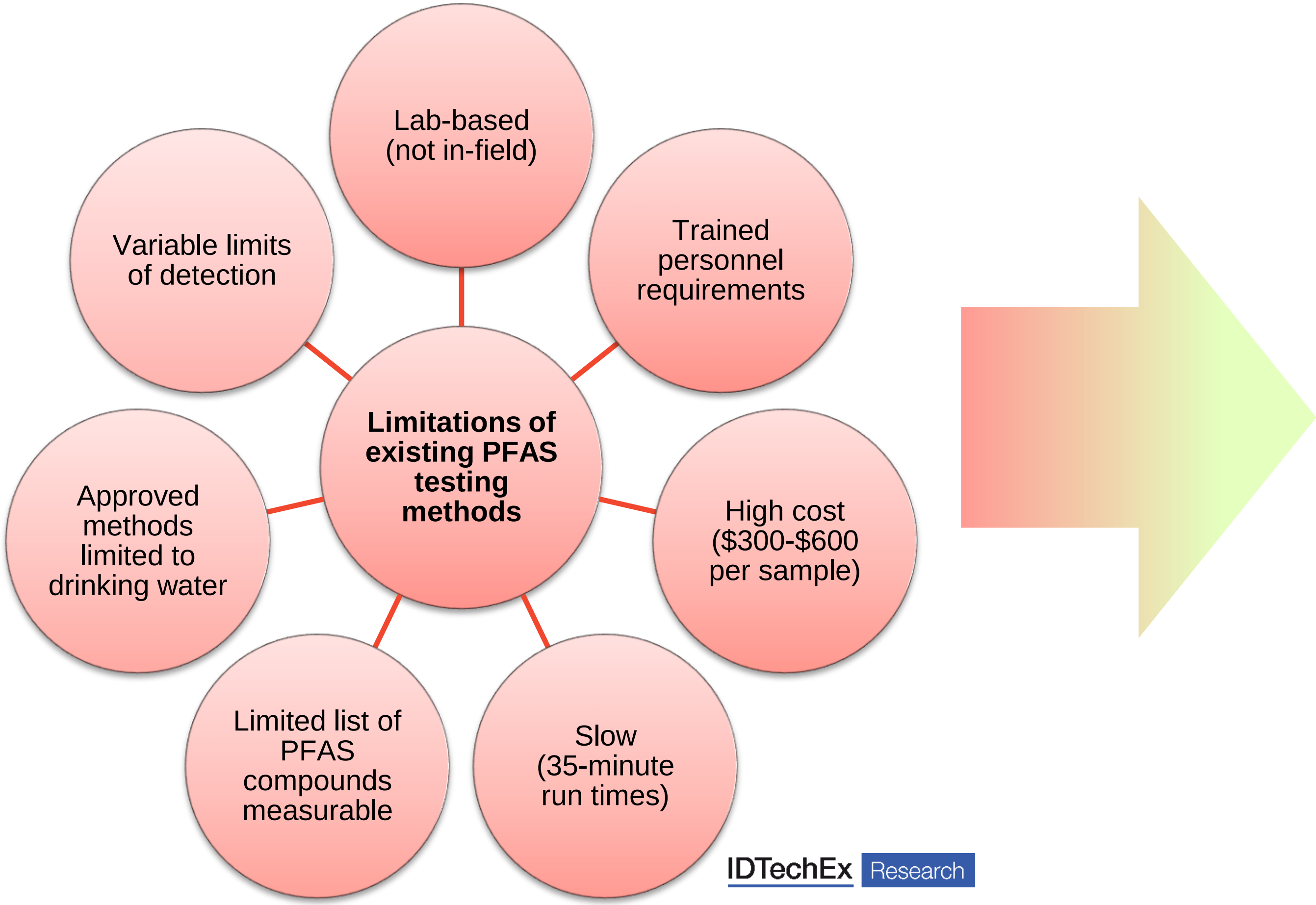
- Building management has long depended on sensors in essential systems which are increasingly being made ‘smart’ – for example fire-safety and HVAC,
- Existing suppliers of safety hardware and sensor networks are increasing their product offerings of IoT solutions – sensor networks, plus automation and/or data dashboards.
- Smart buildings have the potential to optimise energy and resource use, as well as keep occupants healthier, happier and more productive. Air quality is a metric growing in value for these use-cases.
- Overall, the market is dominated by established gas sensor technology – infra-red for carbon-dioxide, metal oxide semiconductor for TVOCs and optical particle counters. These are sensors already produced by many of the major suppliers and a new market opportunity not yet requiring emerging technology.
- Some specialists in indoor air quality are using novel technology to differentiate, for example to detect radon, characterise broader ranges of particulate matter or measure specific VOCs.
- Overall, customers are likely to be hardware agnostic and motivated by compliance with new standards and regulations. There is also growing need for ‘actionable insights’ as opposed to pure data reporting. In the future as the air quality monitoring market develops, opportunities for new gas sensor technology could emerge – but is unlikely to be in the highest volumes within the next ten years.



IDTechEx

Limitations of existing instrument-based methods and the need for sensors

There are methods of testing water for PFAS, but they are largely instrument based methods which depend on a laboratory and trained staff. The EPA approved methods for testing can measure 29 PFAS compounds but are limited to drinking water. The run time for measuring these samples is approximately 35 minutes. The approved methods utilize combinations of solid phase extraction, liquid chromatography and mass spectroscopy. These methods play an important role and are effective when used at the right time and place. However, they are ultimately limited by the high costs and personal needs, and not suited to widespread testing. These challenges translate into a 'wish-list' of what new PFAS sensors would ideally offer.



IDTechEx

Contact IDTechEx

Founded in 1999, IDTechEx offers trusted independent research and intelligence on emerging technologies and their market opportunities.

We help our clients to understand new technologies, their supply chains, market requirements, opportunities and forecasts.

Connect with IDTechEx to explore how we can support your business:

- **research@IDTechEx.com**
- **www.IDTechEx.com**