European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

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INDOOR AIR QUALITY MONITORING: GUIDELINES FOR SENSOR NETWORK DESIGN

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IDAD - Institute of Environment and Development / Portugal

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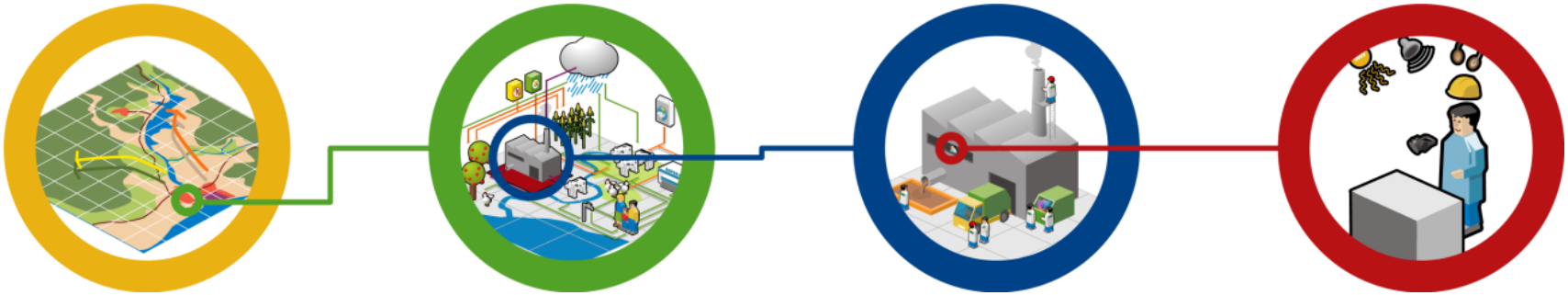


Air Pollution - IDAD carries out the following activities

- Stack emissions
- Ambient air quality
- Indoor air quality
- Odours assessment
- Inventories of air pollutants emissions
- Air quality modelling
- Air Quality Management

Impacts of Air Pollution – different scales

Global scale

- Climate change,…

Local scale

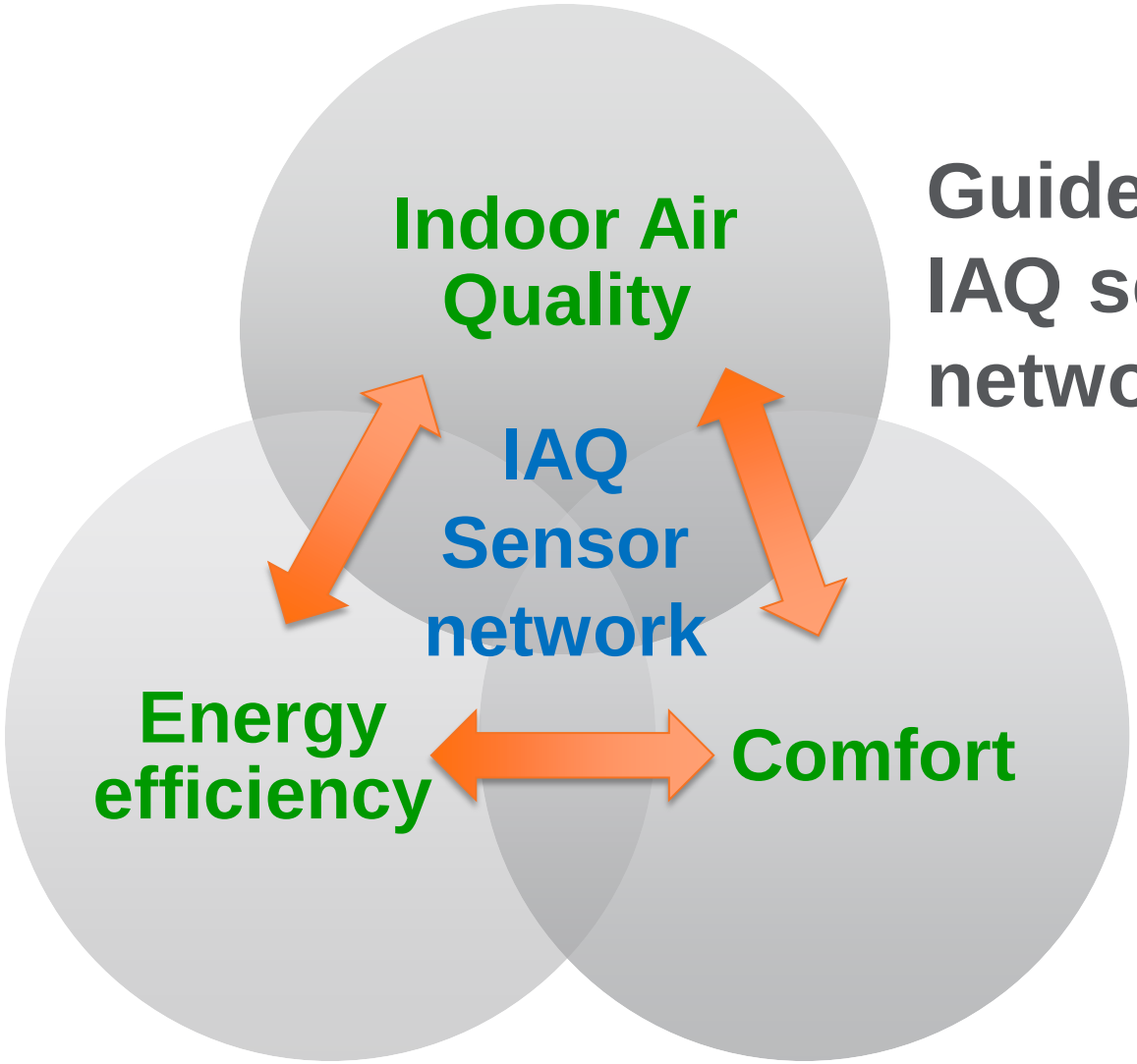
- Exposure to traffic emissions,…

Micro-scale

- Impacts on indoor air quality!

We spend 80-90% of our time indoors!

Sustainable building



Guidelines for IAQ sensor network design!

GUIDELINES FOR SENSOR NETWORK DESIGN

What? → **Pollutants and standards**

How? → **Equipment and methods**

Where? → **Siting criteria, number of sensors**

IAQ measurements

Different typologies of buildings

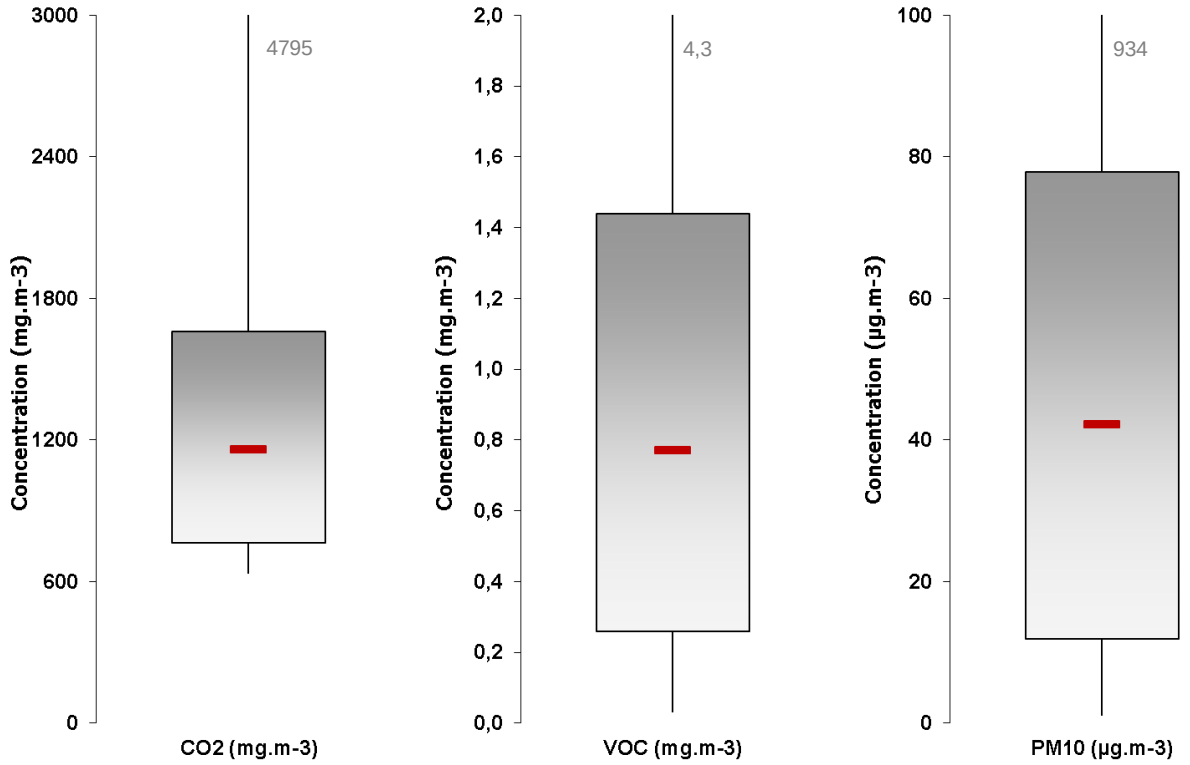
- **School buildings**
- **Shopping centers**
- **Dwellings**
- **Public services buildings**
- **Hospitals**
- **Museums**

Parameter	Example of standard (PT)	Margin of tolerance (%)
PM10	**50** µg/m^3	100
PM2.5	**25** µg/m^3	100
CO	**10** mg/m^3	-
CO_2	**2250** mg/m^3	30
Formaldehyde	**100** µg/m^3	-
VOC	**600** µg/m^3	100

- Principal pollutants
- Typical concentration ranges
- Sources with relevant contribution to indoor air quality

IAQ - Study case

Results



557 houses

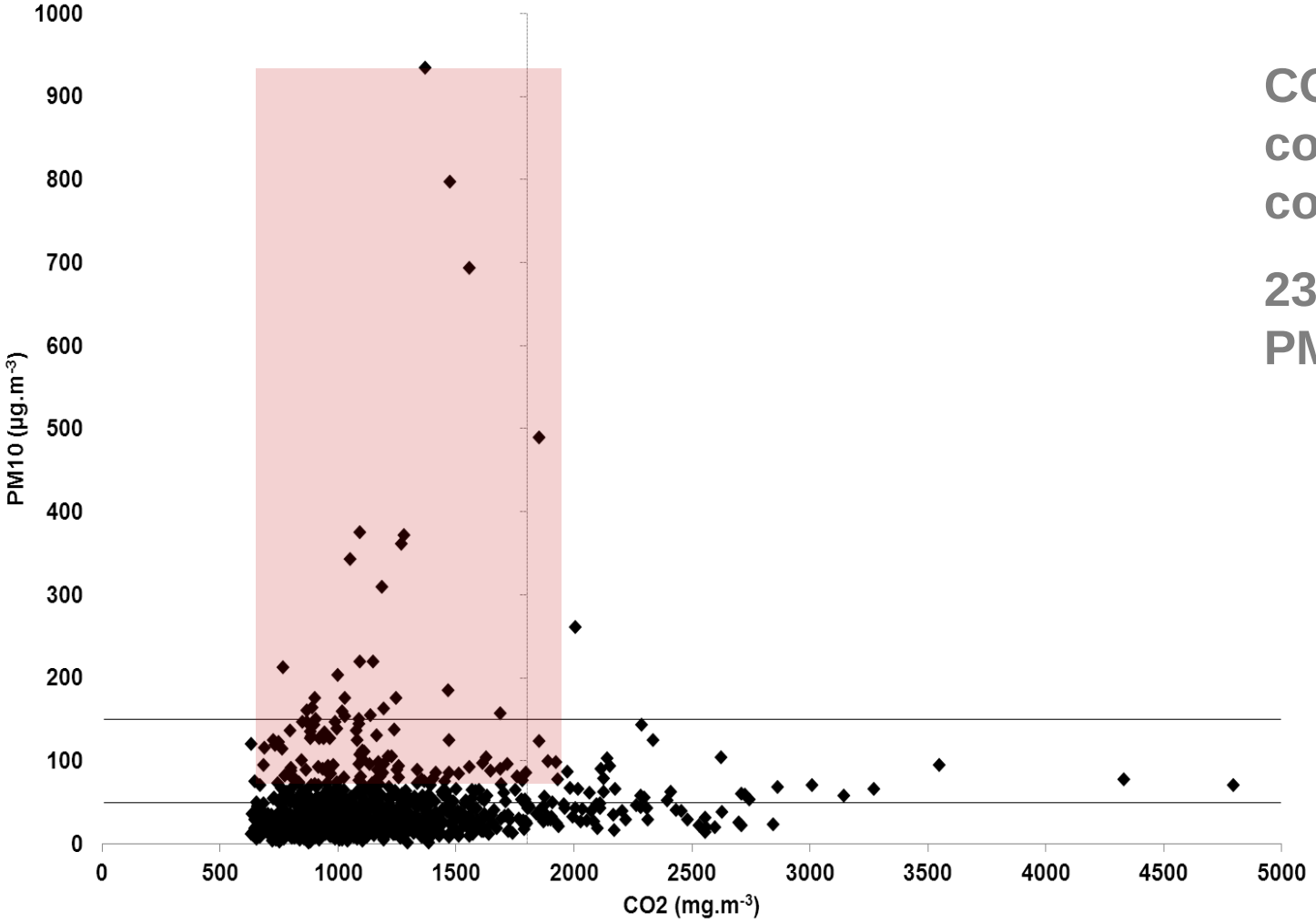
Short-term measurements (≈15 min)

Temp., HR, CO_2, PM10, VOC, CO, O_3, HCHO, SO_2, NO_2

Around 60% of the houses visited had at least one measured value above the reference values.

The majority of the exceedances were VOC, CO_2 and PM10

IAQ - Study case - CO_2 vs PM10



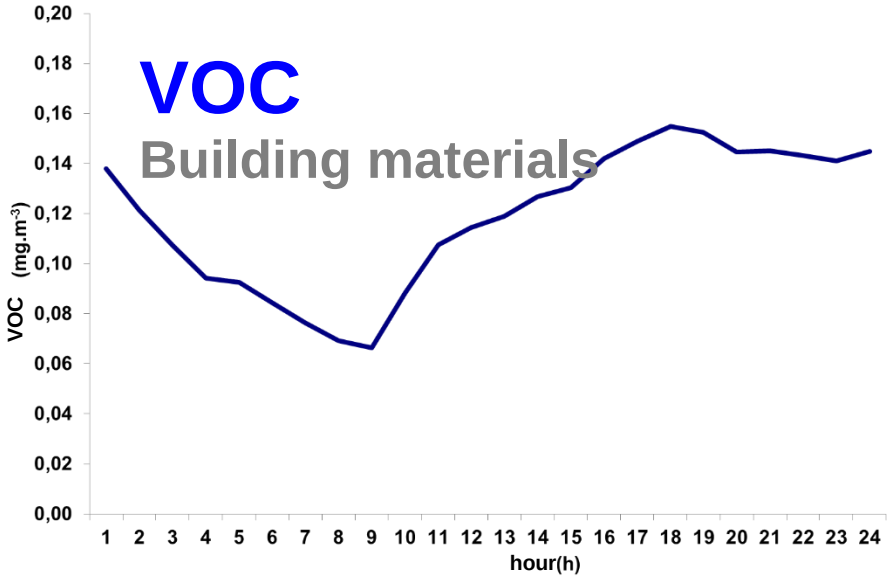
CO_2 and PM10 concentration without correlation (r^2=0,0189)

23% exceedances for PM10 (> 50 µg.m^{-3})

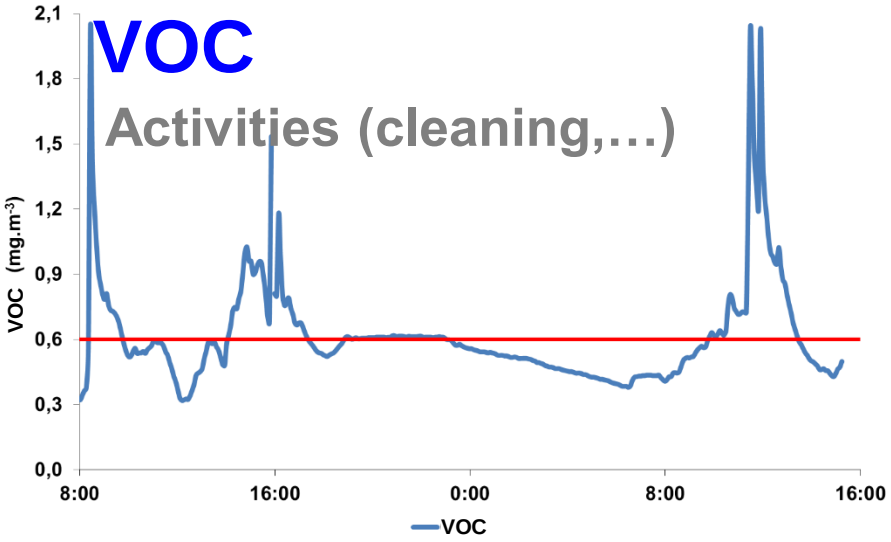
87% exceedances were recorded with CO_2<1800 mg.m^{-3}

Examples of indoor pollutant sources

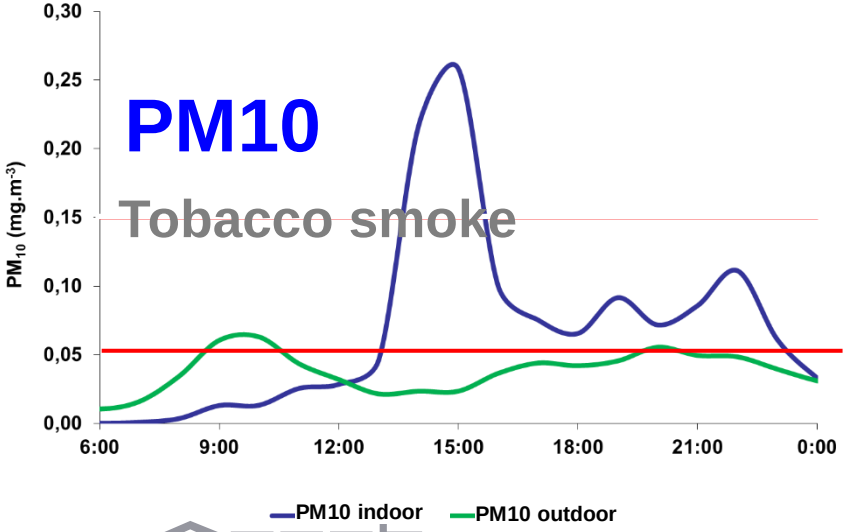
VOC
Building materials



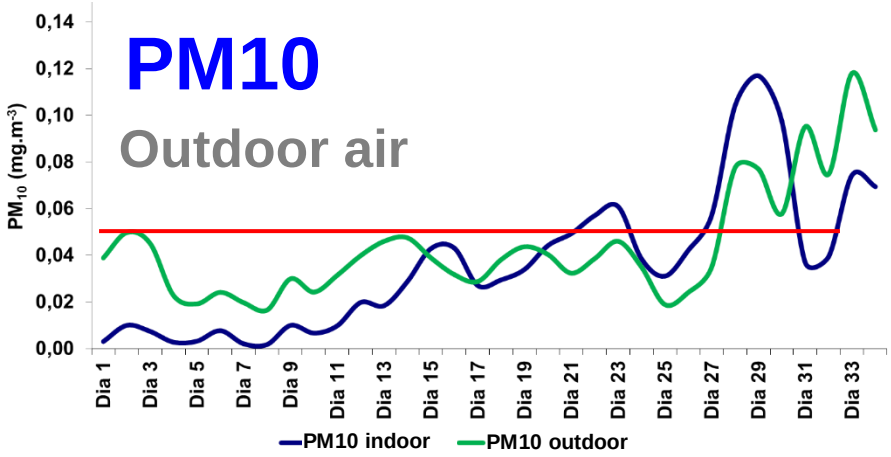
VOC
Activities (cleaning,…)



PM10
Tobacco smoke



PM10
Outdoor air



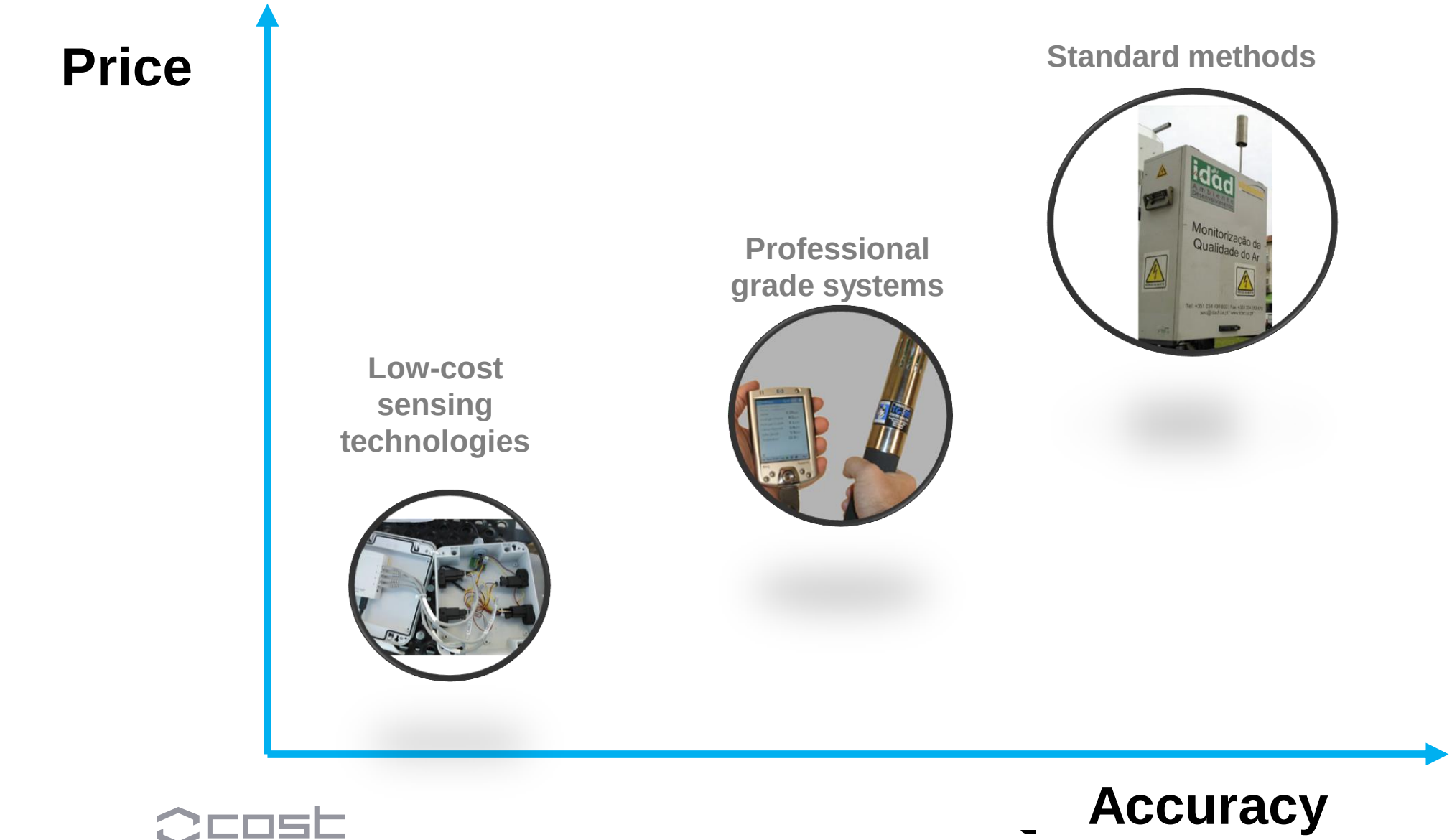
GUIDELINES FOR SENSOR NETWORK DESIGN

What? → Pollutants and standards

How? → Equipment and methods

Where? → Siting criteria, number of sensors

Indoor air quality monitoring

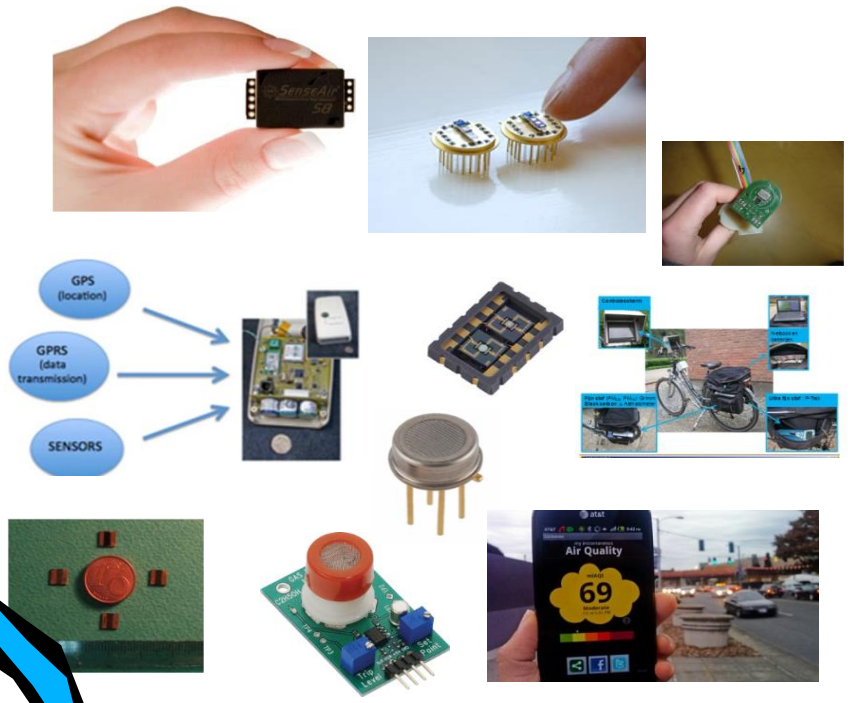


New sensing technologies for air pollution control

Low-cost sensing technologies

The utilization of micro-sensors is still not mentioned for regulatory purposes in European legislation.

Their use can be particularly valuable to have highly spatial and temporally resolved quality data and to improve exposure assessment



Sensitivity? ppb-ppm?

Stability? Lifetime/maintenance?

Selectivity? interferents

GUIDELINES FOR SENSOR NETWORK DESIGN

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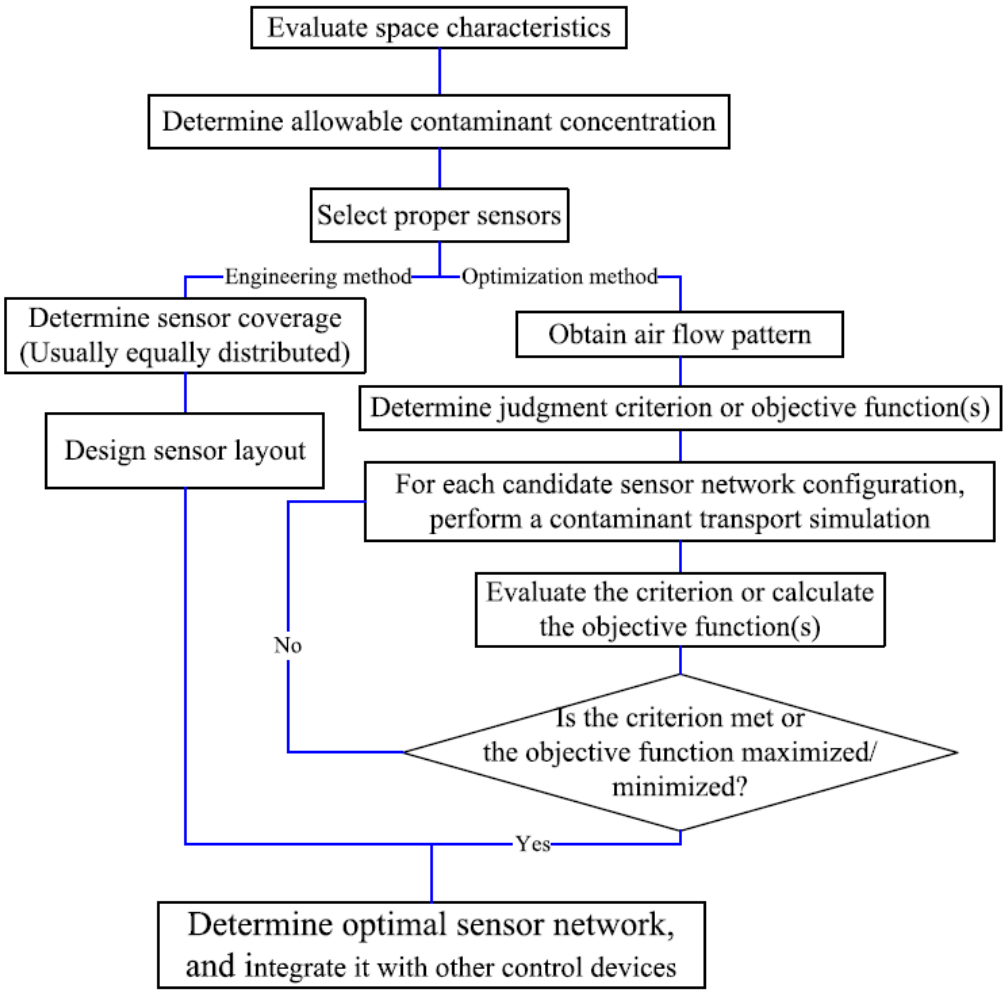
Example of protocol for design an IAQ sensor network



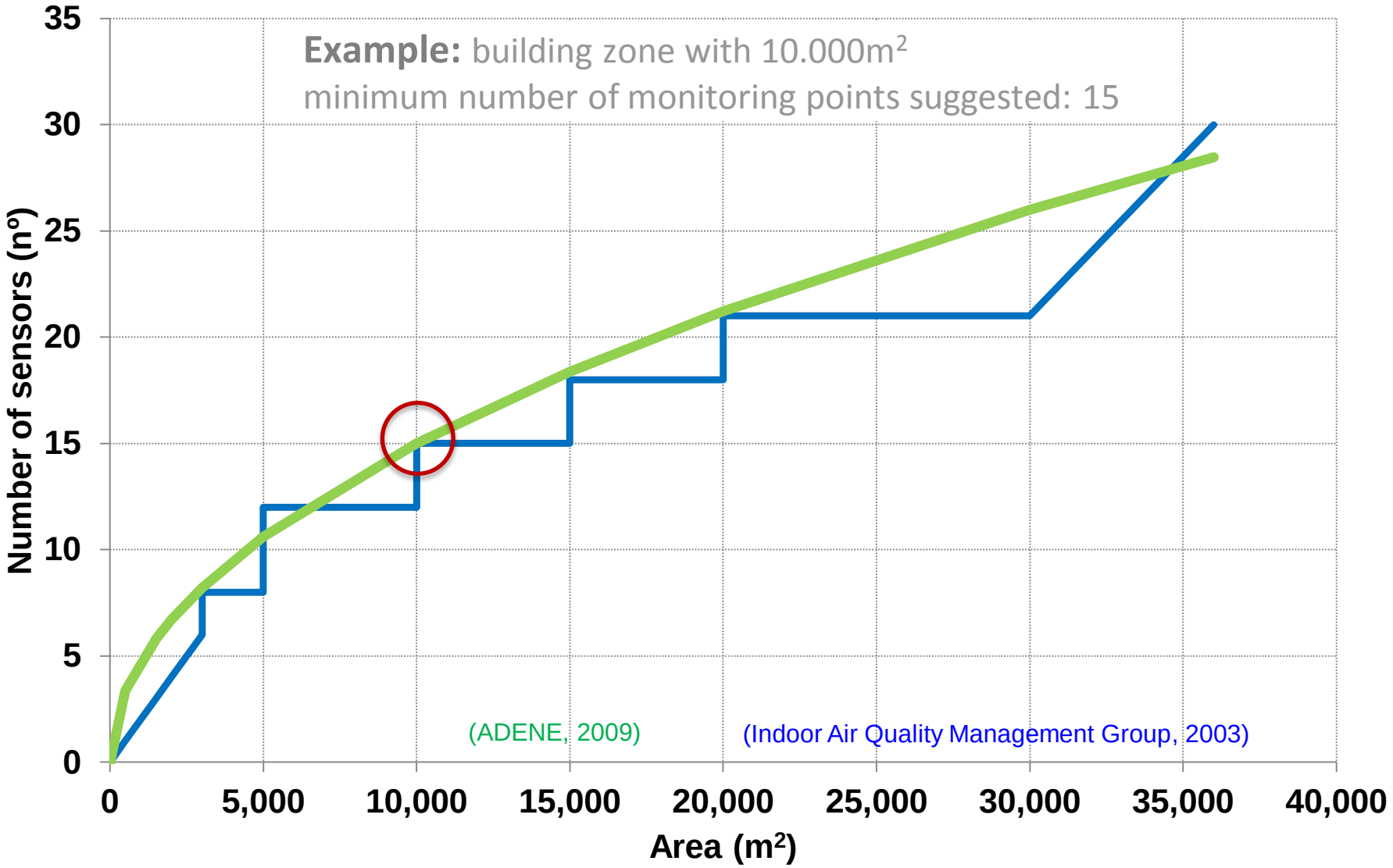
Building evaluation
(space characteristics, sources of pollution, …)
Network objective
(allowable concentrations,…)

Design sensor layout
(sensor coverage, flow pattern analysis)

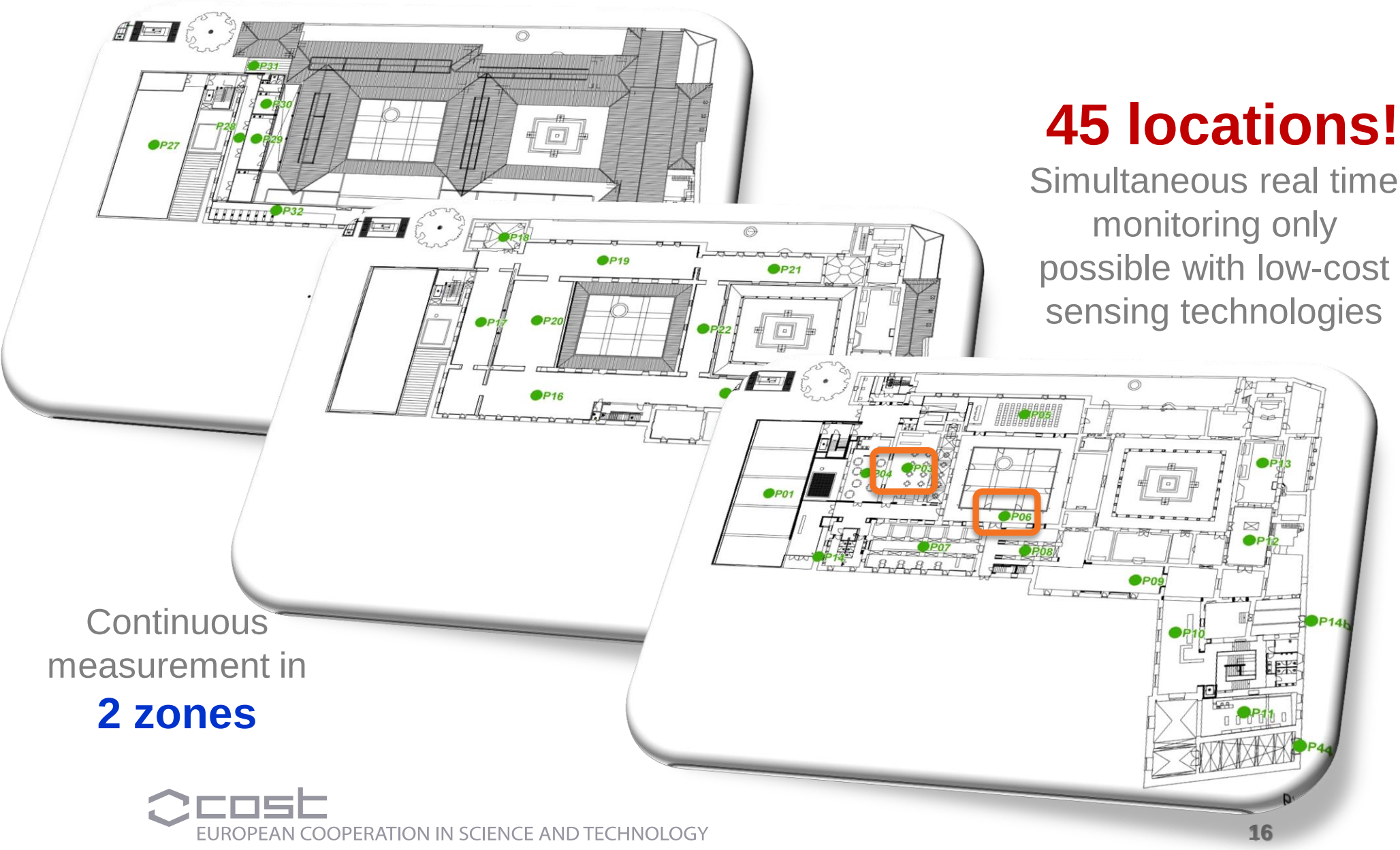
Integration with other control devices / communication systems

(Liu and Zhai , 2009)

Minimum number of monitoring points



Case study - museum



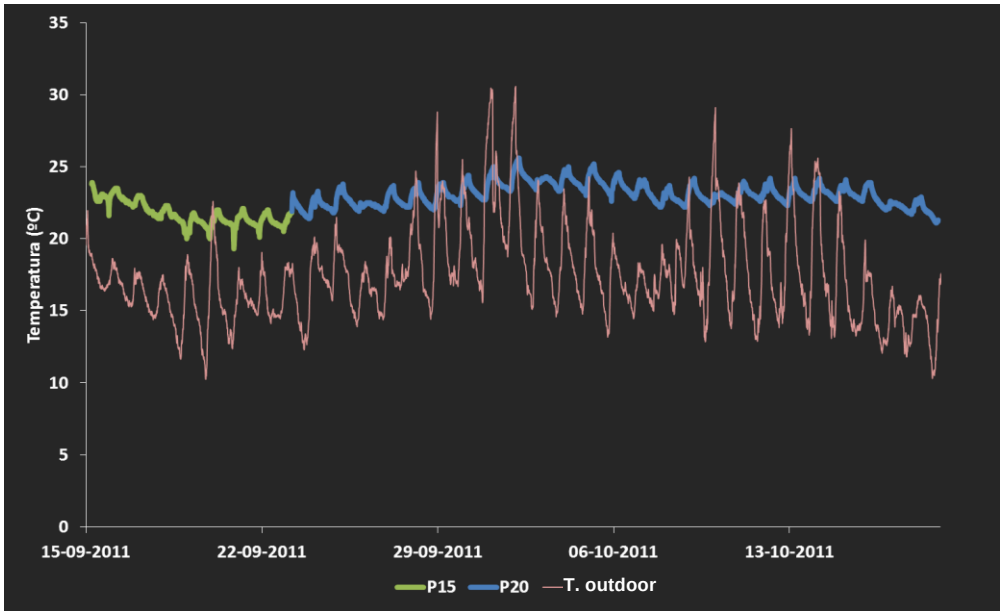
45 locations!

Simultaneous real time monitoring only possible with low-cost sensing technologies

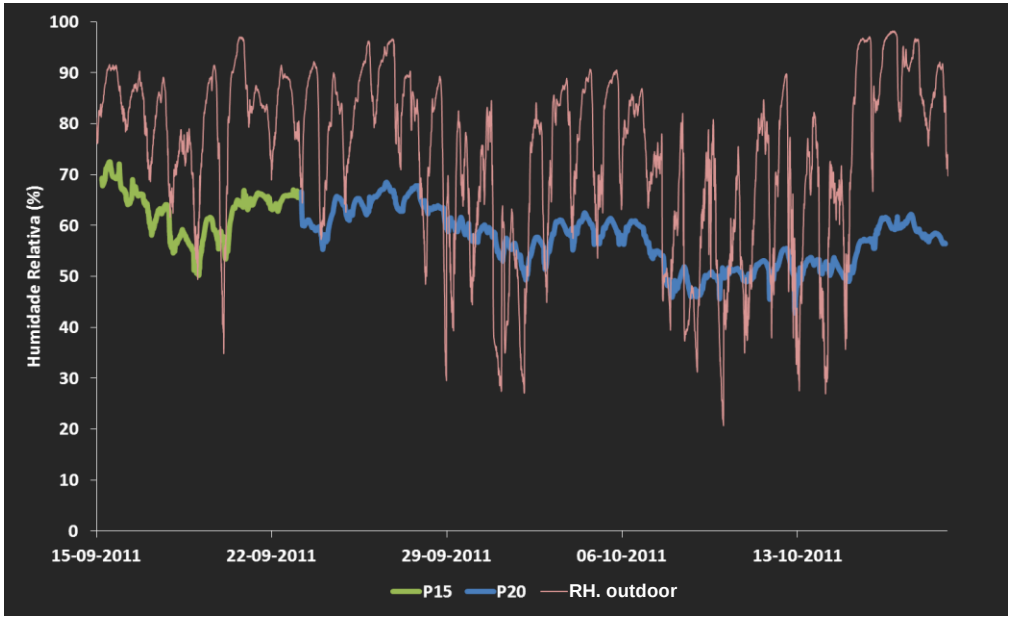
Continuous measurement in **2 zones**

Case study - museum

Temperature



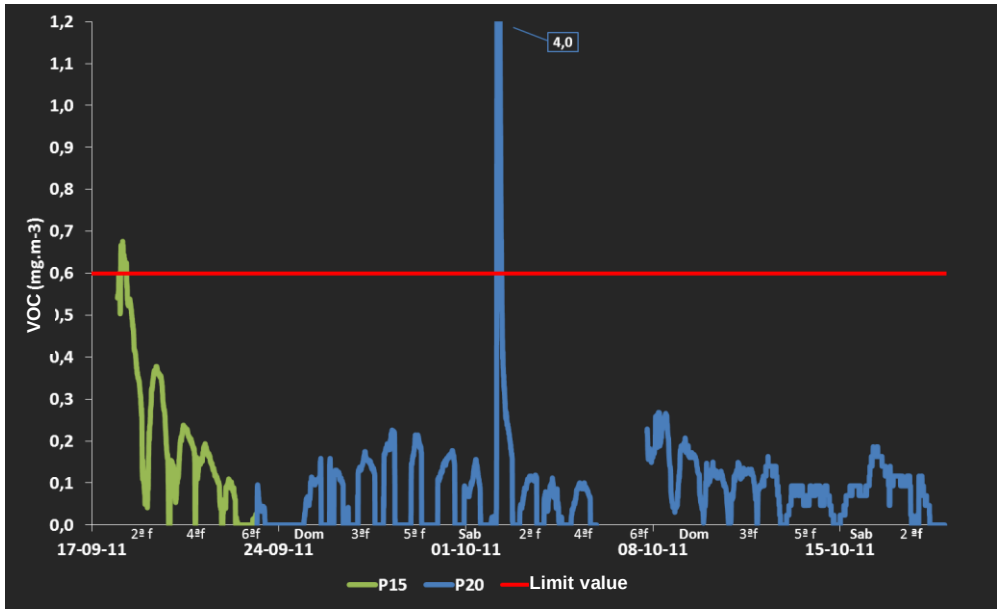
Relative humidity



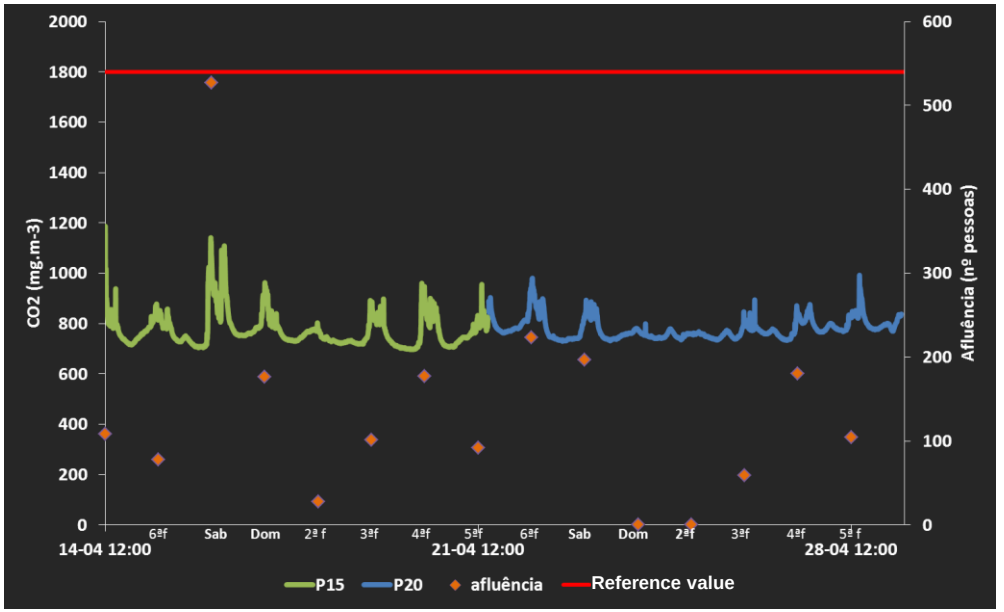
Temperature and RH – information already used for HVAC control
Adequate environmental conditions with energy efficiency

Case study - museum

VOC



CO2



VOC – identification of peak situations related with building interventions, other emissions

CO_2 vs nº.visitors – CO_2 below reference values even with high number of visitors

CO_2, VOC, PM10,… - could also be used for building control/public information

CONCLUSIONS

- Confirmation of the importance of some sources with relevant contribution to indoor air quality such as:
  - materials, cleaning;
  - **tobacco smoke** or **fireplaces**;
  - individual strategies of **ventilation**;
  - and **ambient air quality**.
- Result: CO_2 levels should be considered with precaution as an indicator of indoor air quality;
- An intervention in indoor air quality based on the concentration of CO_2 disregard possible exceedance for PM10 and VOC.

CONCLUSIONS

- The **raise of awareness on IAQ issues** combined with the **development of low-cost sensing technologies** allowed to look to other potential utilizations of monitoring data.

- The real-time collected data can be used to **inform occupants** in addition to security or HVAC control purposes.

- The use of **new sensing technologies** for IAQ assessment could be seen as a valuable contribution to create **healthy** and **comfortable** living environments**!**

Thank you for your attention!

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