AIVC April Workshop

Series of four webinars
organised in collaboration with
IEA-EBC Annex 86 ‘Energy efficient IAQ management’

April 1, Building ventilation: How does it affect SARS-CoV-2 transmission?
April 8, IAQ and ventilation Metrics
April 13, Big data, IAQ and ventilation - part 1
April 21, Big data, IAQ and ventilation - part 2

Previous webinars available on www.aivc.org
Scope and Goals

Provide a framework to improve energy efficiency of IAQ management for residential buildings both new construction and refurbishment

To select metrics to assess energy performance and indoor environmental quality of an IAQ management strategy and study their aggregation
To improve the acceptability, control, installation quality and long-term reliability of IAQ management strategies by proposing specific metrics for these quality issues
To set up a coherent rating method for IAQ management strategy that takes into account the selected metrics
To identify or further develop the tools that will be needed to assist designers and managers of buildings in assessing the performance of an IAQ management strategy using the rating method
To gather existing or provide new standardized input data for the rating method
To study the potential use of smart materials as (an integral part of) an IAQ management strategy
To develop specific IAQ management solutions for retrofitting existing buildings
To benefit from recent advances in sensor technology and cloud-based data storage to systematically improve the quality of the implemented IAQ management strategies, ensure their operation and improve the quality of the rating method as well as the input data
To improve the availability of these data sources by exploring use cases for their providers
To disseminate about each of the above findings.

Partners

42 institutes from 24 countries

Open to new partners

Active participation by companies encouraged!

List of annex participants per country:
Australia: CSIRO
Austria: University of Innsbruck
Belgium: UGent, KUL, BBRL, University of Antwerp
Brazil: Pontifical Catholic University of Parana
Canada: NRC
Chile: PUC
China: Nanjing University, BUCE and Tsinghua University
Denmark: DTU and Aalborg University Copenhagen
Finland: Aalto University
France: La Rochelle University, ENS PSL, CEREMA, Université de Lille, UPJV and CETIAT
Germany: TH Rosenheim
Ireland: NUIG
Italy: EURAC research center
New Zealand: BRANZ
Netherlands: Technical University of Eindhoven, BBA/TU Delft and Zehnder
Norway: Oslo Metropolitan University and SINTEF
Portugal: University of Coimbra, Polytechnic Institute of Viseu and University of Porto
Singapore: National University of Singapore
Spain: Eduardo Torroja Institute for Construction Sciences – CSIC
Sweden: Chalmers University and KTH
Switzerland: ETH
Turkey: TITMD
United Kingdom: University of Strathclyde, Lancaster University and University of Nottingham
USA: Syracuse University, UMD, UTexas andLBL
### Annex 86

#### Workplan

**6 Subtasks**

- ST 1 and 2: methodology
- ST 3 and 4: application to technology
- ST 5: new opportunities through IoT
- ST 6: dissemination and management

#### Subtask 1 Metrics and development of an IAQ management strategy rating method

This subtask is devoted to the development of a general rating method for the benchmarking of the performance of IAQ management systems. In addition to relevant metrics, a set of appropriate tools, consistent modeling assumptions and monitoring protocols are also proposed.

#### Subtask 2 Source characterization and typical exposure in residential buildings

This ST creates consistent input values for the assessment method developed in ST 1 and control strategies in ST 4. It starts from information available in literature, adding new experimental results where needed and reviewing and developing models (empirical, semi-empirical or physical models) for characterizing relevant residential sources.

#### Subtask 3 Smart materials as an IAQ management strategy

This ST identifies opportunities to use the building structure and (bio-based) building materials (focusing on hemp concrete) and the novel functional materials inside it to actively/passively manage the IAQ, for example, through active paint, wallboards, textiles coated with advanced sorbents or hemp concrete, and quantifies their potential based on the assessment framework developed in ST 1.

#### Subtask 4 Ensuring performance of smart ventilation

This subtask focuses on practical conditions that assure reliable, cost effective and robust implementation of smart ventilation. This includes both installation and operation. A poor performance of smart ventilation systems can only lead to waste of energy and aggravated IAQ. It can also create a bad reputation of smart ventilation among relevant stakeholders - designers, installers as well as occupants. This, in the end, can lead to adoption of more primitive, less efficient (in terms of energy use) and less effective (in terms of IAQ) forms of IAQ management. The subtask defines a smart ventilation according to the AVC.

#### Subtask 5 Energy savings and IAQ improvements and validation through cloud data and IoT connected devices

This subtask is exploring the potential of the new generation of IoT connected devices (both standalone and embedded in e.g. AHU’s) for smart IAQ management. What can we learn from big data? Can we benchmark system energy and IAQ performance based on this data? How can we make sure that the data is available and can be accessed? Can we update what we think we know about what happens in dwellings based on what we see in big data? How can we use these data to create a new picture of the relationships between IAQ and other variables? What are the best protocols and ontologies? How to make the data available to all stakeholders? How do we integrate data with smart grids?

#### Subtask 6 Dissemination, management and interaction

The final subtask assures the close alignment of the activities within the annex and the interaction with the AVC. This subtask includes the outreach of the annex, e.g. by managing the dedicated section of the IEA EBC webpage. It uses the different platforms that the AVC provides to interact with the broader target audience. This task will also ensure the continuation of the link with (the results from) other ongoing and ended annexes, especially annex 68.
Energy savings and IAQ: improvements and validation through cloud data and IoT connected devices

- **Smartness**
  (e.g. smart ventilation incl. continuous commissioning & optimization, use of remote data, ST4)
- **Knowledge & data-sets**
  (e.g. for defining metrics (ST1), typical exposures (ST2))
- **Applications**
  real-time & delayed, on-line & off-line, new business cases?
- **Challenges**
  • real-life, uncontrolled environments (cause/effect?)
  • data quality: often limited number and lower cost sensors
  • GDPR
  • IT
  • ...

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- April 8, IAQ and ventilation Metrics
- April 13, Big data, IAQ and ventilation - part 1 (academics)
- April 21, Big data, IAQ and ventilation - part 2 (industry)

**Objectives:**
To address
- **the applications** of IoT devices and big data in IAQ and ventilation
- discuss **the possibilities** they provide for **industry**.

To set the starting stage for subtask 5 of IEA-EBC Annex 86
Big data, IAQ and ventilation – part 2

09:00 | Introduction
Benjamin Hanoune – Université de Lille, France

09:10 | Data analytics at Renson: from airflows to dataflows
Steven Delrue – Renson, Belgium

09:25 | CO₂: a reference point for ventilation standards
Sandra Chochod & Marcin Mezynski – Netatmo, France

09:40 | rCloud – Geolocation and Cloud Storage of Airtightness Test results and Real-time Pressure Logging
Ben Walker – Retrotec, Canada

09:55 | Sensors and machine learning to improve HVAC control
Inouk Bourgon – Foobot, Luxembourg

10:10 | Questions and Answers
10:30 | Closing & End of webinar

How to ask questions during the webinar

Locate the Q&A box

Select All Panelists | Type your question | Click on Send

Note: Please DO NOT use the chat box to ask your questions!
NOTES:
• The webinar will be recorded and published at www.aivc.org in a few days, along with the presentation slides.
• After the end of the webinar you will be redirected to our post event survey. Your feedback is valuable so take some minutes of your time to fill it in.

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Q&A

Big data, IAQ and ventilation – part 2
Data Analytics at Renson: From airflows to dataflows
Steven Delrue – R&D Manager Data Analytics

Creating healthy spaces
VENTILATION | SUNPROTECTION | OUTDOOR

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Introduction

RENSON THROUGH THE YEARS

Polidore
RENSON
1909-1913

Georges
RENSON
1913-1950

Jan
RENSON
1950-1982

Paul
RENSON
1982-...

Cast iron

Aluminum

Profiles

Concepts

Ventilation

Sunprotection

Outdoor

WHERE MAGIC HAPPENS

NATURALLY FEELING GOOD...
Introduction
DIGITAL INNOVATION ROADMAP

Customer value
Services
Data analytics
Connectivity
Sensor / actor
Product

Introduction
RENSON CONNECTED DEVICES

<table>
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<th>Healthbox 3.0</th>
<th>Waves</th>
<th>Sense</th>
<th>Outdoor</th>
<th>Screens</th>
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<td><img src="image2" alt="Waves" /></td>
<td>± 700</td>
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<td>2022</td>
<td><img src="image5" alt="Screens" /></td>
<td></td>
</tr>
</tbody>
</table>
Data analytics at Renson

The Logical Next Step

**Vision**
Take the concept of ‘Creating Healthy Spaces’ to the next level using product data.

**Mission**
Develop data tools and methods to assist the company in creating innovative concepts and products for healthy and comfortable living.

- **Data** → **Great product/solution**
- **Attract**
- **Generate**
- **Improve**

**Users/Stakeholders**
Data analytics at Renson
A MODERN DATA PLATFORM

Cloud-device communication → Real-time ingestion → Batch ingestion

Reporting – Dashboarding – Advanced control

Data science & analytics

SOME EXAMPLE DATA
Data analytics at Renson

SOME EXAMPLE DATA

[Graph showing ventilation rates and CO2 levels over time]

USE CASES

- Research and decision-making
- Improved customers engagement
- Product improvement
- Service development
Data analytics use cases

RESEARCH AND DECISION-MAKING

Cloud based large-scale performance analysis of a smart residential MEV system

Articles

This article is based on a paper presented at the 4th IIEE Conference "From energy crisis to sustainable urban future" 15-18 October 2019, Ghent, Belgium

moving_average=24h

mean concentration [%]

percentile

0.00 0.50 1.00

mean concentration [%]

percentile

mean concentration [%]

percentile

mean concentration [%]

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mean concentration [%]

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mean concentration [%]
Data analytics use cases
IMPROVED CUSTOMER ENGAGEMENT

[Image of a user interface with a mobile app and a comfort index chart]

Data analytics use cases
PRODUCT IMPROVEMENT - RENSON COMFORT CONTROLLER

[Diagram showing system identification and preference identification]

MAX

Level of insights into the system

NULL

[Images of houses and a celebrity experience]

IN

OUT

IN

OUT

White-box

Gray-box

Black-box

System identification

Preference identification
Data analytics use cases
SERVICE DEVELOPMENT

**Installation score**

![Installation score graph]

**Wrong valve detection**

![Wrong valve detection diagram]

**Key take aways**
Key take aways

- Data analytics is on the rise for managing and maintaining healthy and comfortable indoor environments
- Data analytics can be used to create awareness
- Data analytics allows optimization of the performance of HVAC systems
- Data analytics is key to unlock various insights of your system (comfort, energy efficiency, maintenance, ...)
- ...

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CO2: a reference point for ventilation standards

Agenda

- Netatmo vision
- Key facts in Europe
Netatmo vision

**Which sensors to measure Indoor Air Quality?**
- CO2 sensor on our products
- Other sensors on the market: VOC, Formaldehyde, PM etc...

**Is CO2 a good indicator for Indoor Air Quality?**
- CO2 is a good indicator of stuffiness\(^1\).
  - It means that CO2 measurements can be used to evaluate the adequation between air exchange rate and room’s occupancy density. When there is too much CO2 in a room, it means this room is not ventilated enough.
  - If there are other pollutants, they are not evacuated and therefore they might be highly concentrated.
- CO2 is a worldwide well-known indicator (increased consideration with the current situation, legislation...)
- CO2 sensors are reliable

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**Source:**

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Netatmo vision

**Can CO2 alone be considered as the perfect indicator of the Indoor Air Quality?**
- Other pollutants can be high in the room even with a low CO2 level (domestic activities like cleaning, maintenance, DIY, painting that can induce COV production).
- A high concentration of CO2 means a bad Indoor Air Quality but the opposite is not true.

**CO2 is the best indicator of Indoor Air Quality and more over of the need to ventilate a room.**
- CO2 being naturally produced by humans they are the main source in indoor environment. It gives an indicator of the level of air containment in a room at the most important time: when there are people in it.
User behaviour in Europe

Rate of polluted households in EU / 2018

Methodology:
- CO2 measurements from a minimum of 1,000 Netatmo Weather Stations per country
- GDPR compliant with anonymous data
- Proportion of Stations exceeding the limit of 1,000ppm of CO2 at least once per day.
- Error margin: 4%

User behaviour in Europe during 1st lockdown

Indoor air pollution from the 1/3 to the 26/4, Year on Year

Methodology:
- CO2 measurements from a minimum of the same 1,000 Netatmo Weather Stations per country, on two consecutive years - GDPR compliant with anonymous data
- Average ppm measured - Error margin: 4%
Why is it relevant for individual households?

- As it’s not yet mastered by the users
  - Figures shown are for Netatmo clients, who have a device monitoring this gas, what about other clients who don’t have it?

- As it’s a common factor for other pollutants/elements: Covid-19 has proven it

- As behaviours will change in the next years
  - For example, we believe that the remote work will keep its growth, which was real even before Covid\textsuperscript{1}

Source:
- (1) Joint research center, Telework in the EU before and after the COVID-19: where we were, where we head to, EU Commission

Contacts

- Sandra Chochod - Weather & Air Care R&D PM: sandra.chochod@netatmo.com

- Marcin Mezynski – Weather & Air Care Marketing PM: marcin.mezynski@netatmo.com
Co-CEO of Retrotec for past 3 ½ years.

Prior role as technical director and lead the company’s development efforts in both hardware and software for air tightness testing.

Email: ben@retrotec.com

Ben Walker
Co CEO at Retrotec
Todays Key Topics

• rCloud Walk Through – Airtightness Test Data
  • Remote Logging Digital Pressure Gauges

• Mobile Test Platform
• GEO Location
• Cloud Storage
• Data Integrity
• Results Analysis
Walk Thru (Demo)

Blower Door Setup
Test Location

Select the type of test

- Blower door
- Duct test
- Exhaust test
rCloud Tests Around the World

Realtime Remote Pressure Logging
Thank You!

ben@retrotec.com

[Retrotec Logo]
Sensors & machine learning to improve HVAC control

https://foobot.io/offices

Inouk Bourgon, cto | inouk@foobot.io

Our first product, Foobot
First connected air quality sensor measuring beyond CO2
Based on the first 100 Foobots connected with Nest

![Bar chart showing cumulative hours in polluted air over 10 days before and after using Foobots.

- PM2.5:
  - Before: 40.6 hours
  - After: 15.1 hours

- VOCs:
  - Before: 50.5 hours
  - After: 33.05 hours

![Pie chart showing the percentage reduction in pollutants.

- PM2.5: -50%
- VOCs: -30%
- DCV: -10%]
Smart Air Building
HVAC Optimization for
- Carbon Footprint
- Indoor Air Quality

Deployment of SAB

AI AGENT
EXTERNAL DATA
Weather & Forecast,
Outdoor pollution, energy cost...

MQTT

HVAC
BUILDING BMS
GATEWAY
OUR SENSORS
*Optional
Pre-Training Technology

Building model > Simulation > AI agent trained

Building Model > Digital Twin

Open Studio model
Building envelope, HVAC system, local outdoor conditions

Model Calibration
Align real life data with model data, following ASHRAE 14 standard
**Reinforcement Learning**

- **EnergyPlus simulation**
  - Digital twin, OpenAI Gym

- **Agent selection**
  - Benchmark control strategy and agents

- **Ability to predict results**

**Results in our first building**

- **52.6%** Energy savings
  - From HVAC

- **98.9%** Thermal comfort
  - Delivered

- **100%** CO₂ & IAQ
  - Below threshold*
Indoor Air Quality
measured by FoobotSAT

- Sensors:
  - tVOC
  - PM1 / 2.5 / 10
  - CO2
  - T/H
  - Motion

- Connectivity:
  - BLE / WiFi / Ethernet

- Power:
  - AC adaptor / POE

8 real-time measures of Indoor Air Quality and Thermal Comfort

Smart Air Building result summary

- 3.35€/m² SAVED over 12 months
- 62 tCO₂ AVOIDED over 12 months
- 5 months RETURN on investment

- 51 625€ energy savings over 12 months
Before we go

- Reach out if you want SAB deployed in your building!

- Check our tech article explaining how we can save so much energy: http://bit.ly/foobot-ai

https://foobot.io/offices

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