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AND ARCHITECTURE

DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING  
BUILDING PHYSICS, CONSTRUCTION AND SERVICES RESEARCH GROUP

VOC VS. CO<sub>2</sub> CONTROLLED DCV:

# A CASE STUDY

AIVC 2018 Webinar



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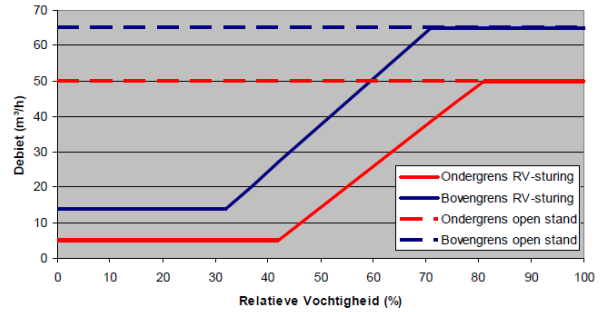
 Ghent University

 @Jlaverge

 Jelle Laverge

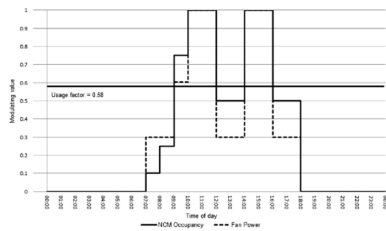
# The Context: Belgian DCV

## A BIT OF HISTORY OF 'DCV' IN BELGIUM



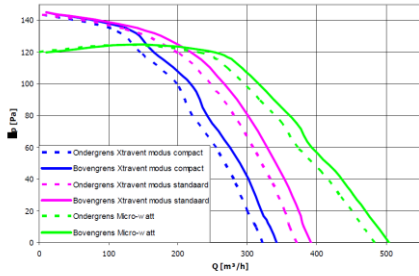
1<sup>st</sup> Generation: mechanical exhaust control imported from France  
+- 2007

## A BIT OF HISTORY OF 'DCV' IN BELGIUM



2<sup>nd</sup> Generation: RH/presence detection triggering exhaust fan  
+- 2009

# A BIT OF HISTORY OF 'DCV' IN BELGIUM

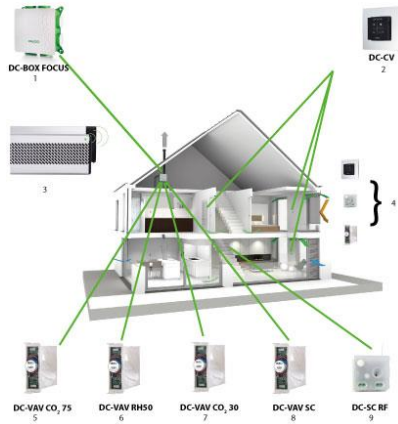


Figuur 3: 90-90 interval van de ventilatorkarakteristiek



3<sup>rd</sup> Generation: electronic dampers per exhaust space  
+- 2010

# A BIT OF HISTORY OF 'DCV' IN EUROPE



4<sup>th</sup> Generation: Electronic supply grids and additional exhausts  
+- 2012

# The Research Objective

## RESEARCH OBJECTIVE

Demonstrate the behaviour of DCV controlled by  
'cheap' HVAC grade metal oxide sensors  
in modern low-energy dwellings

Bonus: can they be 'all-in one' replacements for CO<sub>2</sub>?

# The Case Study



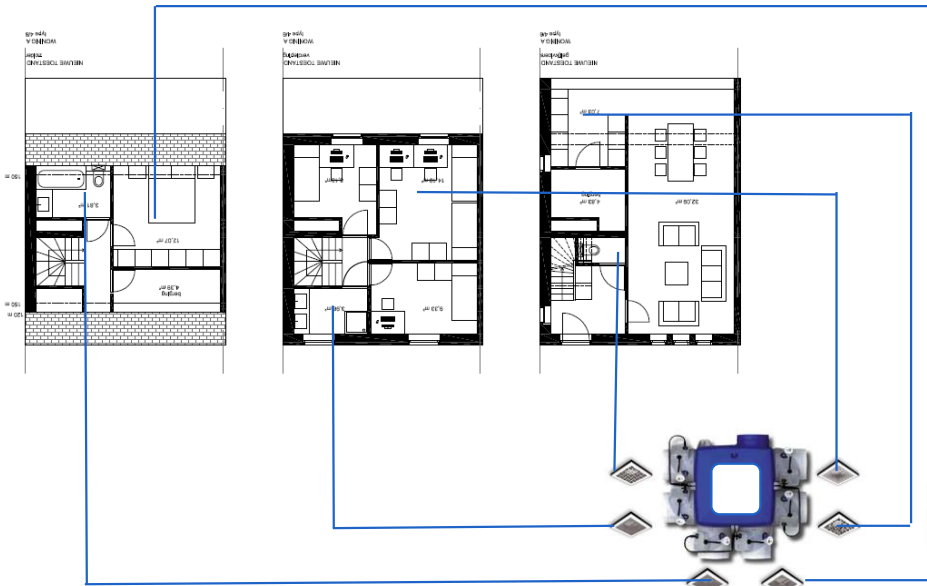
Social housing estate 'Venning'  
Kortrijk, Belgium

Renovation part of concerto 'Eco-Life'





Focus on the individual dwellings



NDIR CO<sub>2</sub>  
MOS



# EXPERIMENTAL SETUP

In every test house:

- Mode 1: system controlled by NDIR (2 weeks)
- Mode 2: system controlled by MOS (2 weeks)

MOS output = factory calibrated to 'CO<sub>2</sub> equivalents'

Same setpoints in both modes

Campagne	1	2	3	Campagne	1	2	3
<b>Fase 2</b>				<b>Fase 3</b>			
W2.1	X	X	X	W2.16	-	X	X
W2.2	X	X	X	W2.17	-	X	X
W2.3	X	X	X	W2.18	-	X	X
W2.4	X	X	X	W2.19	-	-	X
W2.5	X	X	X	W2.20	-	-	X
W2.6	X	X	X	W3.1	X	X	X
W2.7	X	X	X	W3.2	X	X	X
W2.8	X	X	X	W3.3	X	X	X
W2.9	X	X	X	W3.4	X	X	X
W2.10	X	X	X	W3.5	X	X	-
W2.11	X	X	-	W3.6	X	X	-
W2.12	X	-	-	W3.7	X	-	-
W2.13	-	X	-	W3.8	-	X	X
W2.14	-	X	X	W3.9	-	-	X
W2.15	-	X	X				

Table 1: Monitoring campaigns

	Campaign 1	Campaign 2	Campaign 3
DCV <sub>CO2</sub>	November 14, 2015	December 11, 2015	January 09, 2016
	November 24, 2015	December 23, 2015	January 20, 2016
DCV <sub>VOC</sub>	November 29, 2015	December 25, 2015	January 22, 2016
	December 09, 2015	January 06, 2016	February 02, 2016



# The Results





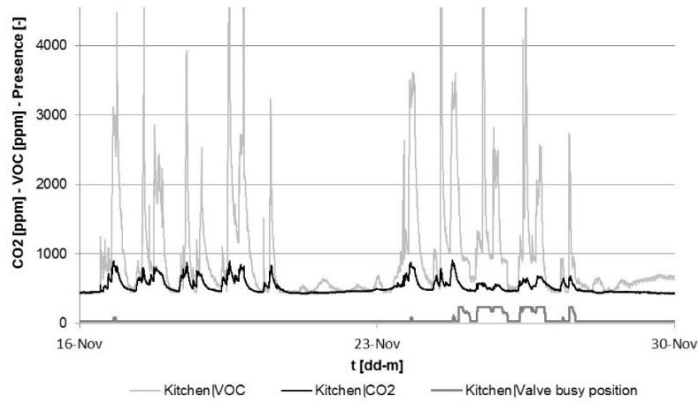
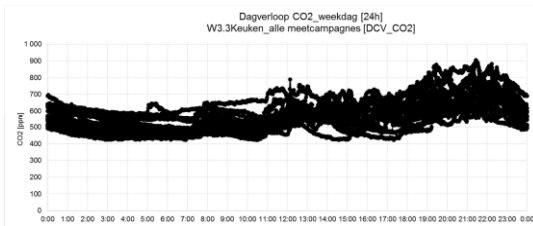


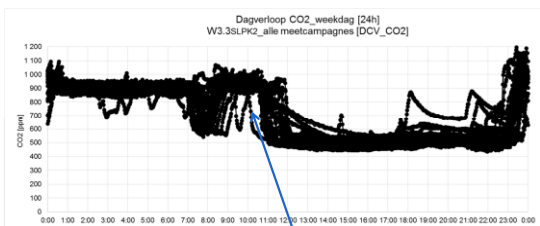
Figure 1: CO<sub>2</sub> and VOC concentrations over 2 weeks [week 1: DCV<sub>CO2</sub> ; week 2: DCV<sub>VOC</sub>]

CO<sub>2</sub> concentration over 24 h

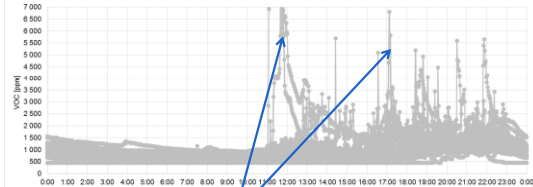
Kitchen



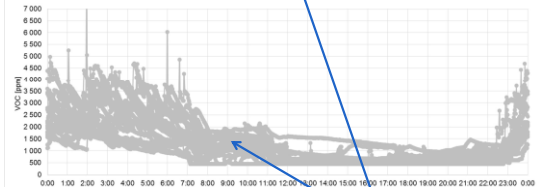
Masterbedroom



Kitchen



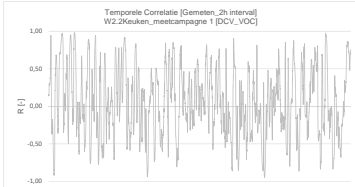
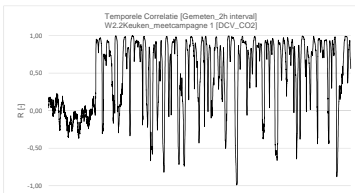
Masterbedroom



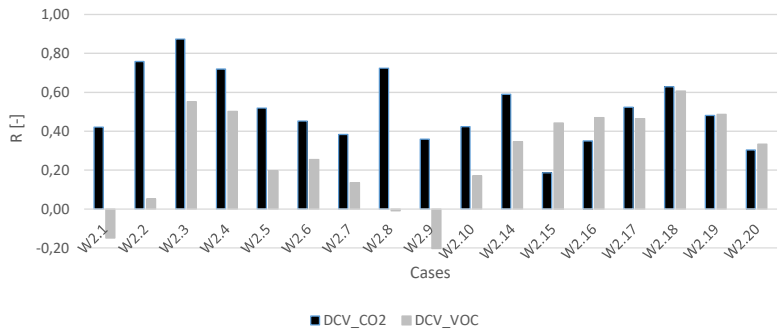
Cooking activities

different emission rate

VOC concentration over 24 h



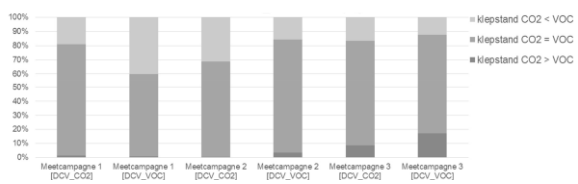
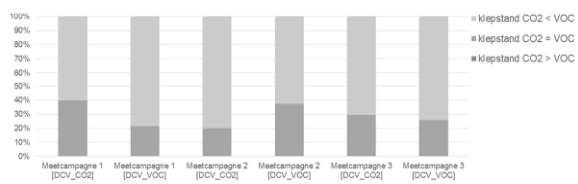
Figuur 17: Temporele correlaties voor W2.2Keuken [meetcampagne 1]



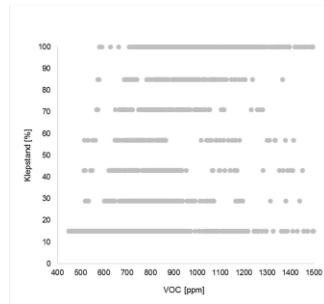
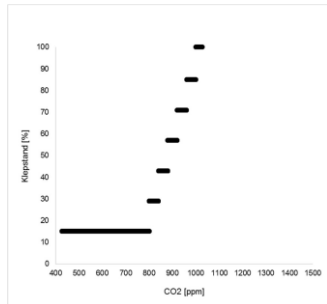
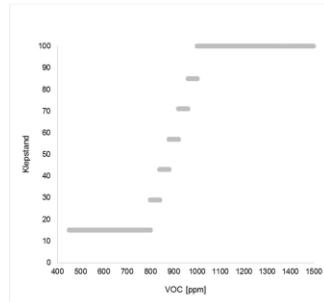
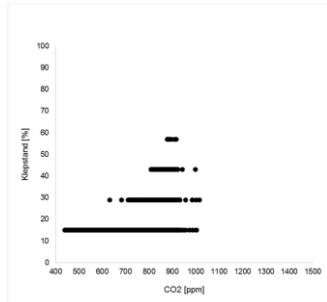
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### Pearson Correlation between CO2 and VOC concentration

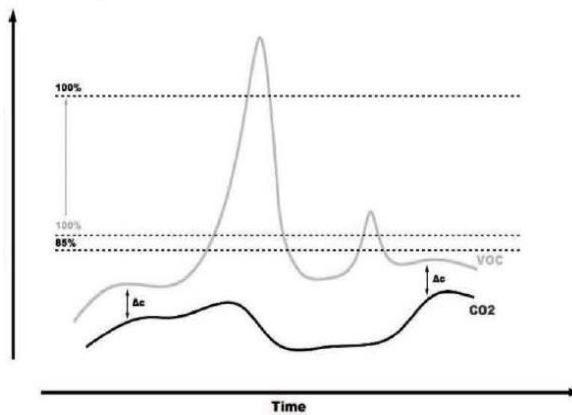
Differences between individual houses, based on number of people, type of sources...



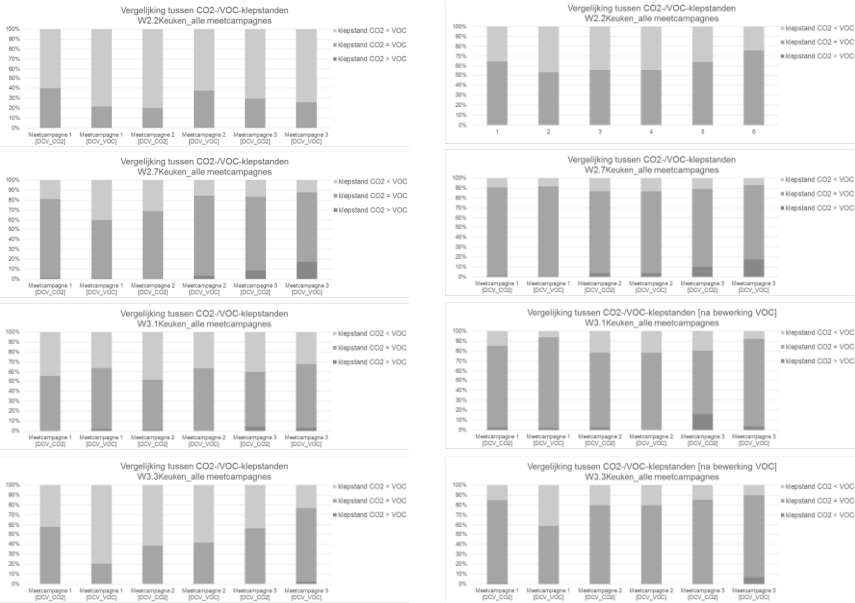
valveposition  
as a function of  
CO2/VOC  
concentration



How to handle this type of signal for better ventilation?



## Differences between individual houses, based on number of people, type of sources...



# Lessons learned

## Lessons learned

- ‘equivalent’ TVOC concentration was more than 50% higher than the CO<sub>2</sub> concentration
- TVOC much more peaked with occupant behaviour
- TVOC control significantly increases total ventilation (+69% in bedrooms, +176% in kitchens)
- ‘transforming’ the TVOC signal looks promising but requires some more work
- ‘raw’ TVOC signal suitable for event detection