# Practical use of the Annex 68 Indoor Air Quality Dashboard

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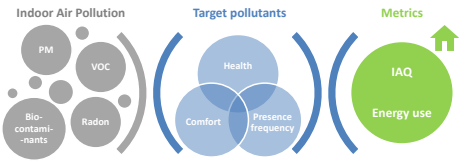


AIVC2019 40th AIVC - 8th TightVent & 6th venticool Conference From energy crisis to sustainable indoor climate
40 years of AIVC, 15-16 October 2019, Ghent, Belgium

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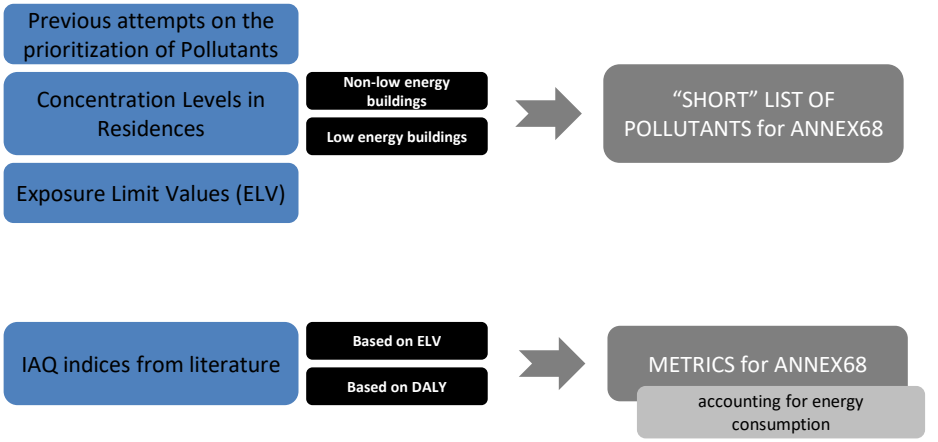
# Subtask1 – Defining the metrics

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# List of pollutants of concern for Annex68

| | Long-term Exposure | | | Short-term Exposure | | |
|---|---|---|---|---|---|---|
| | ELV | Averaging period | Source | ELV | Averaging period | Source |
| **Acetaldehyde** | 48 | 1 year | Japan | - | - | - |
| Acrolein | 0.35 | 1 year | USA-California | 6.9 | 1 h | France |
| **α-pinene** | 200 | 1 year | Germany | - | - | - |
| **Benzene** | 0.2 | whole life (carcinogenic risk level: $10^{-6}$) | France | - | - | - |
| Carbon dioxide | - | - | - | 1250 | 8 h | Portugal |
| **Formaldehyde** | 9 | 1 year | USA-California | 123 | 1 h | Canada |
| **Naphthalene** | 2 | 1 year | Germany | - | - | - |
| **Nitrogen dioxide** | 20 | 1 year | France, Canada | 470 | 1 h | USA-California |
| **PM10** | 20 | 1 year | WHO | 50 | 24 h | WHO |
| **PM2.5** | 10 | 1 year | WHO | 25 | 24 h | WHO |
| **Radon** | 200 | 1 year | Austria, Canada, Hong-Kong | 400 | 8 h | Austria, China, Portugal |
| **Styrene** | 30 | 1 year | Germany | - | - | - |
| **Toluene** | 250 | 1 year | Portugal | - | - | - |
| **Trichloroethylene** | 2 | whole life (carcinogenic risk level: $10^{-6}$) | France | - | - | - |
| TVOC | - | - | | 600 | 8 h | China, Hong-Kong, Portugal |
| Mold | 200 | 1 year | EU | - | - | - |

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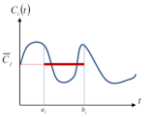
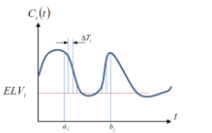
# Metrics for Annex68 – Dashboard

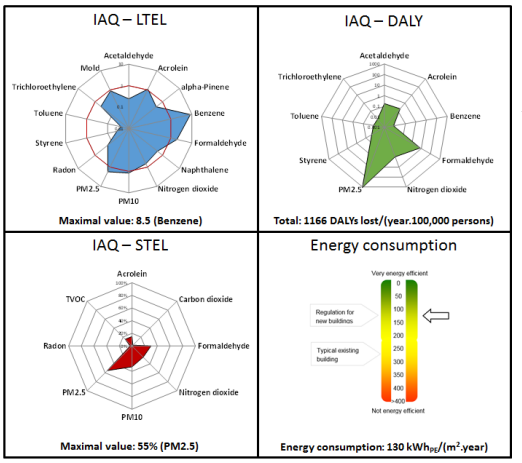


$$\overline{C_i} = \frac{1}{n}\sum_{n=1}^{n}\left[\frac{1}{b_j - a_j}\int_{a_j}^{b_j} C_i(t)dt\right]$$

$$I_p = \frac{\overline{C_p}}{ELV_p}$$



$$I_i = \frac{\sum_{j=1}^{n}(b_j - a_j)\times f_j(C_i(t) \geq ELV_i \text{ over } \Delta t_i)}{\sum_{j=1}^{n}(b_j - a_j)}$$




*Data represented here are just for display and do not represent actual situation*

$$DALY^{p} = \sum_{j=1}^{n_{hours}} DALY_j = \sum_{j=1}^{n_{hours}} f_j(\overline{C_i})$$

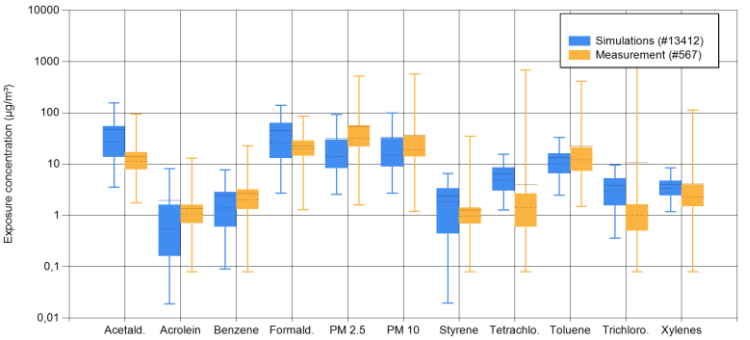
- **Energy** needed **to condition the outdoor air** i.e. heat, cool, humidify or dehumidify.
- **Energy to power the systems** like fans or air cleaning devices (electrostatic precipitation, plasma or photocatalytic oxidation)





# Case Study

- Numerical evaluation of exposure concentration with **TRNSYS – CONTAM coupling**
- **Prototypical house** + **scenarios** regarding ventilation systems, pollutant source strengths, outdoor pollution, occupants' activities…
- **Validation** against French survey from **567 houses and apartments** (Kirchner et al., 2006)

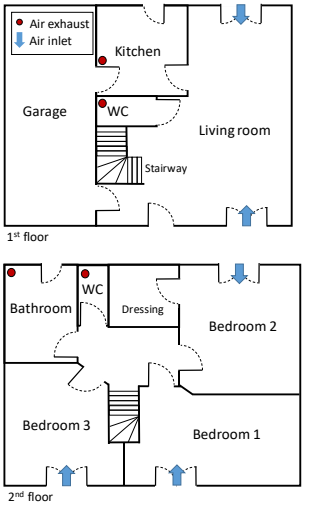



- Louis Cony-Renaud-Salis: PhD Thesis to be defended in beginning of 2020

*Kirchner S, Arene JF, Cochet C, Derbez M, Duboudin C, Elias P, Gregoire A, Jedor B, Lucas JP, Pasquier N, Pigneret M, Ramalho O. 2006a. Campagne nationale logements: état de la pollution dans les logements français. Report, CSTB/DDD/SB – 2006-57, 165 pages.*

# Case Study

- Two-storey house : 1 living room and 3 bedrooms
- Location : La Rochelle (small city, low pollution), France
- Envelope, furniture, occupant activity : “standard” see Cony-Renaud-Salis et al (2018 and 2019) for details.
- Ventilation rates (French standards):
  - 180 $m^3/h$ during 30 min. at noon and 19:30
  - 105 $m^3/h$ otherwise
- Ventilation systems :
  - Natural ventilation using vertical ducts for extraction (NAT)
  - Pressure-controlled exhaust ventilation (EXH)
  - Balanced mechanical ventilation (BAL)
- Occupants: Sedentary people (always at home)
- Considered pollutants (9/16 ST1 target pollutants): acetaldehyde, acrolein, benzene, formaldehyde, nitrogen dioxide, particulate matter (PM2.5, PM10), styrene and toluene.
- Simulation: 1 week, timestep = 5 min.

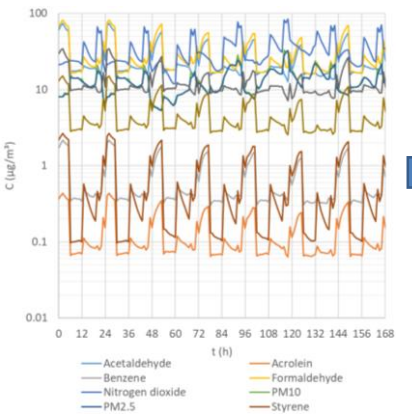


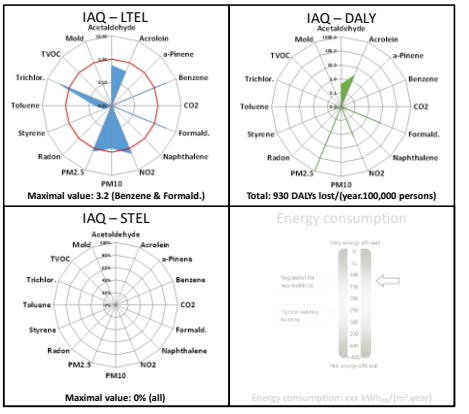

*Cony-Renaud-Salis, L., Ramalho, O., Abadie, M. (2018). Development of a Numerical Methodology to Assess Indoor Air Quality in Residential Buildings, Proceedings of the 15th Conference of the International Society of Indoor Air Quality & Climate (ISIAQ), July 22 to 27, Philadelphia, USA.*
*Cony-Renaud-Salis, L., Belhaj, N., Ramalho, O., Abadie, M. (2019). Analysis of the need of detailed modelling for the assessment of indoor air quality in residential buildings. Proceedings of 13th REHVA World Congress CLIMA 2019, May 26 to 29, Bucharest, Romania.*





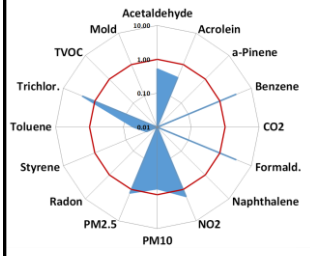
# Results – example for Natural Ventilation



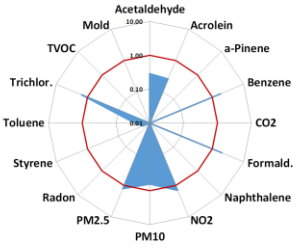



## Results – comparison

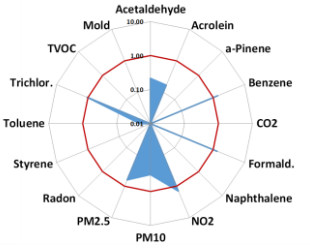
NAT




EXH




BAL




| | NAT | EXH | BAL |
|---|---|---|---|
| **LTEL** | 3.2 | 2.3 | 1.4 |
| **Target Pollutant** | Benzene and Formaldehyde | Benzene, Formaldehyde | Benzene, Formaldehyde and NO2 |
| **DALY** | 930 | 900 | 494 |
| **Target Pollutant** | 98.1% (PM2.5) | 98.7% (PM2.5) | 98.3% (PM2.5) |





## Conclusion

- ***AIVC Contributed Report***

EBC
Energy in Buildings and Communities Programme

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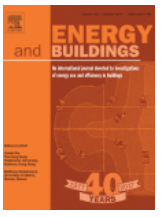
- Energy and Buildings Special Issue for EBC Annexes:

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Energy and Buildings
Volume 152, 1 October 2017, Pages 492-502

Towards the definition of indicators for assessment of indoor air quality and energy performance in low-energy residential buildings

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*Thanks to the financial supports of:*