EMISSIONS ANALYTICS

# Vehicle interior air quality

## *Pollution exposure in the cabin and the opportunity for standardized international ratings*

Nick Molden

March 2021

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# Our Belief

When it comes to the pursuit for improved air quality, we believe in the power of clarity, transparency and integrity. With real-world data we can meet emissions challenges – instilling trust and confidence in our industry partners and public.

It's with our commitment and independence we are able to make a significant contribution toward positive change and to achieve enduring results.

EMISSIONS ANALYTICS

# Introduction

- Founded in 2011
- Headquartered in the UK
- Operations in UK, Germany, USA and South Korea
- Independent testing house specialising in real-world emissions testing
- Over 2,500 vehicles/ machines PEMS tested across passenger, commercial and off-road
- Largest commercially available database of real-world emissions data
- We work with regulators, OEMs, Tier 1/2 suppliers, fuel and chemical companies, fleets, consumer media
- Chair of EU CEN Workshops 90 and 103

# Overview

- Vehicle Interior Air Quality is unregulated
- Except in a limited way when deemed a workplace
- Pollutant exposures can be higher inside than outside
- Has health and safety effects
- China is leading new regulations, but with limited scope
- Opportunity to accelerate understanding through new standards

# Independent testing

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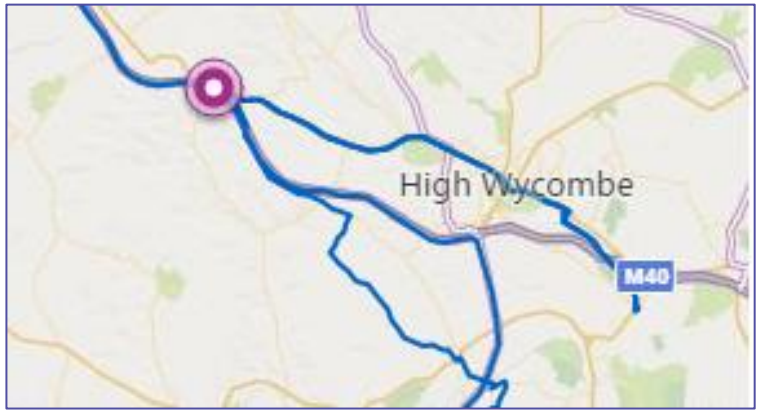
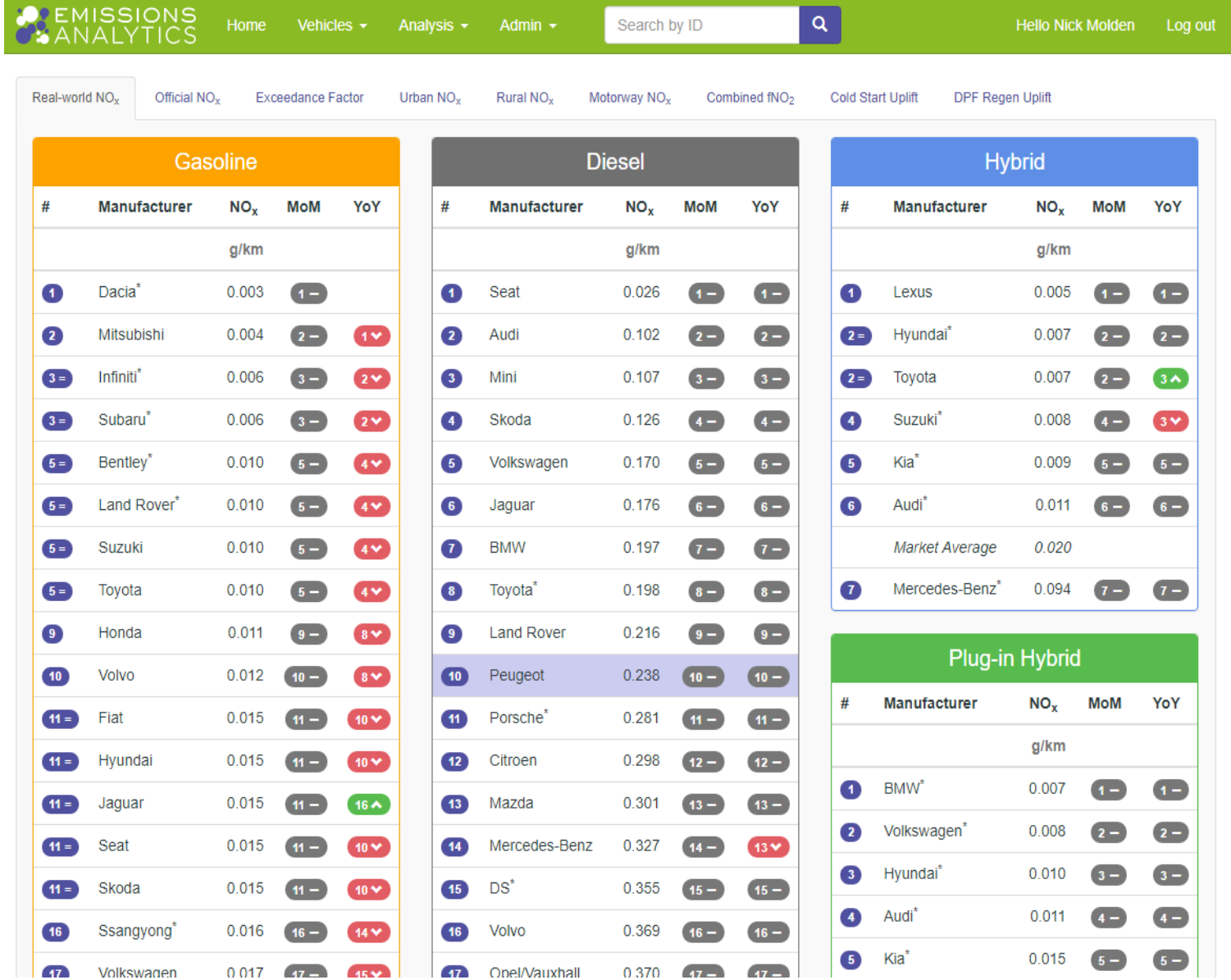
# Light-duty test cycles




- Normal cycle defined geographically
- With multiple repetitions
- And dynamic boundary condition verification
- Extended cycle driven flexibly to take in range of operating conditions
- Outside RDE boundaries, especially for v*a_pos@95 and RPA
- No extreme altitudes, gradients and temperatures
- Total length ~4 hours
- Exact cycle not published

# EQUA database

- Ranking by pollutants
- Segmentation
- Meta data
- Drill-down



# Pollutant infiltration

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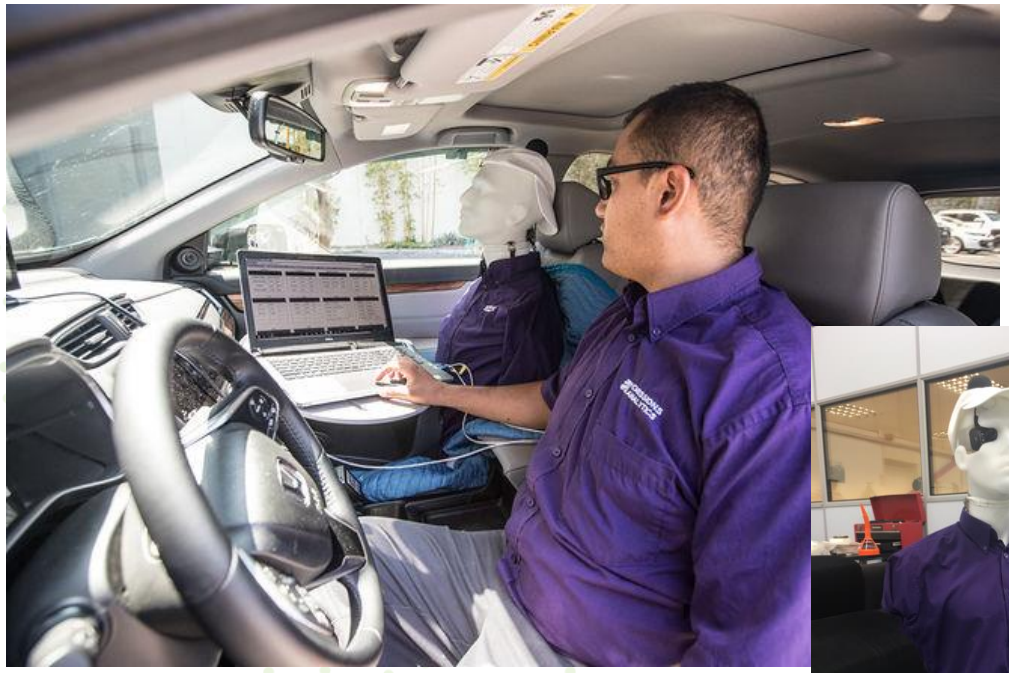
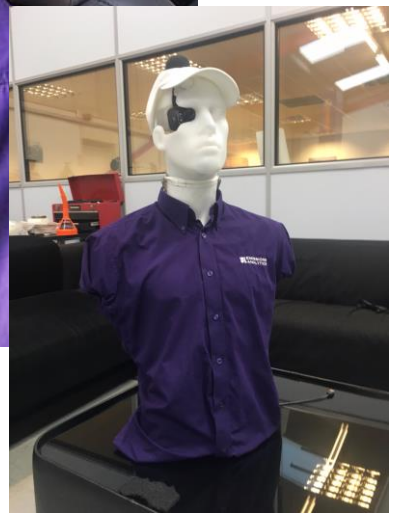
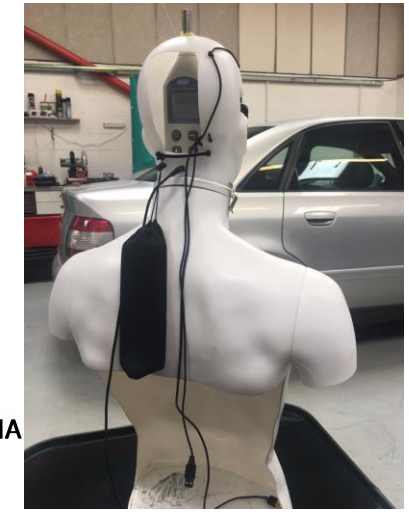
# Cabin air quality – real-world testing

- Pollution in-cabin measurement system: PN (15nm) and $CO_2$ at 1Hz







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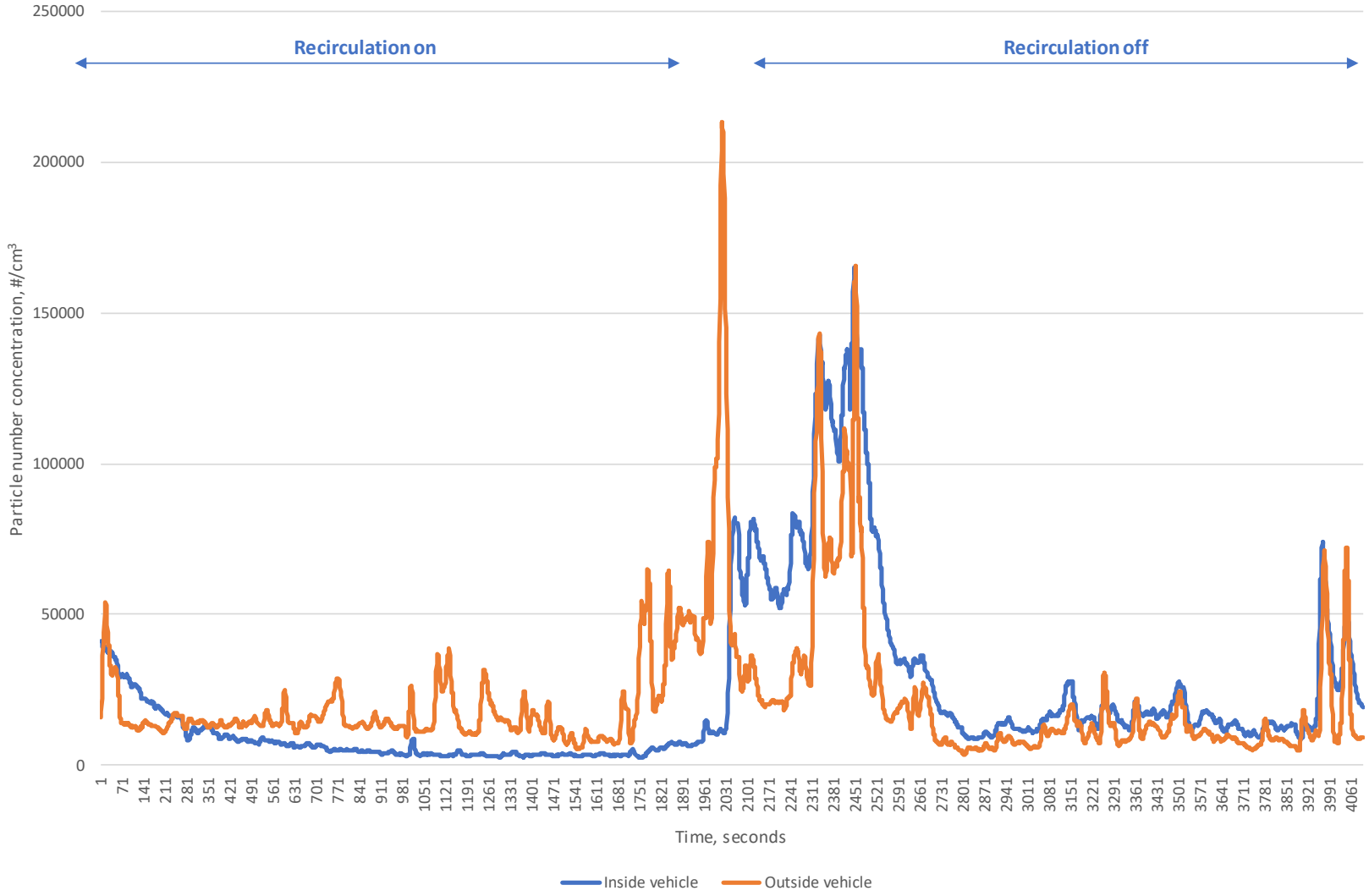
# On-road particle infiltration

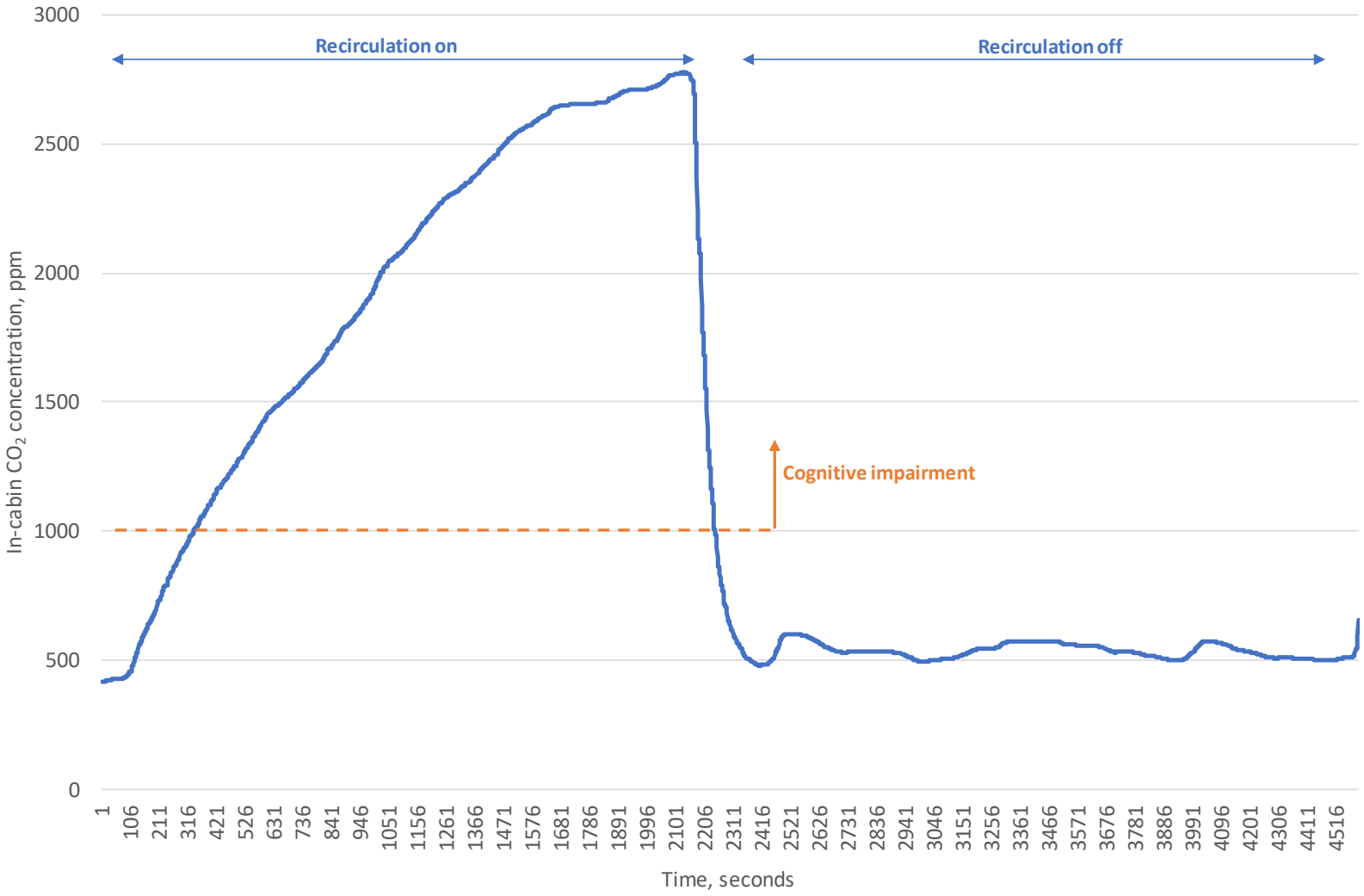
- Recirculation effective
- On fresh air mode, interior levels can persist above exterior




EQUA real-world test database

# Carbon dioxide build-up

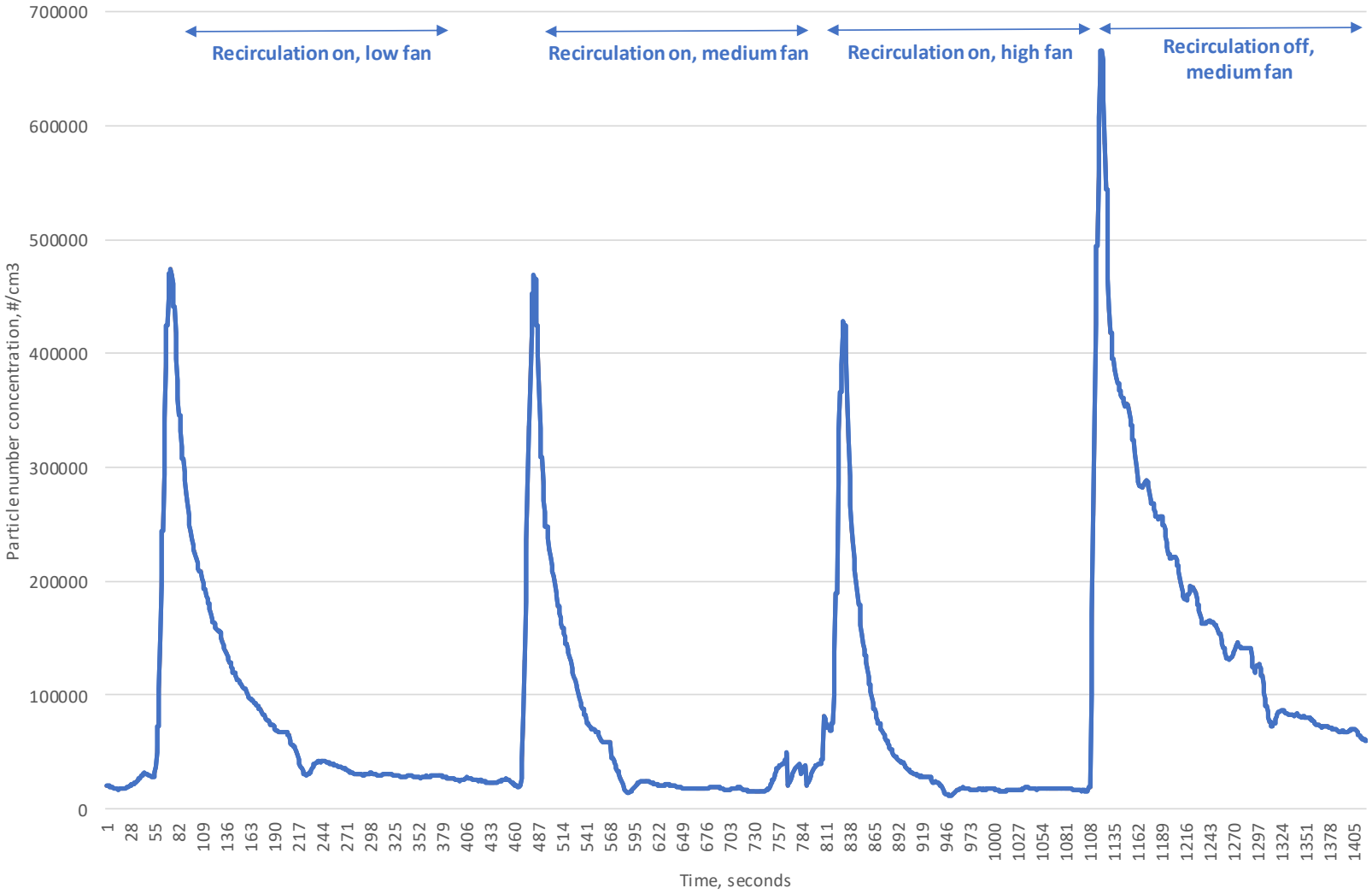
- $CO_2$ rises steadily from background
- Can reach 3,000ppm even with just driver
- Cognitive impairment above 1,000ppm
- No issue on fresh air mode




EQUA real-world test database

# Static air exchange rate

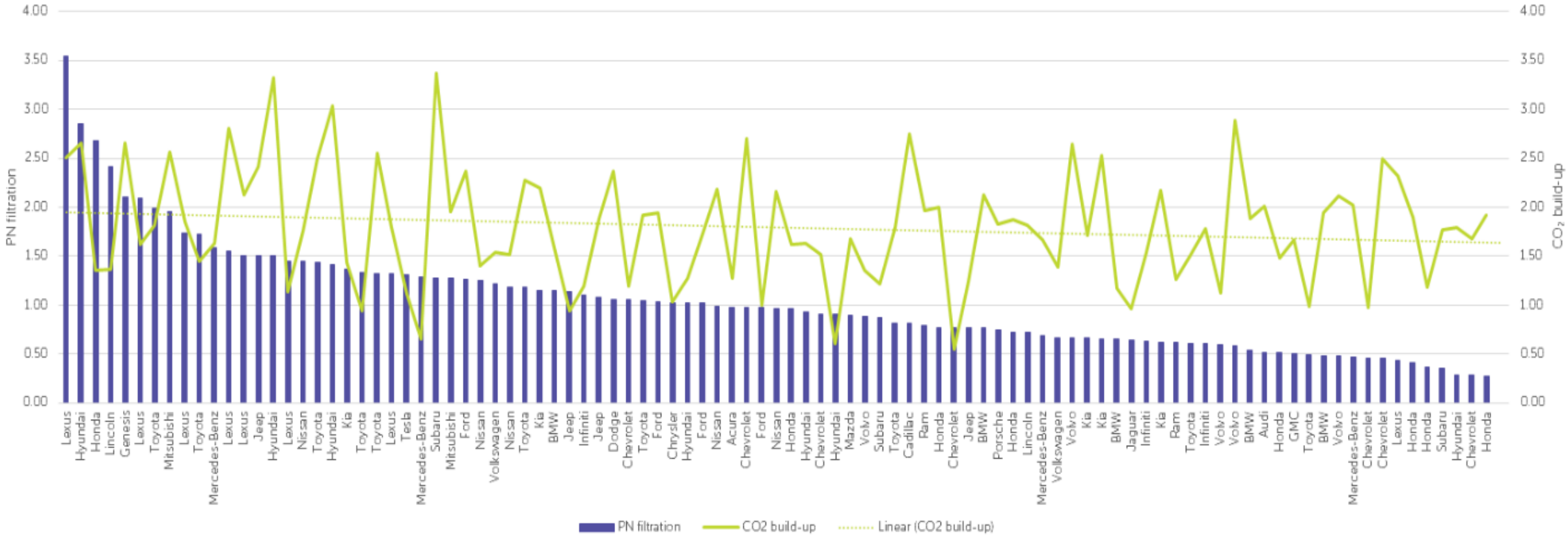
- Canister of particles deployment for instant spike in concentration
- Quickest clean-up on recirculation and maximum fan speed




EQUA real-world test database

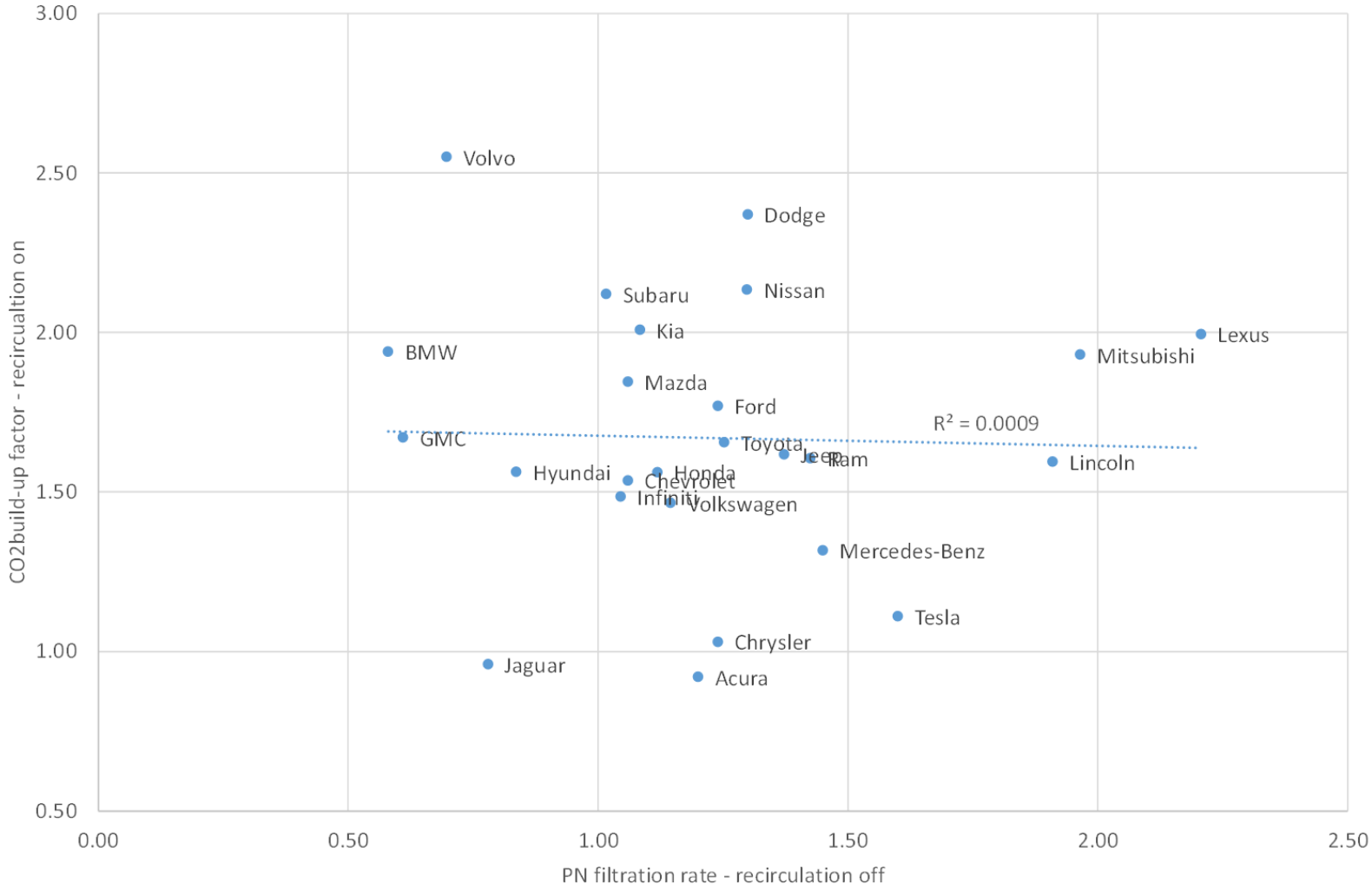
# 97-car test programme

- PN concentration in cabin up to 3.5 times ambient, on fresh air mode
- $CO_2$ concentration can treble in 30 minutes on recirculation



# Particles vs carbon dioxide

- No correlation at OEM level between PN filtration rate and $CO_2$ build-up
- HVAC set-up and filter choice can move trade-off by multiple factors




EQUA real-world test database

# Volatile organic compounds

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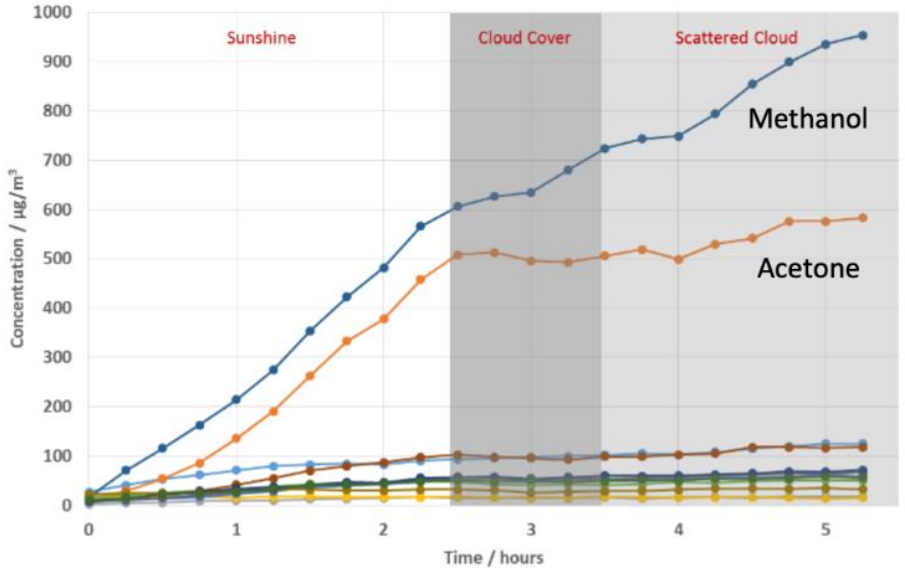
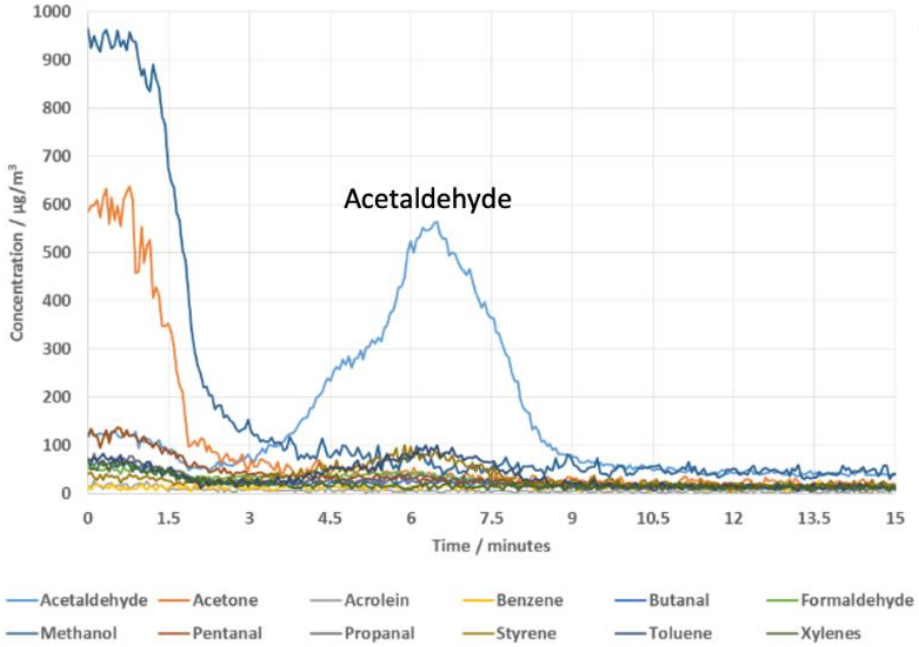
# Cabin air quality – VOCs

- New Chinese regulations will cover eight target compounds from 2021 (limits in µg/m3)
- Methanol and Acetone built up with windows closed across daytime test
- During venting with windows open and AC on, there was a peak of acetaldehyde

| Analyte | China | Japan | Korea | Symptoms |
|---|---|---|---|---|
| Formaldehyde | 100 | 100 | 100 | Respiratory irritant and a contributory factor in asthmas and cancer |
| Acetaldehyde | 50 | 48 | No limit | Causes 'flush reaction' among some populations – itchiness or blotchiness of the skin and a flushed complexion |
| Acrolein | 50 | No limit | No limit | Highly toxic and severely irritating to the eyes, mucous membranes, respiratory tract, and skin |
| Benzene | 110 | No limit | 30 | Known carcinogen and declared as such by the US Environmental Protection Agency |
| Ethylbenzene | 1500 | 3800 | 1600 | Can cause throat irritation, and dizziness at higher concentrations |
| Xylene | 1500 | 870 | 870 | Causes headaches, dizziness, drowsiness, and nausea |
| Styrene | 260 | 220 | 300 | Causes headaches |
| Toluene | 1100 | 260 | 1000 | Solvent familiar as nail-polish remover, can cause headaches and nausea |
| Tetradecane | No limit | 330 | No limit | Irritating to the eyes, mucous membranes, and upper respiratory tract, and can cause skin irritation. |

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# International ratings

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# Methodology development



SAE INTERNATIONAL

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## Development of a Standard Testing Method for Vehicle Cabin Air Quality Index

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***Kent Johnson and Heejung Jung,*** *University of California, Riverside, USA*

### Abstract

Vehicle cabin air quality depends on various parameters such as number of passengers, fan speed,

**History**

Received: 14 Dec 2018
Revised: 14 Mar 2019

EQUA real-world test database

# CEN Workshop 103

- Kicked off 4 November 2019 in Brussels
- Nick Molden appointed chairman
- Wide attendance of OEMs, suppliers and cities

2019-08-05

**Draft**

**Project Plan for the CEN Workshop on real drive test method for collecting vehicle in-cabin pollutant data (CEN/WS 103)**

**Workshop**

**(to be approved during the Kick-off meeting on 2019-11-04)**

# Workshop scope

- Volatile Organic Compounds (VOCs): Covered by other programmes
- Particle mass: Established health effects, but low in-cabin concentrations
- Particle number: Growing health evidence, and high in-cabin concentrations
- Carbon dioxide: Consequence of using recirculation to protect from external pollution
- Nitrogen dioxide: Illegal ambient levels in many cities, but low absolute concentrations
- Flexible to include others

# Conclusion

- Human exposures inside vehicle matter
- Combination of particles, $CO_2$ and VOCs
- Chinese regulations are driving changes in materials
- Performance of the HVAC system needs attention
- Voluntary standardisation is underway

# Thank you.

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Emissions testing in real-world conditions brings challenges that experience anticipates and expertise overcomes. We deliver.

**Independent**
Objectivity and candour are the driving forces in all our work, so you know the facts.

**Responsive**
We're fast on our feet so we can conduct emissions testing when and where we're needed.

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