REAL-TIME MONITORING OF AIRBORNE GASEOUS AND PARTICULATE CONTAMINANTS AT A LARGE-SCALE CHICKEN PROCESSING FACILITY

MULTI-ZONE FRAMEWORK, SENSOR CONFIGURATION AND EMISSION SOURCE CHARACTERISATION

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Asia-Pacific Odour CONFERENCE 2026

FRAMING THE PROBLEM

PERCEIVED ODOUR

- **Sensory nuisance, not toxicology**
- **Nicell (2009): risk-independent**
- **Nuisance thresholds at perimeter**

WORKER EXPOSURE

- **Chemical safety, not odour**
- **Toxicological exposure limits**
- **Processing floor, offices, cafeterias**

This paper addresses both within a single multi-zone framework — while keeping the two objectives distinct throughout.

WHY PERIODIC ASSESSMENT ISN'T ENOUGH

OLFACTOMETRY

Point-in-time only — misses fast-changing emissions

FIELD SURVEYS

Subjective assessors can't match how fast conditions change

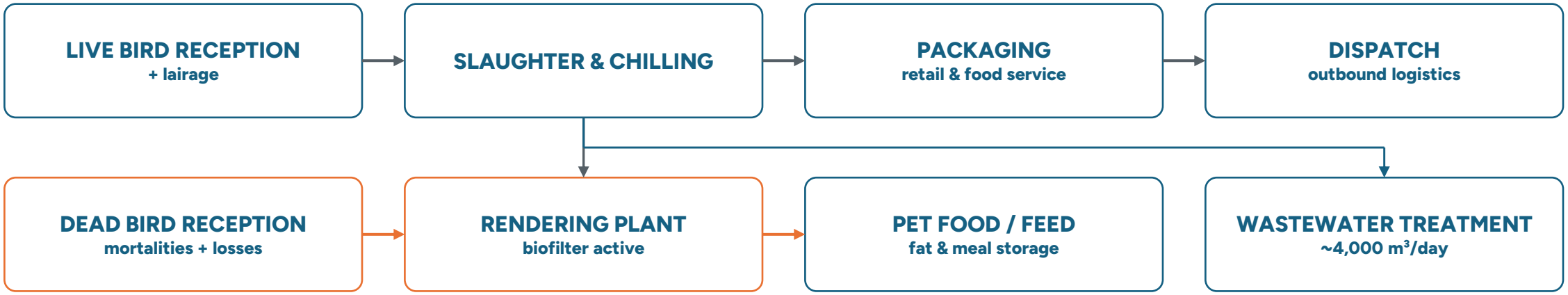
CONTINUOUS SENSORS

This paper's approach: real-time & multi-zone

THE FACILITY: ONE OF EUROPE'S LARGEST

- **One of Europe's Largest**
- **12-hr Shifts, 6 Days/Wk**
- **Circular Production**
- **~4,000 m³/day Wastewater**
- **Biofilter Active**

Central Europe · identity withheld for commercial confidentiality.
Byproducts are rendered on-site into pet-food and animal-feed ingredients.



HIGHEST-PRIORITY ZONE

SIX EMISSION ZONES, RANKED BY RISK

RENDERING & DEAD BIRD RECEPTION
H_2S · NH_3 · VOC · PM10
Nuisance odour, worker exposure
HIGH RISK

SLAUGHTERING & PROCESSING FLOOR
NH_3 · CO_2 · VOC · Temp · RH
Worker comfort, process control
HIGH RISK

WASTEWATER TREATMENT
VOC · H_2S · NH_3
Nuisance odour, worker exposure
HIGH RISK

PET FOOD / RENDERING OUTPUT
VOC
Nuisance odour, undetected leaks
MEDIUM RISK

WORKER ZONES (OFFICES, CAFETERIAS)
CO_2 · PM2.5
Occupational comfort
MEDIUM RISK

FACILITY PERIMETER
PM10 · H_2S · NH_3 · VOC
Nuisance odour, regulatory compliance
MEDIUM RISK

Zones identified via systematic walkthrough, review of existing controls, and wind-rose analysis. Emission profiles are a desktop characterisation pending field verification.

SENSOR TECHNOLOGY & SPECIFICATIONS

PARAMETER	TYPE	RANGE	MIN. DETECTION	DRIFT
H_2S	Electrochemical	0–50 ppm	0.05 ppm	<2%/month
NH_3	Electrochemical	0–20 ppm	0.3 ppm	<2%/month
TVOC	PID	0–40 ppm	0.005 ppm	N/A (periodic recal.)
CO_2	NDIR	0–5,000 ppm	±30 ppm	Mfr-stated, not verified
PM2.5 / PM10	Optical (laser scattering)	0–1,000 µg/m³	1 µg/m³	Mfr-stated, not verified

TVOC is a broad-spectrum, isobutylene-equivalent composite reading — it cannot distinguish individual VOC species (aldehydes, amines, reduced sulfur compounds) present in poultry emissions without supplementary GC-MS sampling.

All units are factory calibrated against certified reference gas before deployment, with periodic field verification against portable reference instruments to correct for drift.

Nayak et al. | Table 2 — manufacturer-published specifications (Oizom Instruments, 2025a; 2025b)

ZONE DEEP-DIVE: HIGH-RISK AREAS

RENDERING & DEAD BIRD

H_2S | NH_3 | VOC | PM 10

- **Decomposition + rendering intake**
- **Negative pressure — not airtight**
- **Fugitive release at doors, loading**

SLAUGHTER & PROCESSING

NH_3 | CO_2 | VOC | TEMP | RH

- **18–21°C comfort band**
- **40–60% RH target**
- **CO_2 800–1,000 ppm**

WASTEWATER TREATMENT

VOC | H_2S | NH_3 | ~4,000 m3/d

- **Inlet — raw wastewater emissions**
- **Sludge handling — disturbance bursts**
- **Downwind-biased perimeter placement**

All three zones share H_2S/NH_3/VOC as common parameters — the basis for the cross-sensitivity and source-attribution challenges covered next.

ZONE DEEP-DIVE: MEDIUM-RISK AREAS

PET FOOD / RENDERING OUTPUT

VOC

WORKER-CENTRIC ZONES

CO_2 PM2.5

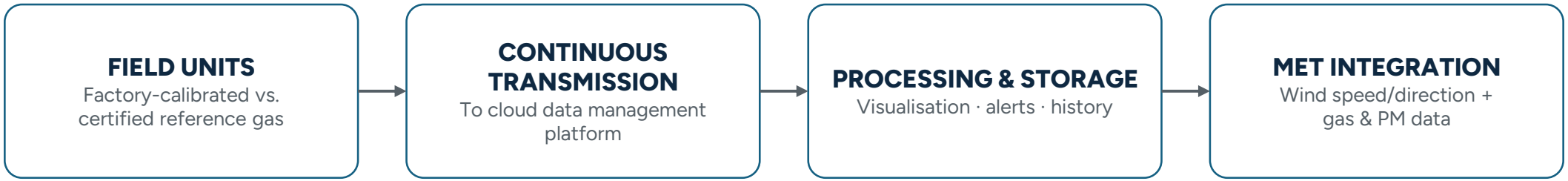
FACILITY PERIMETER

PM10 H_2S NH_3 VOC

- Fat tanks — volatile at ambient temp
- Meal-storage vents discharge intermittently
- Targets leaks fence-line would miss
- 12-hr shifts, high occupancy
- Changing rooms adjoin processing
- $CO_2 \leq$ 1,000 ppm · PM2.5 ≤ 12 µg/m³
- Fixed sensors across wind sectors
- Community hotspot + entrance baseline
- Hotspot choice not yet validated

Medium risk reflects lower emission intensity or indirect exposure — not lower monitoring priority. All six zones report to the same cloud platform.

FROM SENSOR TO DECISION: SYSTEM ARCHITECTURE



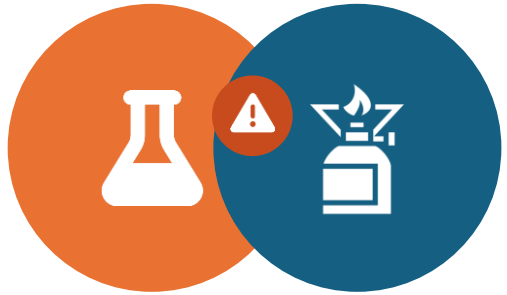
PLACEMENT LOGIC — units positioned per the desktop zone assessment, maximising detection probability while accounting for prevailing wind and sensitive receptors.

UNIT COUNT — informed by spatial extent and directional coverage needed per zone; presented as a deployment plan, not yet validated against field performance.

WIND-INFORMED INTERPRETATION — meteorological data lets boundary readings be read in the context of wind direction, not in isolation.

CALIBRATION CADENCE — factory calibration before deployment, plus scheduled field verification against portable reference instruments to track and correct drift over time.

THE CROSS-SENSITIVITY CHALLENGE



H_2S sensor NH_3 sensor

No published cross-interference coefficient between H_2S and NH_3 for this deployment — a known, unquantified risk in the rendering and wastewater zones.

Fix 1 — Reference Validation

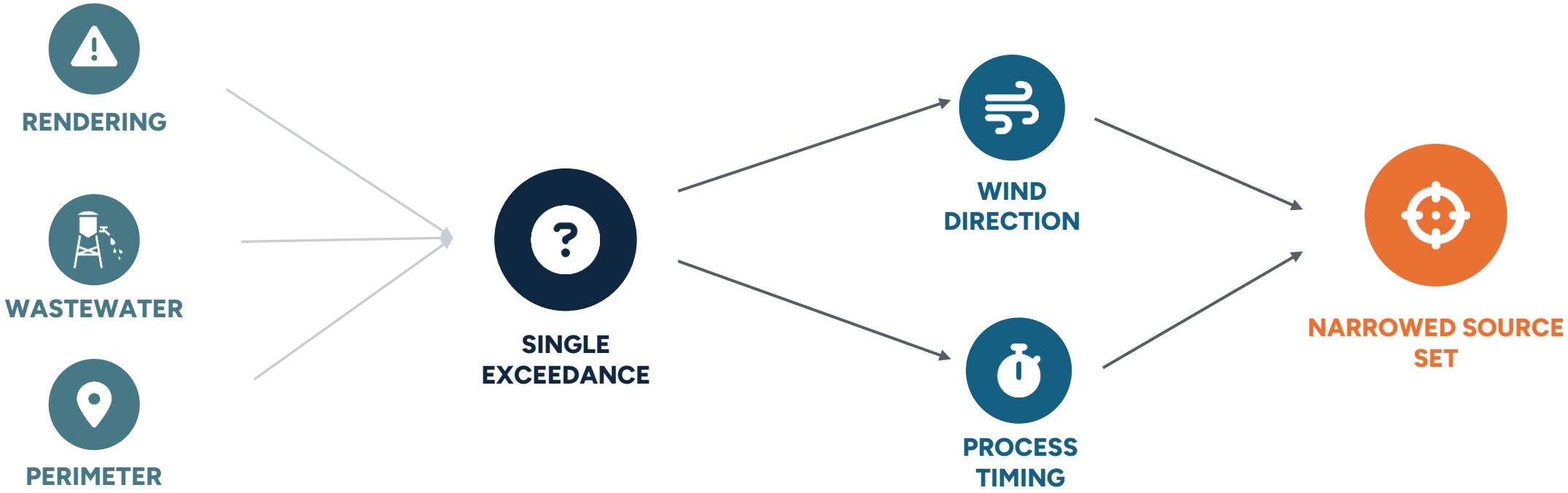
Co-located portable analyser → site-specific correction factor

Fix 2 — Calibration Verification

Scheduled zero/span checks → automated drift flagging

Unfixed, a sensor risks two failure modes: false alarms that erode trust, or a suppressed response that misses a real exceedance.

SOURCE ATTRIBUTION: TRIANGULATION, NOT DETECTION



Probabilistic — not a deterministic single-source ID. Not yet validated against ground truth.

A SINGLE BOUNDARY EXCEEDANCE CANNOT BE UNAMBIGUOUSLY ATTRIBUTED TO ONE INTERNAL SOURCE FROM SENSOR DATA ALONE.

OUTCOMES & OPEN LIMITATIONS

EXPECTED OUTCOMES

- **Diurnal patterns olfactometry can't catch**
- **Faster time-to-awareness vs. complaints**
- **Better — not guaranteed — source narrowing**
- **More evidence-informed community engagement**

Caveat: anticipated from design + literature — field results are still pending.

WHAT WE HAVEN'T PROVEN

- **Zone selection: a priori, not full-suite screened**
- **Cross-sensitivity: identified, not resolved**
- **Atmospheric VOC transformation not corrected for**
- **A missed plume ≠ no real impact**

Sensor data should support — never solely dismiss — a community complaint.

CONCLUSIONS & TRANSFERABILITY

A FRAMEWORK, NOT A TEMPLATE

Sensor + placement matched to each zone's context

TRANSFERABILITY ISN'T AUTOMATIC

Site layout & process vary — including AU processors

ASSESS BEFORE YOU ADOPT

Site-specific desktop + field method, first

A DESIGN, NOT YET A VALIDATED OUTCOME

Value = matching complexity to the emission environment

THE SIX-ZONE FRAMEWORK DEMONSTRATES A REPEATABLE APPROACH TO MATCHING SENSOR TYPE, PLACEMENT, AND DETECTION THRESHOLD TO PROCESS CONTEXT — DEVELOPED THROUGH DESKTOP CHARACTERISATION OF A MAJOR EUROPEAN FACILITY.

Process configuration, ventilation design, wastewater technology and site layout all vary between facilities. A facility with a fully enclosed, biologically treated wastewater system would present a markedly different emission profile — direct transfer of this framework should always be preceded by the site-specific assessment described in Section 3.

THANK YOU

Q&A

Bhumik Nayak