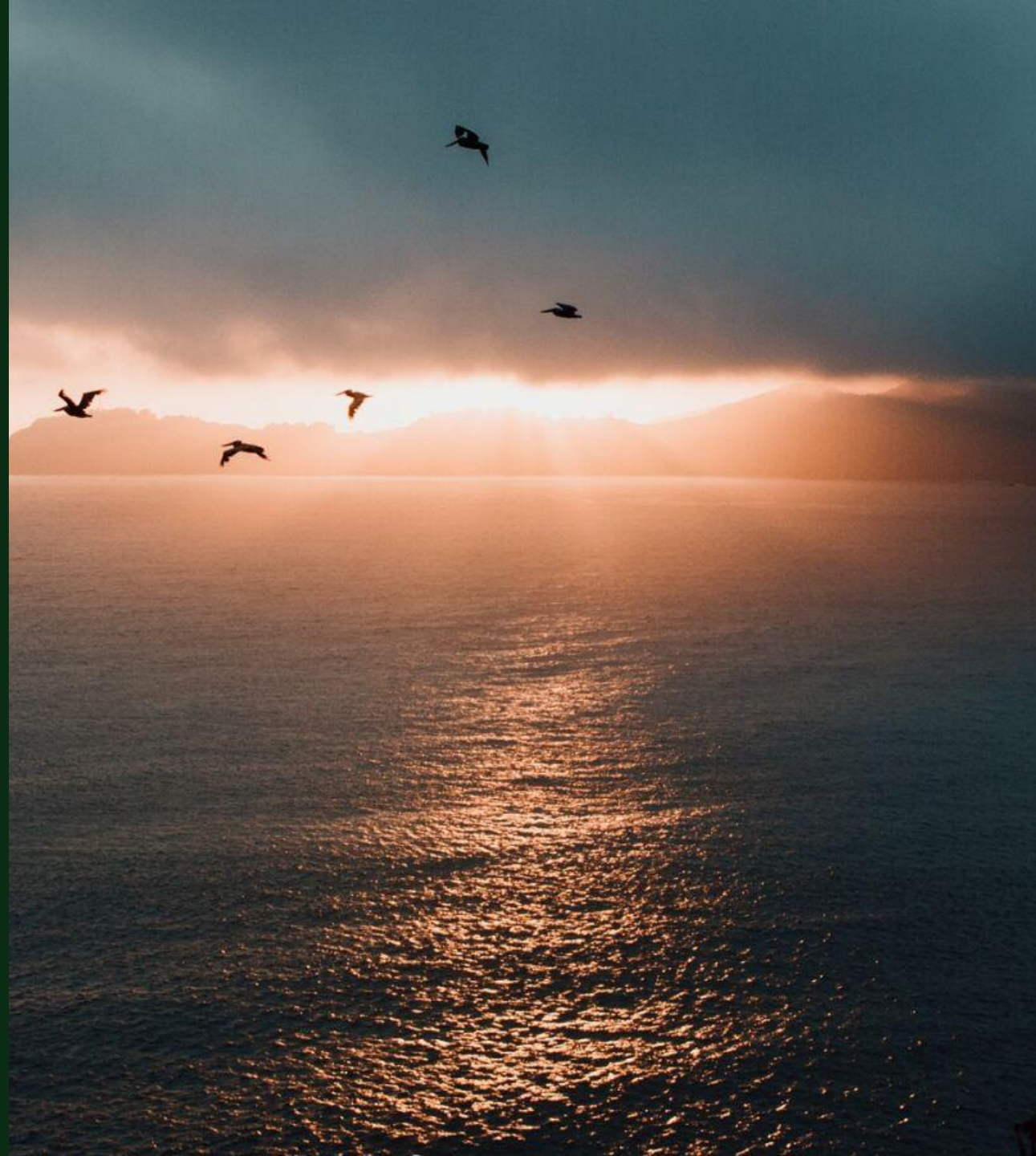
Predictive Emissions Monitoring System

CNOOC BUZZARD

PRESENTED BY: LAURA REID & JAMES SHANNON

Sustainability is our business



Applying AI to optimise emissions and energy efficiency

Our guiding principles:

- Only require existing, readily available data
- Work within context of asset's proven ability to perform
- Assist operators
  - Clear visibility of energy/emissions performance
  - Identify opportunities for improvement
  - Open loop, advisory approach
  - **Amplify operators' abilities**

ERM

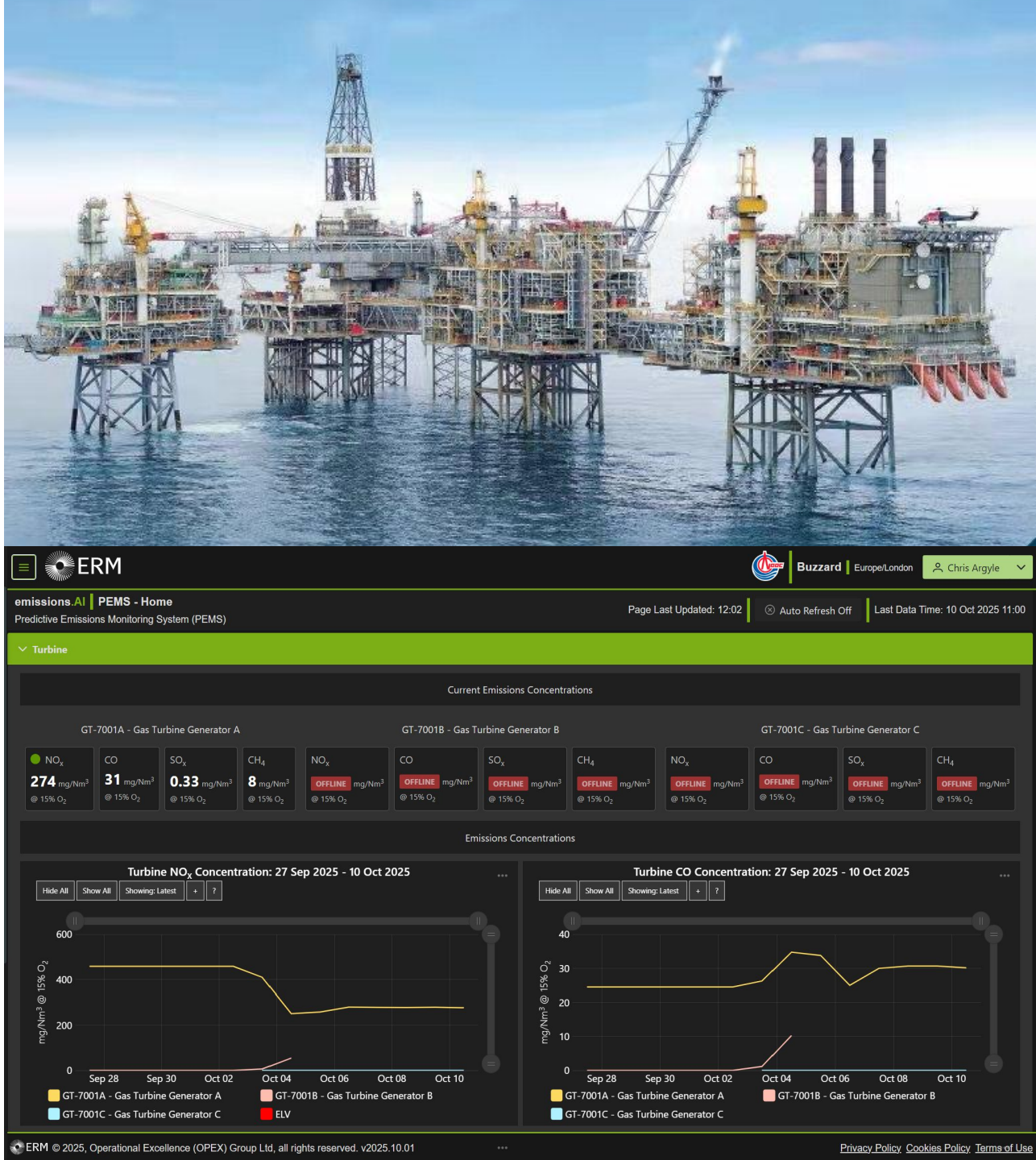
What is a Predictive Emissions Monitoring System (PEMS)?

What?

- PEMS is a software used to determine real-time pollutant emissions from stationary combustion equipment.

Why?

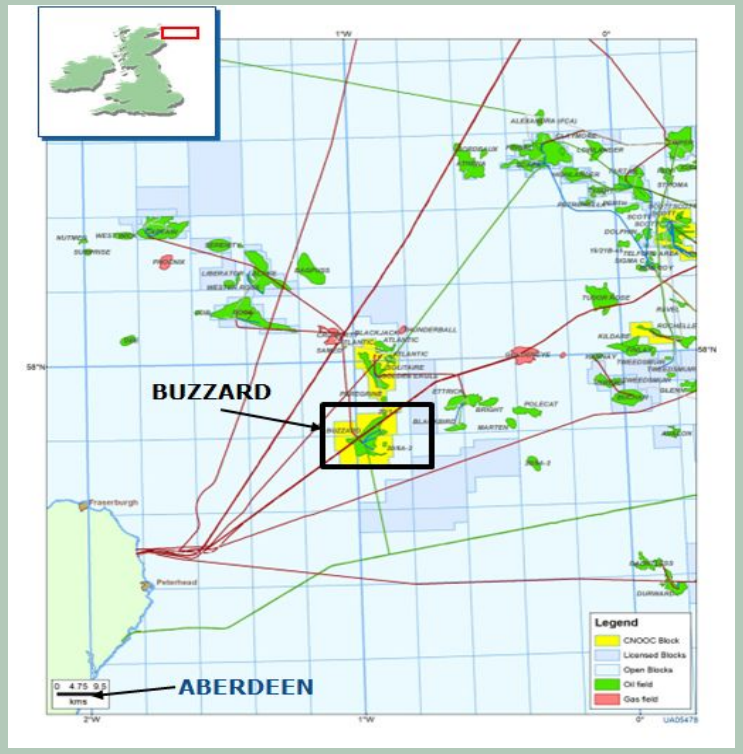
- EU MRV mandate for source and site level methane.
- Direct measurements preferred where feasible.
- OGMP2.0 – PEMS Level 4 for quantification for combustion equipment
- Regulatory requirements for non-GHG pollutants (NOx / CO)



CNOOC Buzzard Installation

Context

- Offshore Oil and Gas Installation
- Regulatory Permit Limits: NOx, SOx, CO
- Industry Methane MRV Challenge



Business Case

Regulatory and Reputation

- PPC Permit Requirement
- Best Available Technology
- Automated compliance tracking
- Stakeholder commitments
- Future MRV Requirements

Technology & Capability

- Equipment agnostic vendor
- OEM solutions
- In-house development
- Capability and experience
- Personnel time and focus

Stack Sampling Frequency

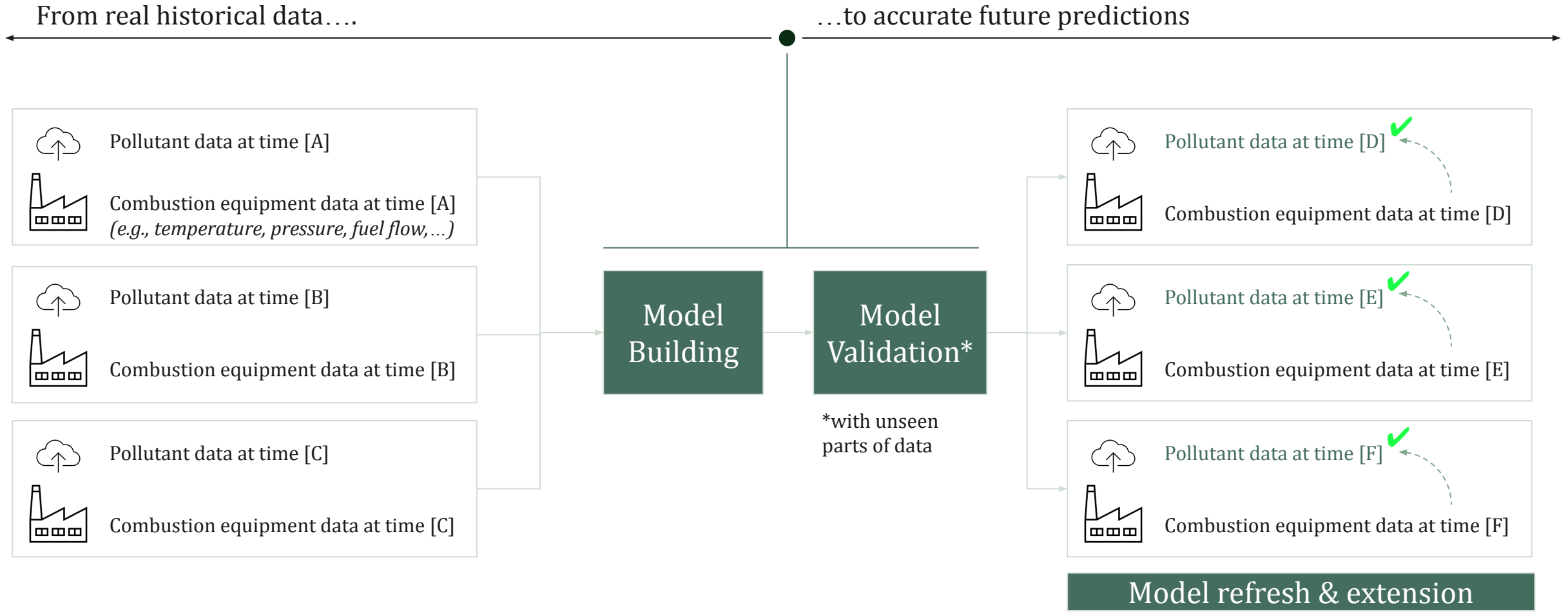
- Third Party sampling technician
- Rental equipment
- Offshore bed space
- Core crew support
- Operational disruption – GT load change
- Coordination

Data Management

- Data and cyber security – transfer and storage
- Data cleansing
- Data augmentation
- Data representativeness

How did we build a PEMS with CNOOC?

Our team of data scientists applies predictive modelling techniques.



We can build and integrate the right models needed.

Facility data-based models vs simple emissions factors.

Solution is a **combination of models that gives the greatest accuracy and reliability**.

Relational Models

Estimate emissions as a function of one or more process parameters, using theoretical or empirical relations.

Theoretical

Prediction based on understood scientific or mathematical relationships e.g., emission factor relationships.

Empirical

Pollutant emissions predicted based on observation or experience, e.g., OEM test bed curves.

Data driven Models

In data driven models, learning algorithms find statistical regularities, between paired historical operating and stack sample data.

Statistical

Statistical models are employed where input variables exhibit linear relationships.

Supervised (Deep) Learning

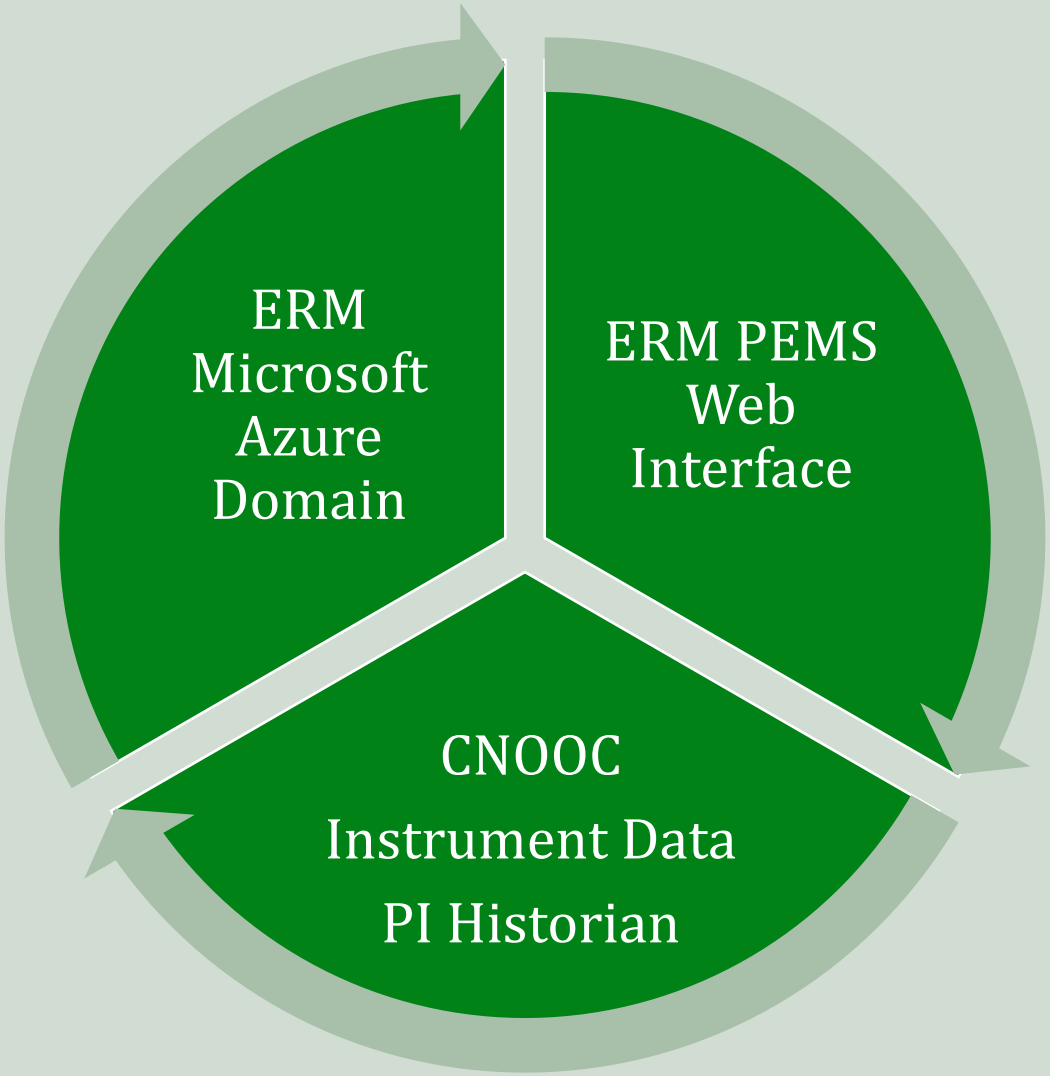
Build and train models using available data, augmenting where required with generative AI techniques.

(SO_x, CO_2) — *Increasing complexity of pollutant formation mechanism(s)* → (NO_x, CO, CH_4)

Standard Equipment — *Increasing complexity of equipment or units* → Complex units with multiple variables

PEMS Module

High Level Data Flow



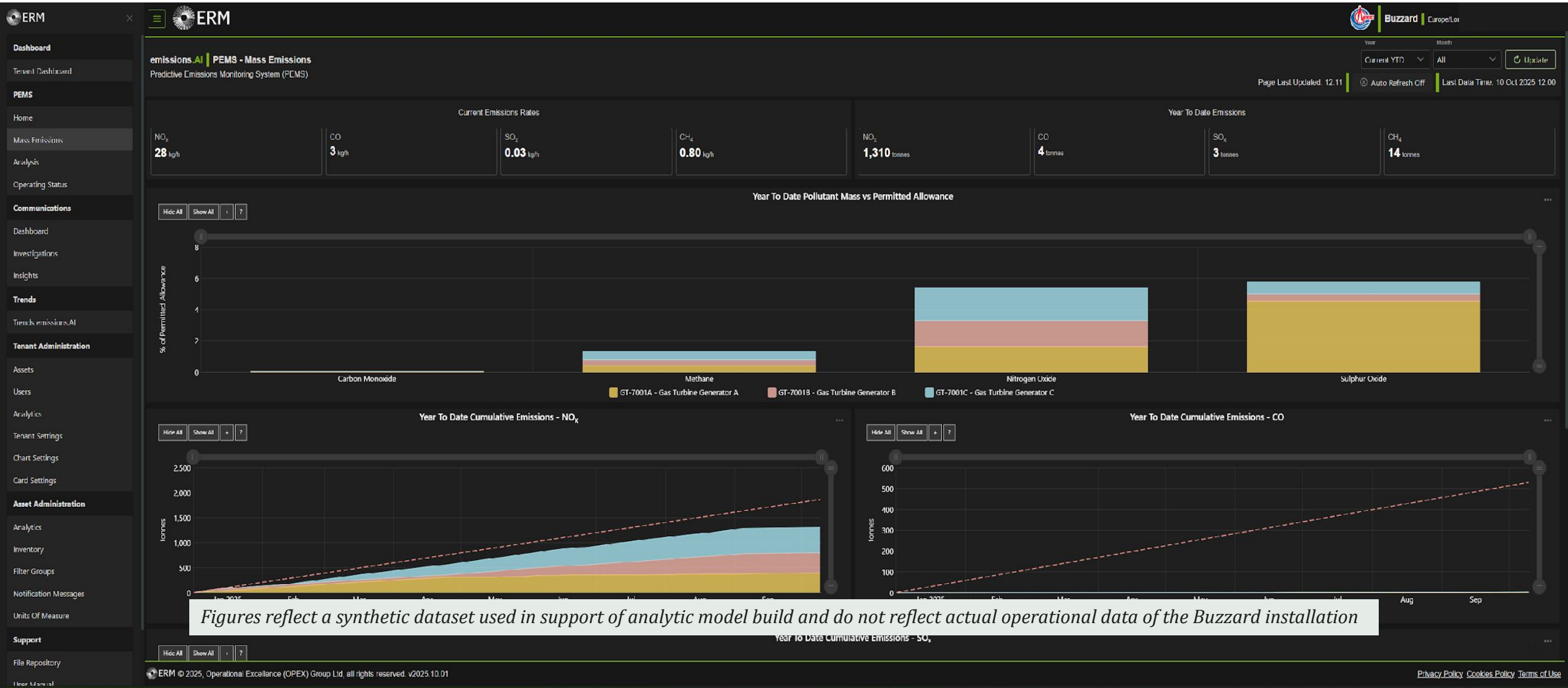
PEMS Module User Interface – Home Page

Pollutant concentrations are meticulously tracked and reported

Figures reflect a synthetic dataset used in support of analytic model build and do not reflect actual operational data of the Buzzard installation

PEMS Mass Emissions Page

Mass emissions are also precisely tracked and recorded



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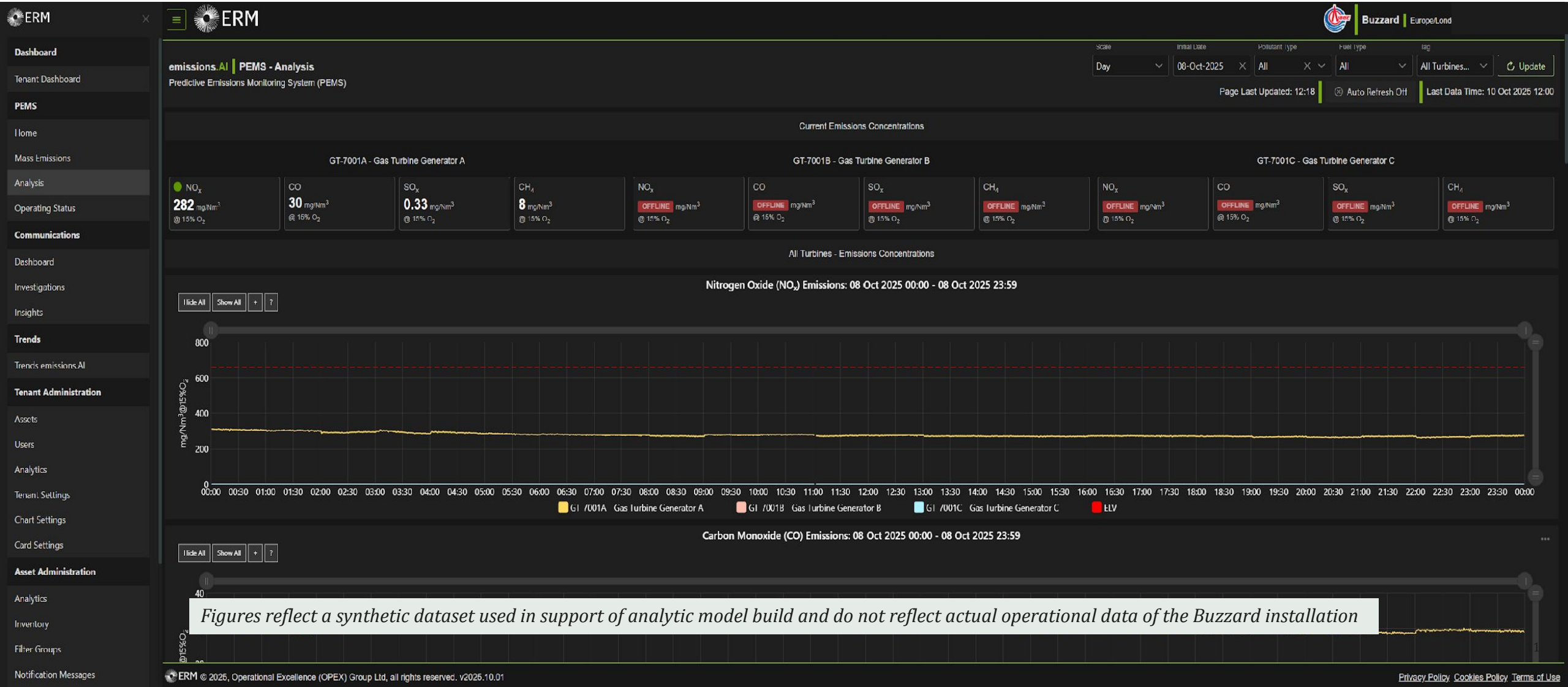
PEMS Analysis Page

Analytics provide more insight to combustion behaviour and support emissions reduction



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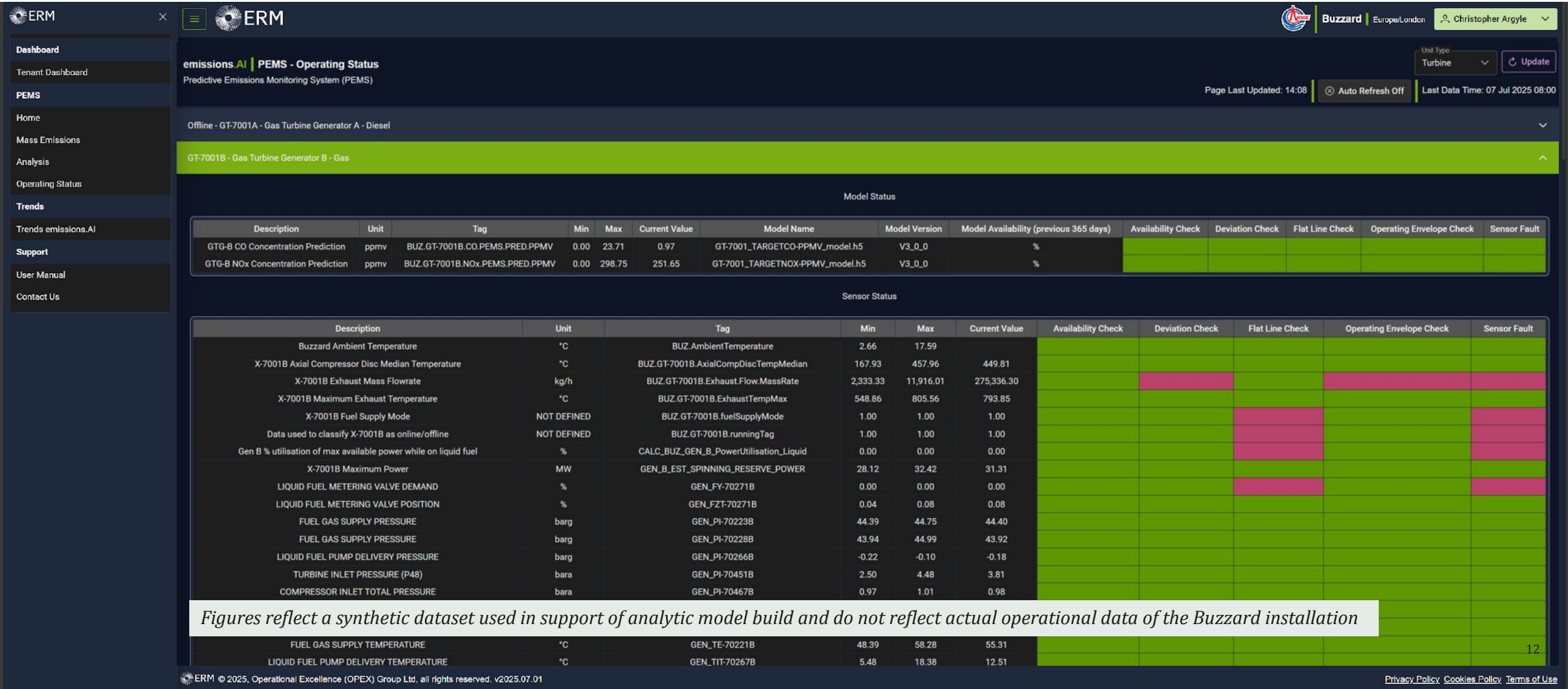
PEMS Operational Status Page

Model validation - monitor model, instrument and data transfer health



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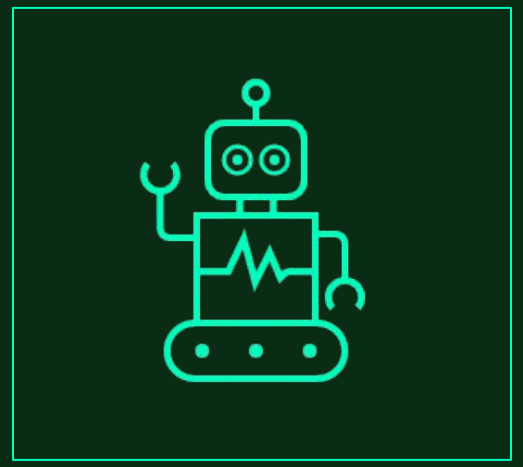
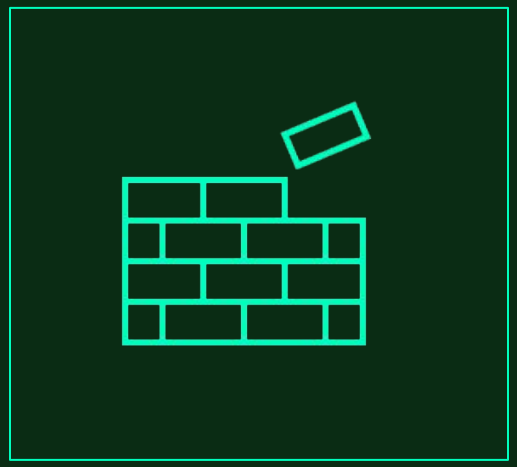
Partnership and Collaboration

Key to Delivering Results

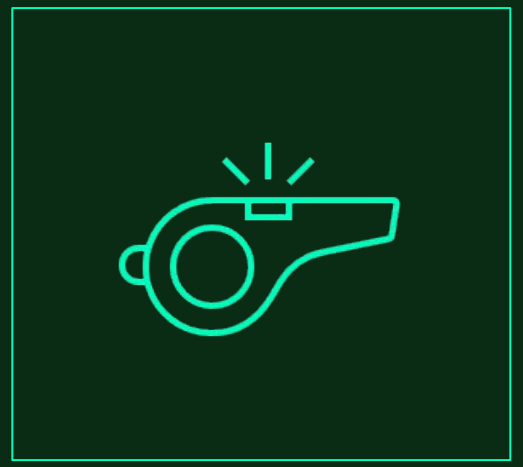
In Summary : Where we are today



PEMS live



Models continually reviewed and maintained



Compliance with PPC

Thank you

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