

ERM and Bumi Armada UK

Driving energy & emissions performance on the
Armada Kraken

Chris Ayres, Chief Customer Officer, ERM,
Dr Helen Drewery, HSE Manager, Bumi Armada UK,
& Scott Renfrew, Bumi Armada UK



Driving energy & emissions performance across FPSOs

CHRIS AYRES (ERM), SCOTT RENFREW (BUMI) & HELEN DREWERY (BUMI)

MAY 2024

Sustainability is our business

© Copyright 2023 by the ERM International Group Limited and/or its affiliates ("ERM"). All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means, without prior written permission of ERM.



Agenda

- 1 Who we are
- 2 How it started
- 3 How it's going
- 4 What's next

Sustainability is our business

The Energy and Emissions Performance Team are a specialist team within ERM

Our mission is to help our customers operationalise their **carbon strategy**, drive **energy efficiency** and deliver on **compliance** requirements.

Our dedicated focus is on energy and carbon intensive industries with complex facilities



ERM OVERVIEW

8000+

Professionals

40

Countries & territories

Climate change consulting Leader

Verdantix Green Quadrant 2023

150+

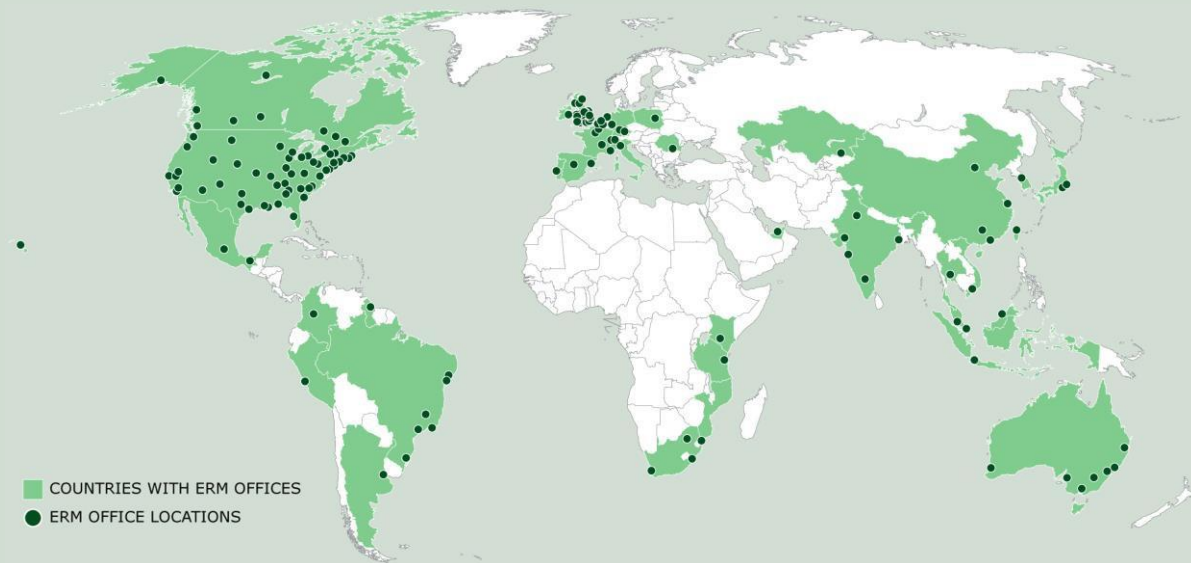
Offices

50+

Years of experience

#1

Sustainability service provider – HFS 2022



We partner with...

70%

of Fortune 100

55%

of Fortune 500

Bumi Armada

Malaysia-based international offshore energy facilities and services provider

Dedicated to ensure we integrate sustainability into daily operations with key objectives in the UK

- Meet regulatory compliance requirements (ISO 14001, BAT etc)
- Integrate carbon emissions into decision making
- Establish carbon lean operations
- Demonstrate industry leading performance to meet commitments
- Deploy agile and relevant technologies



Owner and Operator of the
Armada Kraken



BUMIARMADA

Our journey

emissions.AI

Kick off for deployment on
Armada Kraken

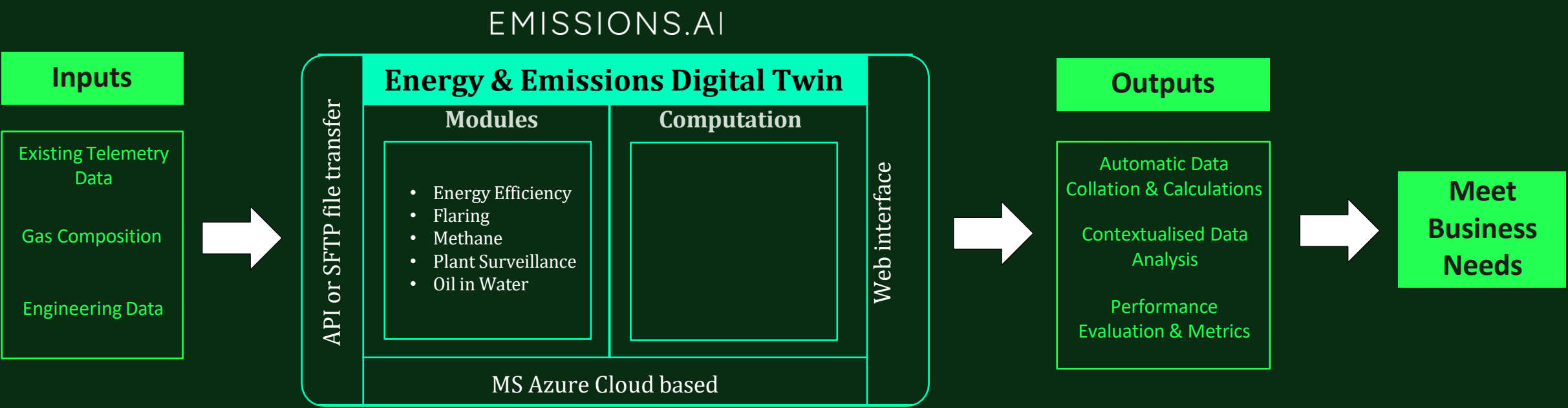




A digital solution to help companies manage energy and emissions performance

Engineering | Analytics | AI | Expert Led Support

How it works



Our journey

emissions.AI

Kick off for deployment on
Armada Kraken



Energy Efficiency

Flaring and Venting

Home

eAI Operational Report

Analysis

Power Generation

Steam Analysis

History

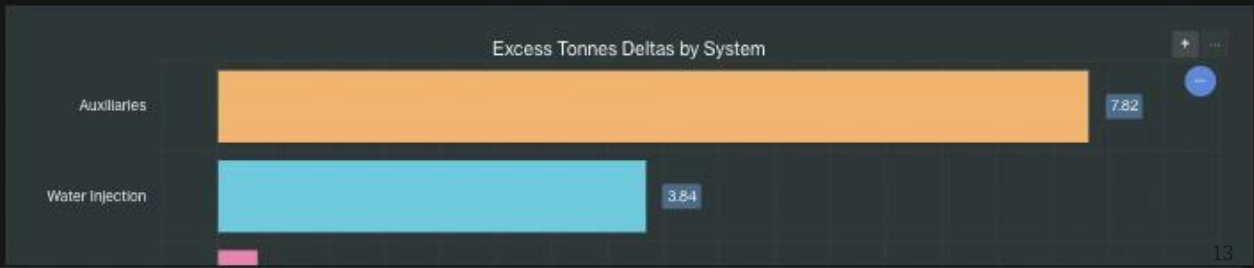
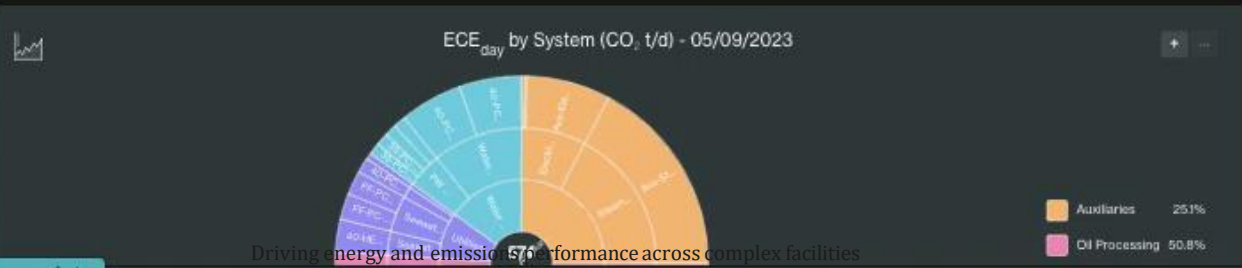
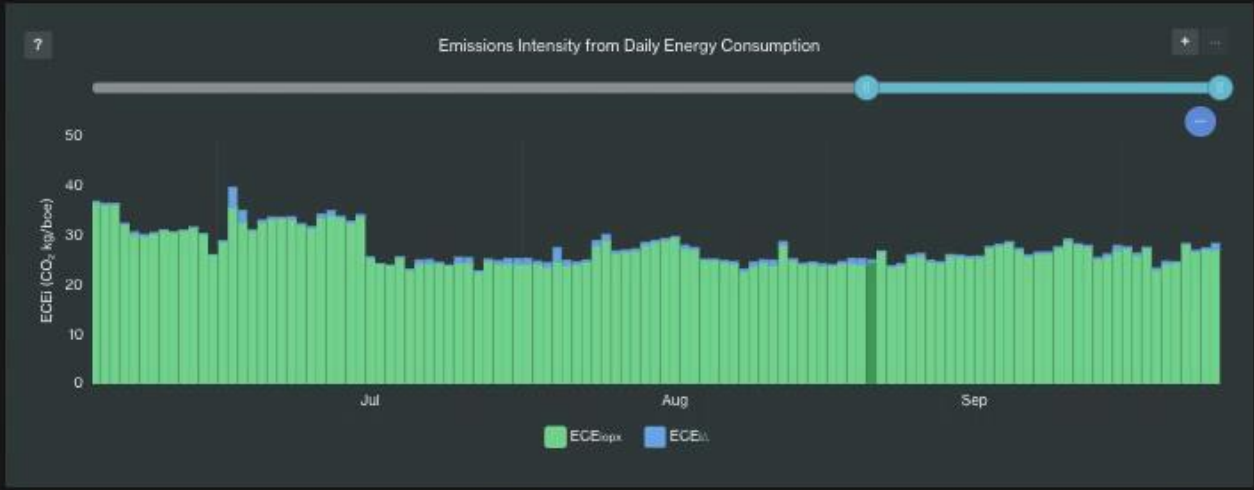
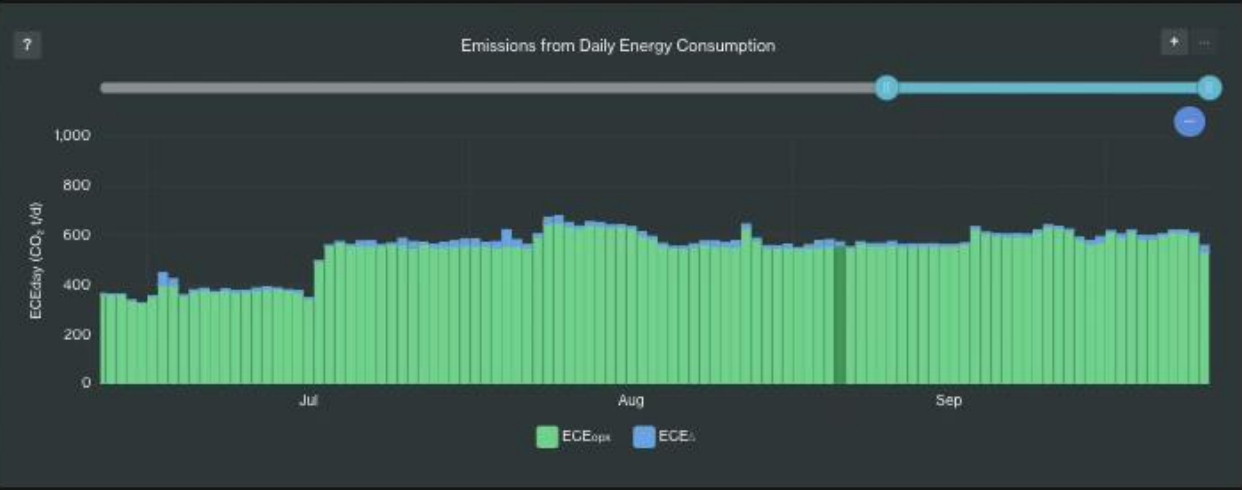
Summary

Statistical Analysis

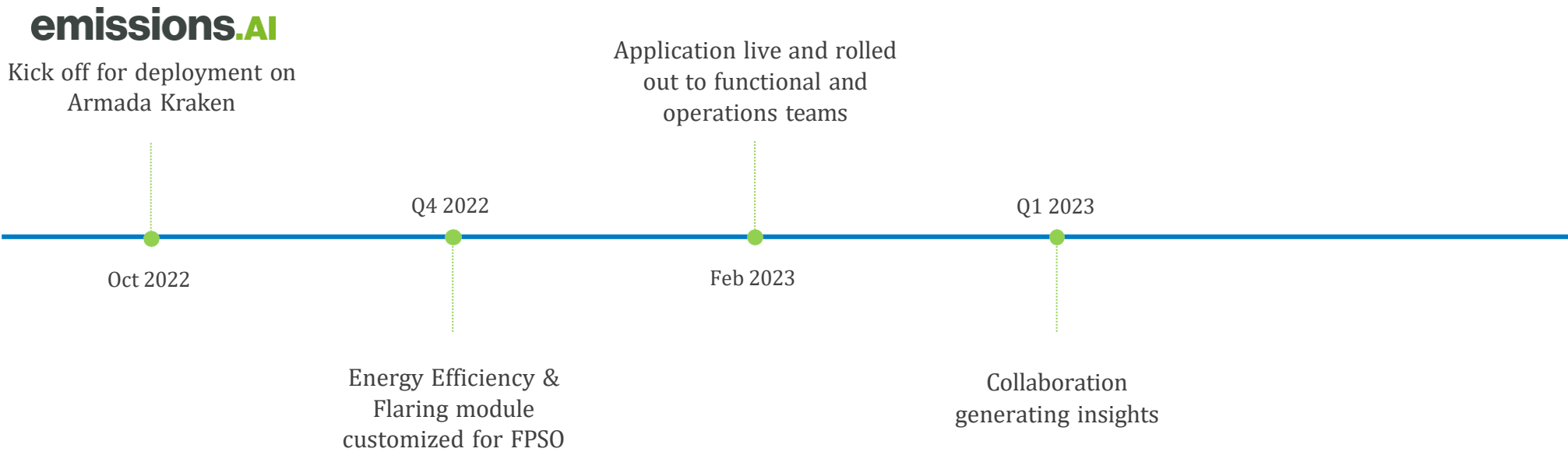
System Status

Current Optimisation & Reduction Opportunities

Power Generation	Steam	Waste Heat Recovery	Flaring	Power	Steam	Total	Emissions Intensity
418.78	272.4	55.7	37.48	0.61	34.86	51.77	2.46
ECE _{day}	ECE _{day}	ECE _{day}	GFE _{day}	ECE _A	ECE _A	ECE _A	ECE _A
(CO ₂ t/d)	(CO ₂ t/d)	(CO ₂ t/d Saved)	(CO ₂ t/d)	(CO ₂ t/d)	(CO ₂ t/d)	(CO ₂ t/d)	(CO ₂ kg/bbl)

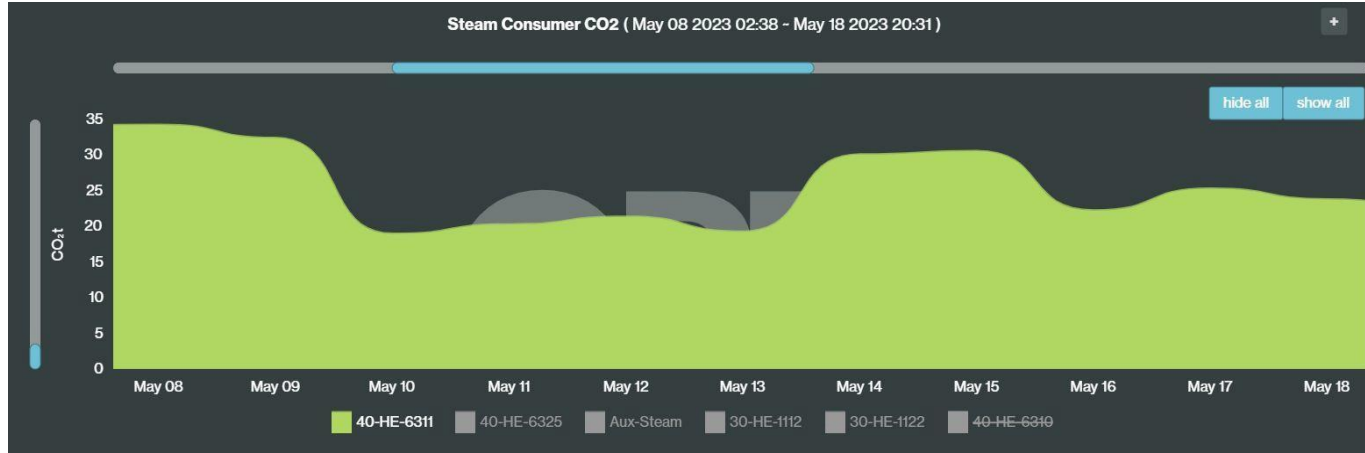


Our journey

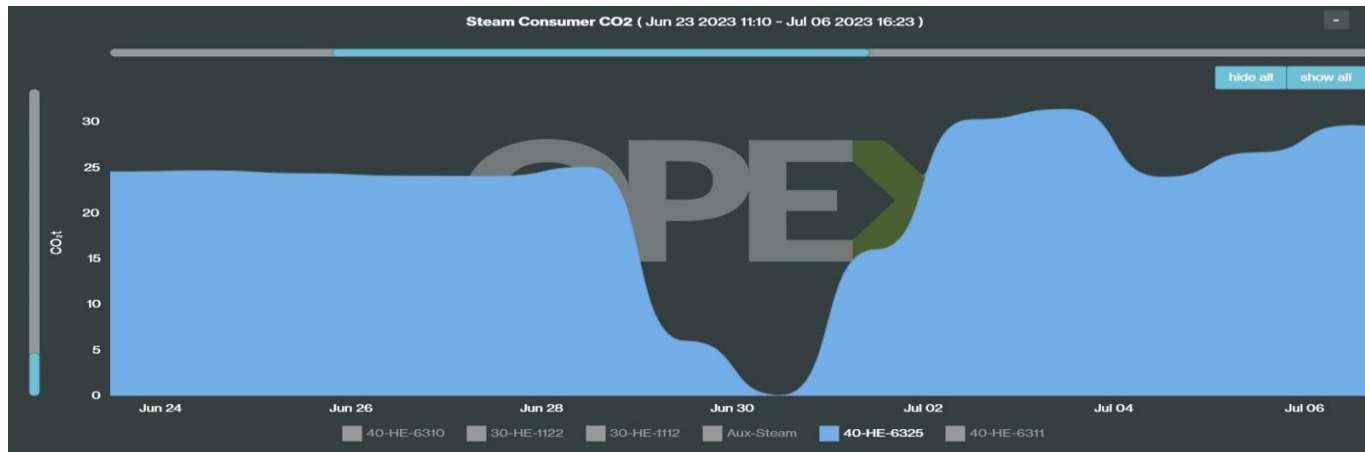


Seawater System & Process Temperatures

Identifying CO2 saving opportunities via steam boiler reductions



- HSP Power Fluid Outlet reduced by 2°C during well testing programme.
- ~10T/D CO2 reduction.
- Opportunity to make a change?



- Seawater heater was turned off for SRP maintenance, whilst WI remained online.
- ~25T/D CO2 reduction.
- Opportunity to make a change?

Temperature Trials – August 2023

Objective: Optimise steam demand across plant, reducing associated diesel consumption/CO2 emissions from the steam boilers

Areas to look at?

- HSP Heater;
- Seawater Heater;
- Oil Heaters;
- Cargo Tank Temperatures.

Trial Findings – 18% load reduction

- HSP Heater turned off – no longer required in operation (9% reduction in steam demand).
- SW temperature reduced by 3.5°C (4% reduction in steam demand).
- Negligible reduction in oil heater steam demand.
- Average COT temperature reduced by 3°C (5% reduction in steam demand).

What does this mean?

- Significant diesel reduction in steam boilers - can achieve full boiler gas burn during extensive period of load cycle.
- **Subsequent reduction in CO2 emissions**
- Potential to perform winter trial using emissions.AI and make permanent plant changes where possible.



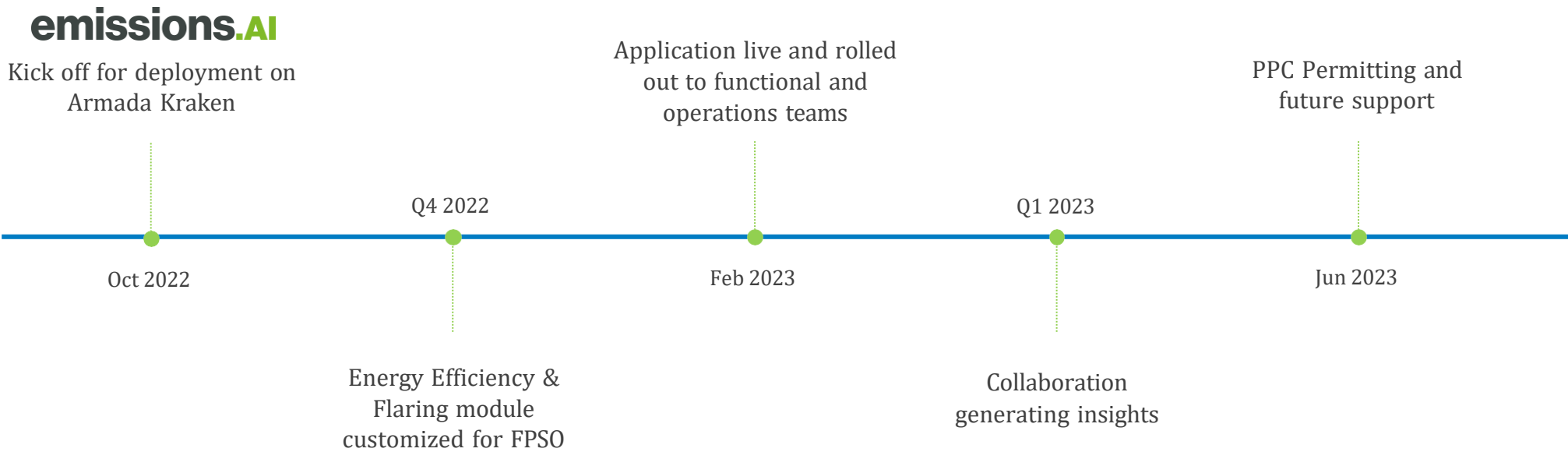
ERM

Driving energy and emissions performance across complex facilities



BUMIARMADA

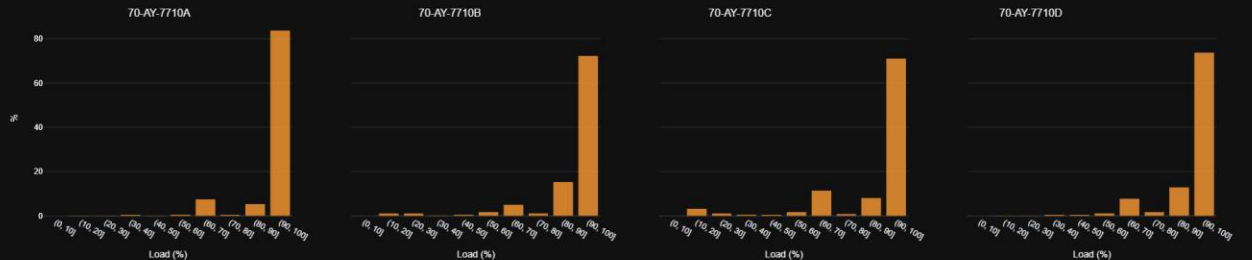
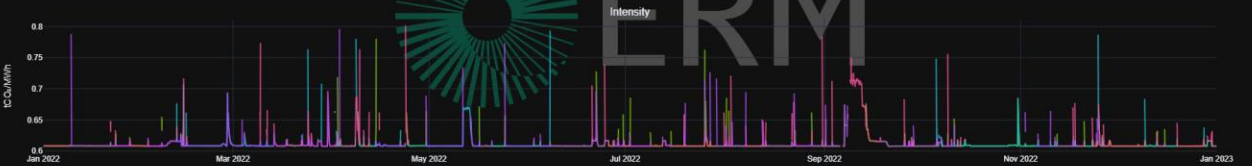
Our journey



Note: The data used for the following analysis has been sourced from Smart Client at varying resolution (typically 5 minutely) and the plots are based on the same data aggregated to hourly resolution

	70-AY-7710A	70-AY-7710B	70-AY-7710C	70-AY-7710D
Rated Power Output	15.2 MW	15.2 MW	15.2 MW	15.2 MW
Mean Online Thermal Input	30.21 MWh	29.66 MWh	28.54 MWh	29.89 MWh
Mean Online Power Output	13.39 MW	13.14 MW	12.83 MW	13.25 MW
Mean Online Thermal Efficiency	44.16 %	44.19 %	44.02 %	44.12 %
Diesel Run Hours	5311 hrs	3688 hrs	3738 hrs	5038 hrs
Gas Fuel Run Hours	0 hrs	0 hrs	0 hrs	0 hrs
Mixed Fuel Run Hours	-	-	-	-
Total Run Hours	5311 hrs	3688 hrs	3738 hrs	5038 hrs

70-AY-7710A 70-AY-7710B 70-AY-7710C 70-AY-7710D Gas Fuel Diesel Fuel Mixed Fuel Spinning Reserve

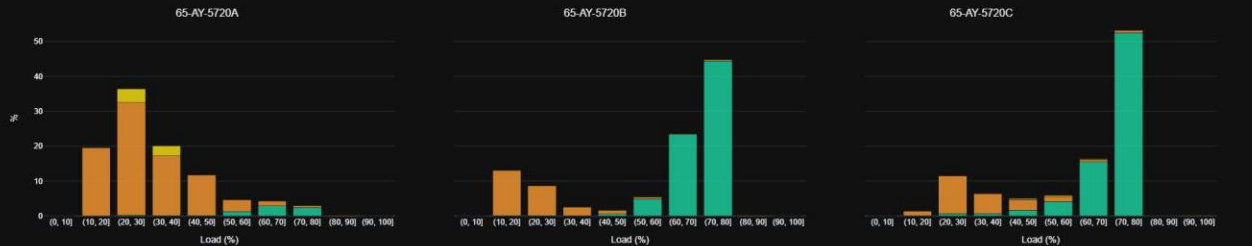


Driving energy and emissions performance across complex facilities

Note: The data used for the following analysis has been sourced from Smart Client at varying resolution (typically 5 minutely) and the plots are based on the same data aggregated to hourly resolution

	65-AY-5720A	65-AY-5720B	65-AY-5720C	70A-40X-7111A	70A-40X-7111B	70B-40X-7111A	70B-40X-7111B
Rated Power Output	49.59 MW	49.59 MW	49.59 MW	5.94 MW	5.94 MW	5.94 MW	5.94 MW
Mean Online Thermal Input	17.67 MWh	31.84 MWh	35.42 MWh	-	-	-	-
Mean Online Power Output	16.11 MW	28.47 MW	30.75 MW	4.52 MW	3.99 MW	4.06 MW	4.07 MW
Mean Online Thermal Efficiency	90.62 %	89.61 %	85.39 %	-	-	-	-
Diesel Run Hours	5598 hrs	1621 hrs	1550 hrs	-	-	-	-
Gas Fuel Run Hours	443 hrs	2857 hrs	4866 hrs	-	-	-	-
Mixed Fuel Run Hours	460 hrs	13 hrs	64 hrs	-	-	-	-
Total Run Hours	6501 hrs	3891 hrs	6480 hrs	4266 hrs	3238 hrs	1415 hrs	4083 hrs

65-AY-5720A 65-AY-5720B 65-AY-5720C Gas Fuel Diesel Fuel Mixed Fuel 70A-40X-7111A 70A-40X-7111B 70B-40X-7111A 70B-40X-7111B Output Reserve



A phased PEMS approach provides unique value

A state-of-the-art solution to establish a monitoring capability for pollutants in your facility.

Relational Models

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

Theoretical

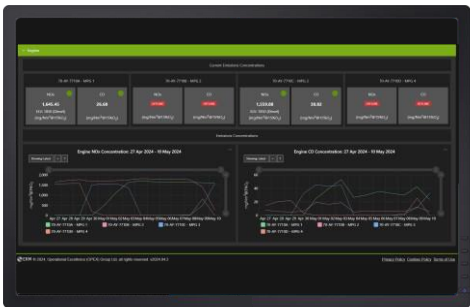
Empirical

Data driven Models

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

Statistical

Supervised (Deep) Learning



All-in-one

Our PEMS incorporates seamlessly multiple calculation models into one interface.

Real time

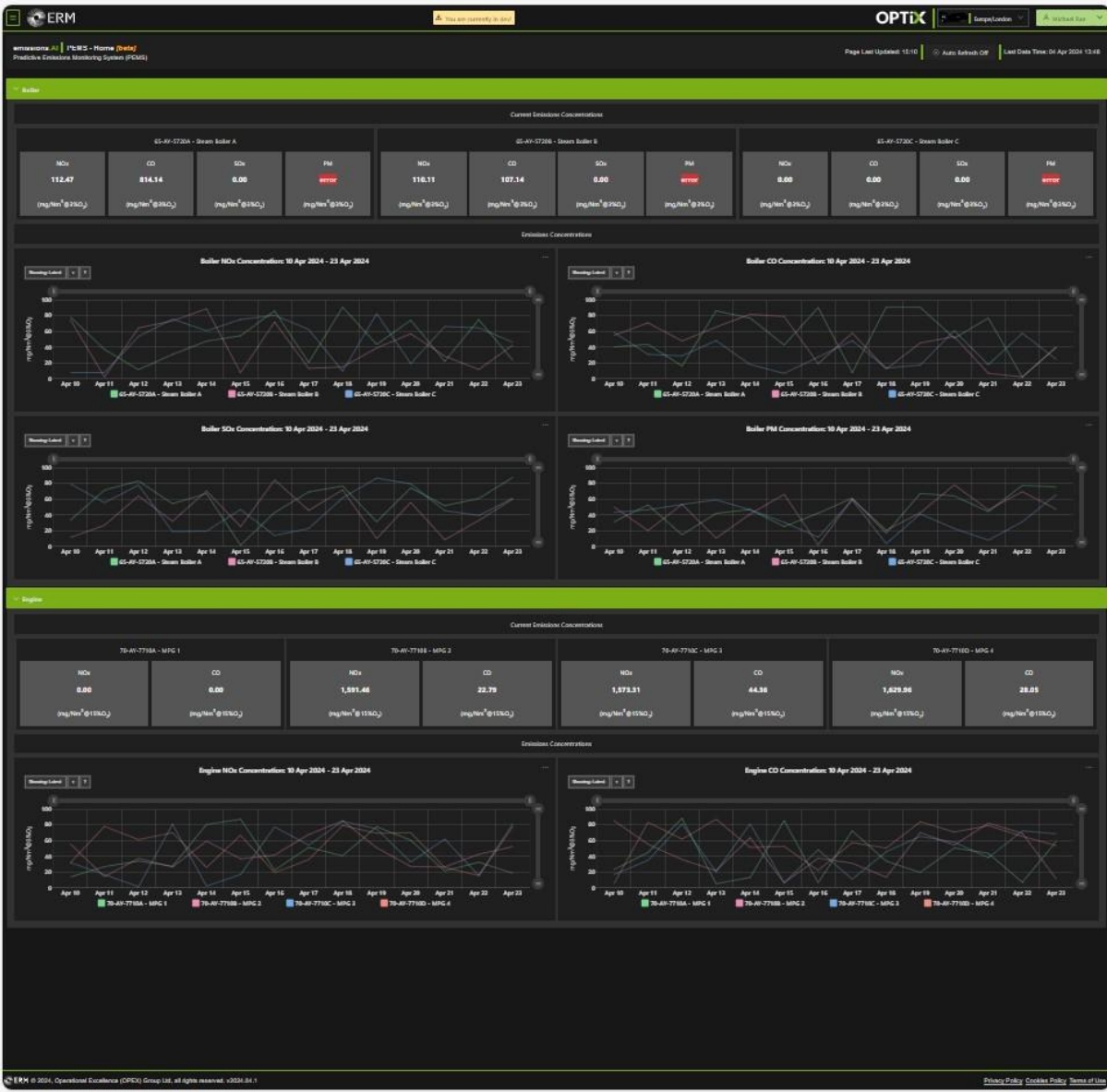
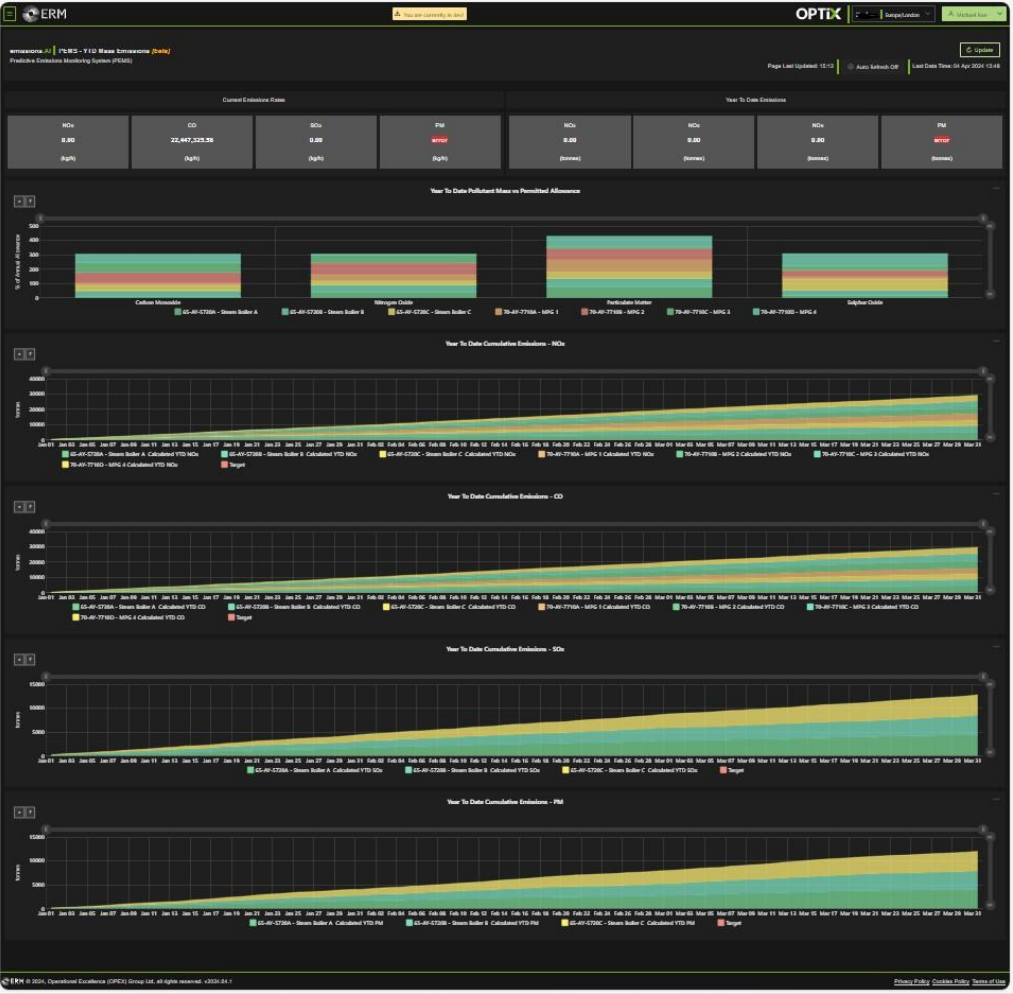
We predict emissions that can be assessed live and used as a monitoring system.

No limitations

We can establish the right PEMS model even for complex equipment or pollutants.

Model Output

Breakdown of emissions behavior per piece of equipment



Working together for the future

