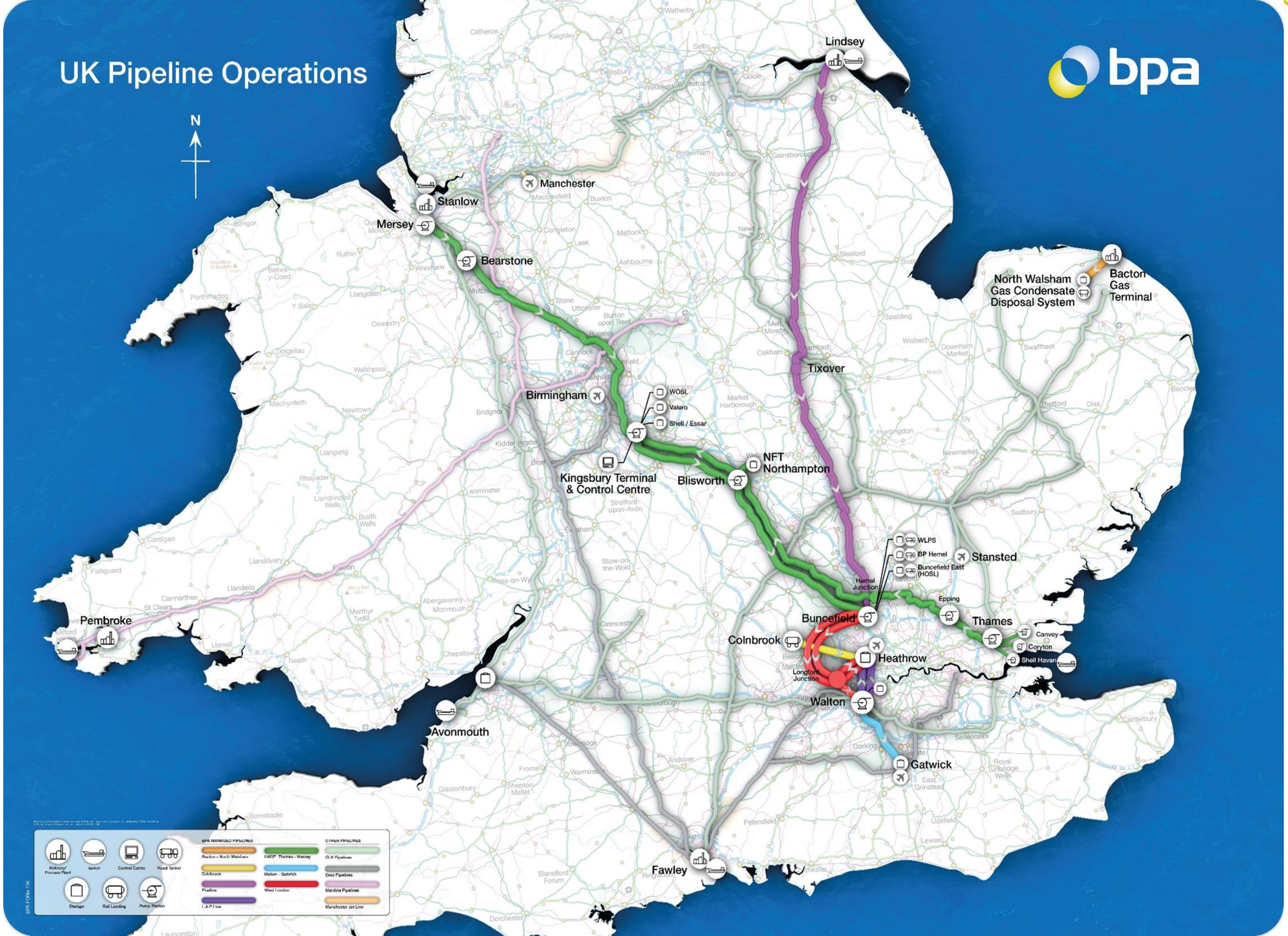
AI analysis of SCADA predicting ESD events

Managing pipelines
and terminals
safely and
sustainably

UK Pipeline Operations



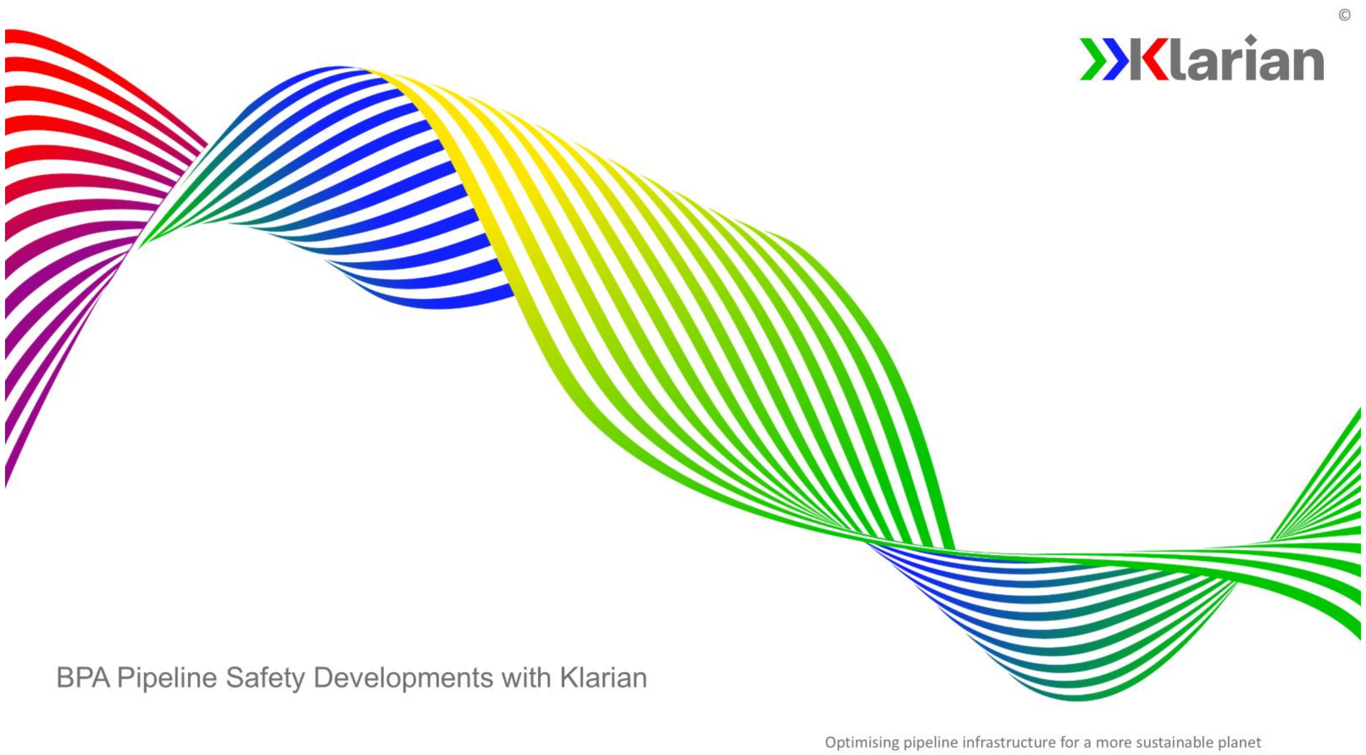
Pipeline safety implications of ESD

Pressure surge

- 7 thousand Tonnes fuel *each* section
- High pressure 80 barg
- Stopping 4 m/s to zero in 10 seconds

Mechanics understood and well managed

“false” activation typically caused by plant faults: data on SCADA



Klarian ©

BPA Pipeline Safety Developments with Klarian

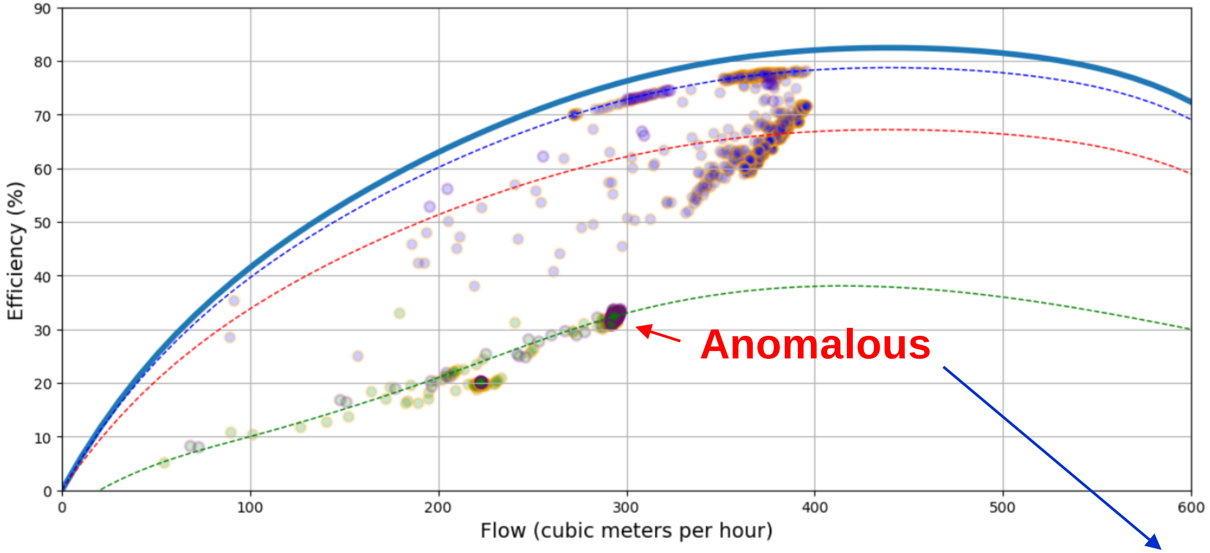
Optimising pipeline infrastructure for a more sustainable planet

Managing pipelines
and terminals
safely and
sustainably

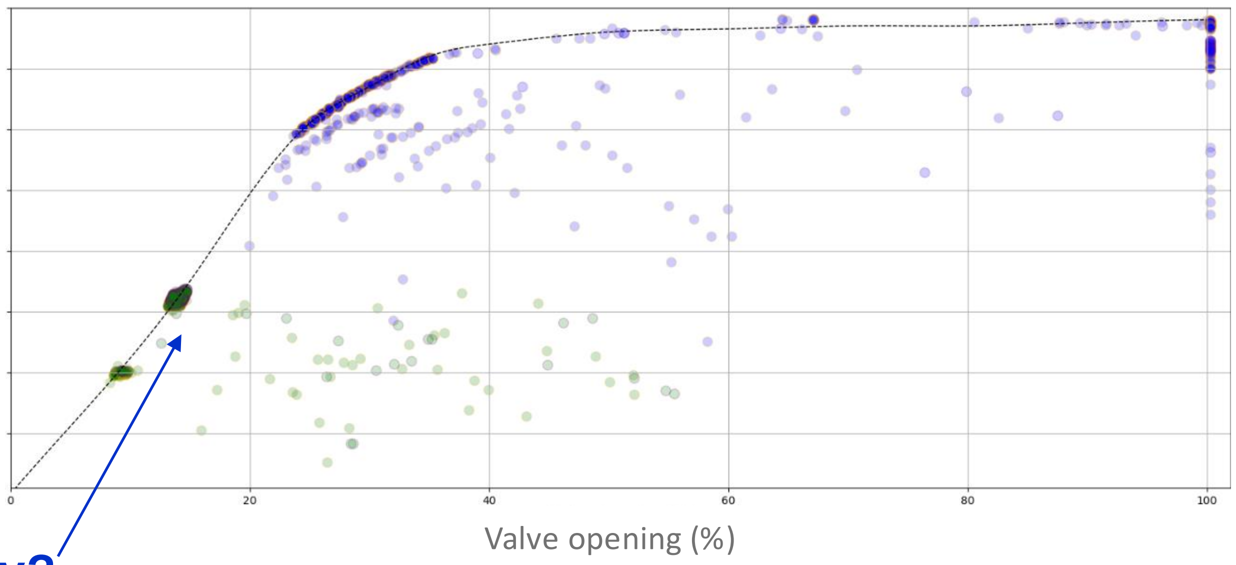
Project History

Agile and evolving scope

- Efficiency & pockets of good operating practice
- Plant condition & fault identification
- Anticipated reduced pump & valve wear – proportional to efficiency
- Less unplanned “stops” – improved pipeline safety



Anomalous



Why?

🟦 Ideal efficiency
🟦 Blue fill – Route 1
🟩 Green fill – Route 2

🟧 Orange outline – Pump 1
🟪 Purple outline – Pump 2

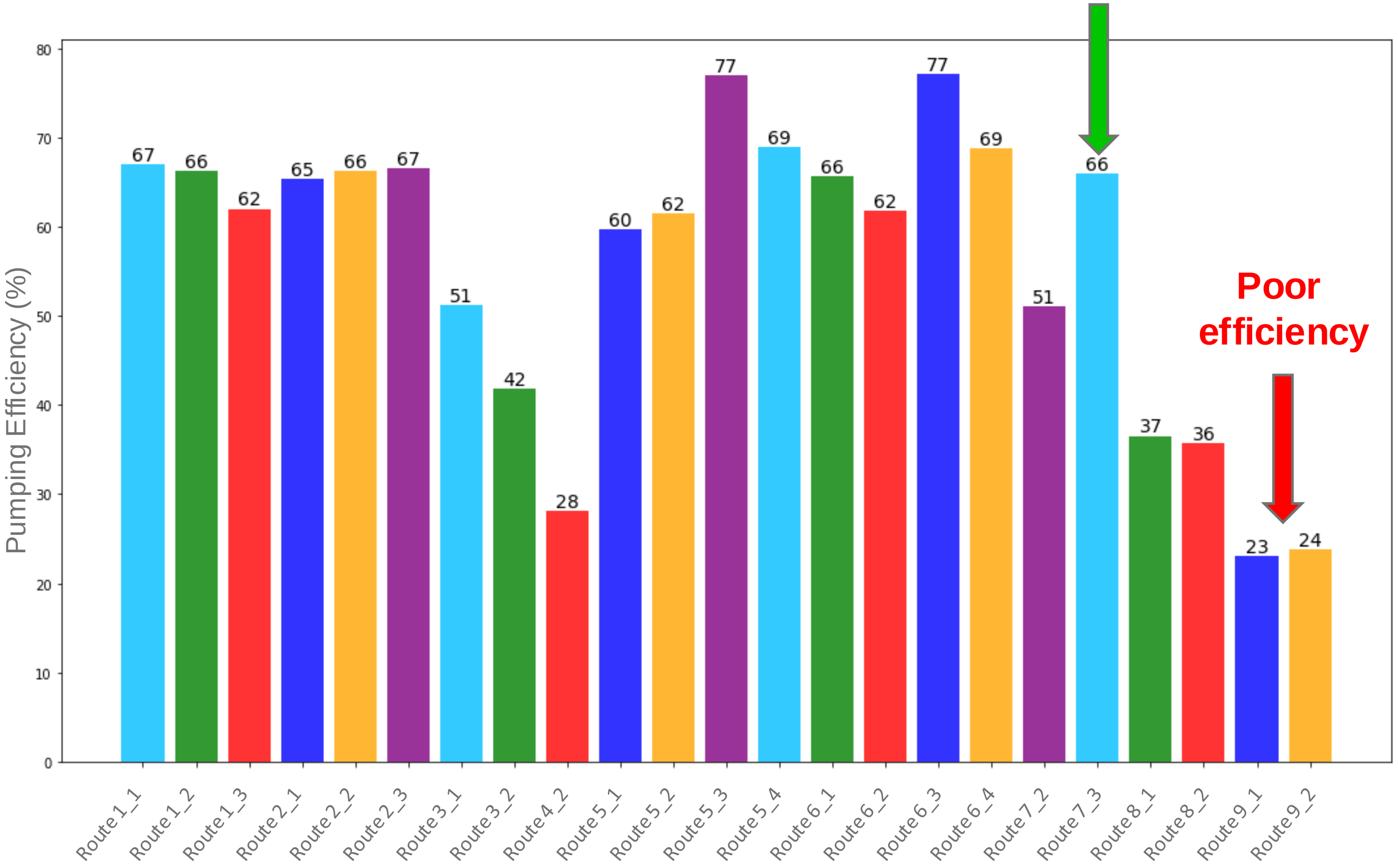
Optimising Safety and Reliability

INITIAL WORK ON EFFICIENCY PROVIDED A FOUNDATION FOR SAFETY AND RELIABILITY

- Operational conditions impact asset degradation. Low efficiency strongly correlates with high degradation.

- Identifying operational patterns which results in low efficiency may result in an opportunity to resolve them.

- Reduced chance of asset failure. Less pressure on integrity and maintenance teams. Ultimately, safer more predictable operations.



A better alternative*

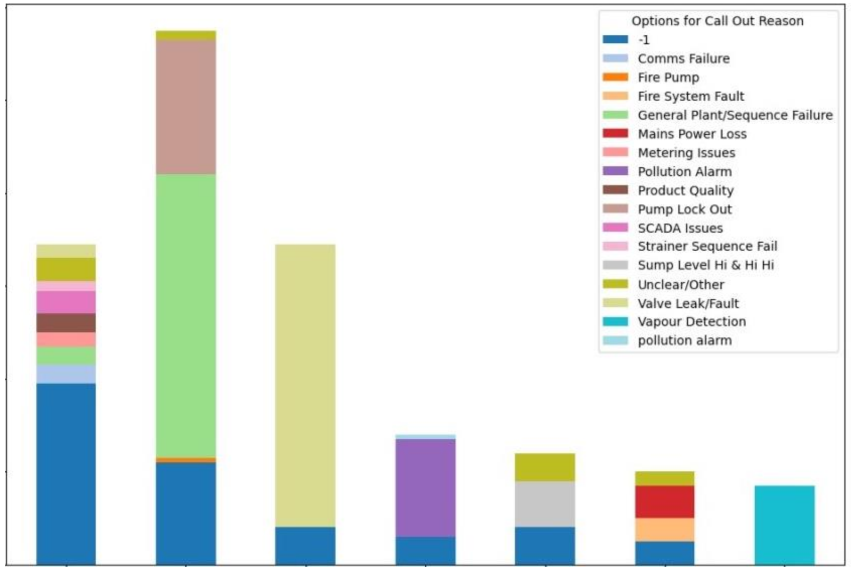
Poor efficiency

*route 7 delivers to the location from route 9 + another location as well, enabling pumping to be more efficient

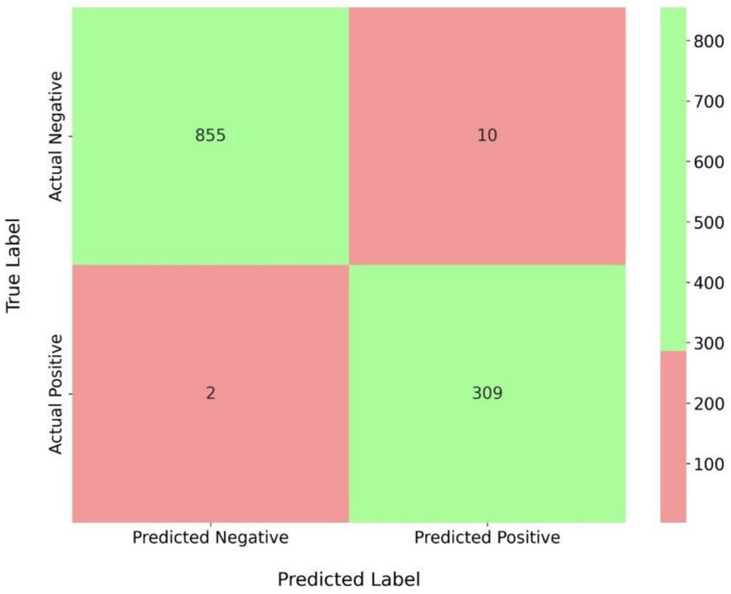
Prediction of Downtime

MODELS TO IDENTIFY DIFFERENT DOWNTIME CAUSES AND ANALYSIS TO PROVIDE ADVICE FOR PREVENTION

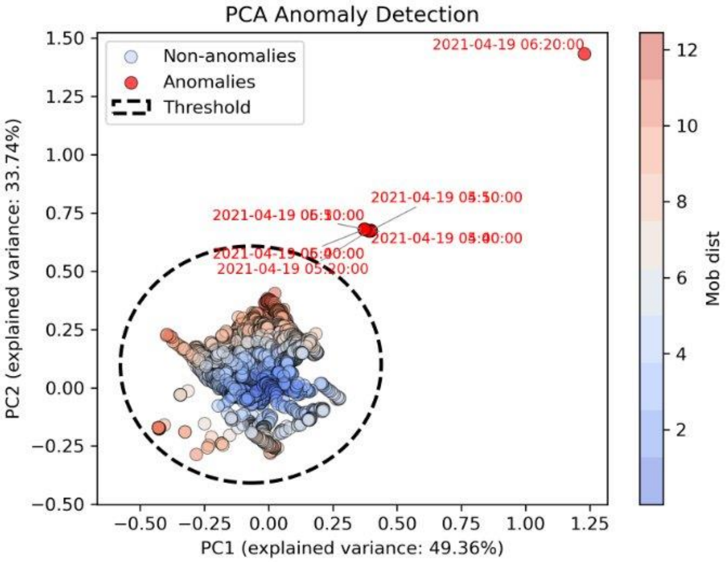
- Operators seldom have *perfect* visibility of their sources of downtime. Better knowledge of the problem causes allows better action to be taken.
- Automated detection and labelling of downtime ensures more informed choices to minimise system ESD (false).



Language model (AI) to automatically group and fill incomplete downtime logs



Support vector machine model using SCADA to categorise un-logged downtime.

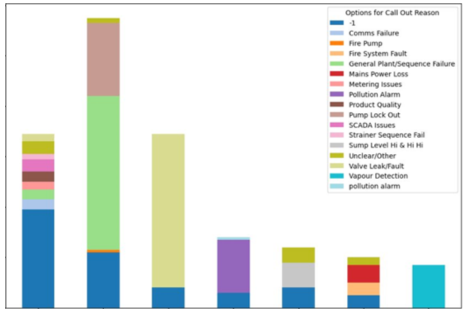


Statistical model to identify incidents of anomalous behavior that deviate from the norm.

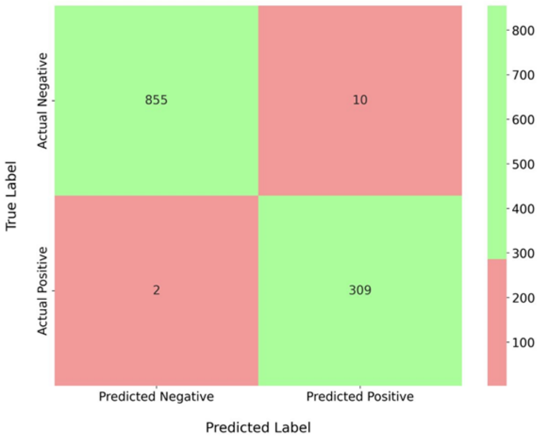
End

Real People
investigate plant

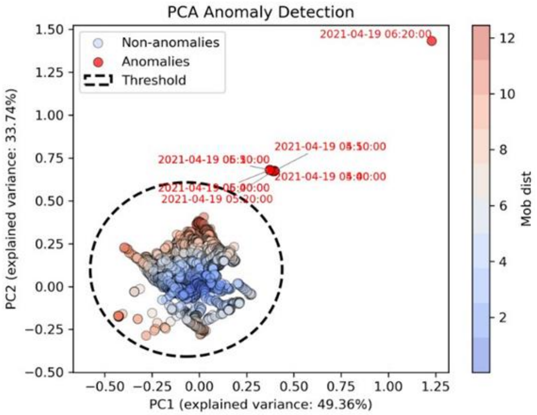
Start



AI fills in missing parts of operators' manual downtime log



Decision machine
matches SCADA data with downtime log categories



Statistical model
Identifies "unusual" plant data associated with a downtime event

The data challenge

Data visibility – Different SCADA pipeline operator “alarms” & background (software activity) data

Data structure – Reading/ breakdown huge quantity of data (>20k data points) suitable for AI analysis

Data Access - Secure access to SCADA data by specialist 3rd party (NIS)

6 monthly transfer – volume and out of date

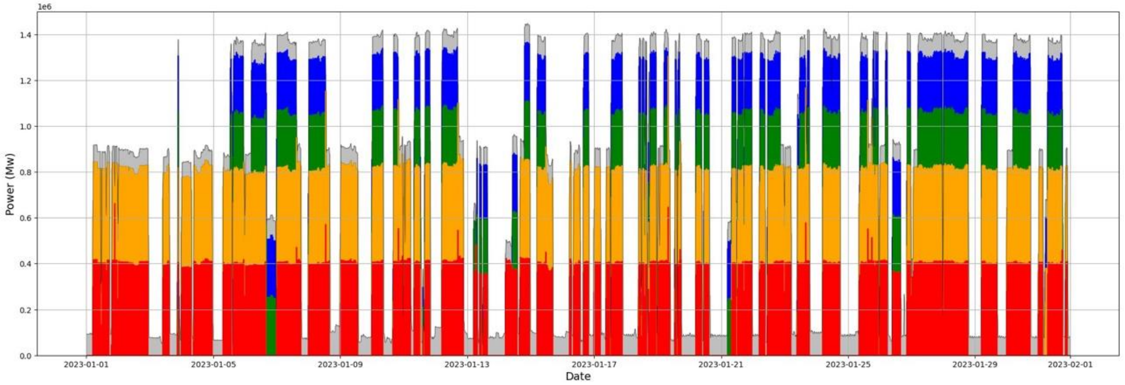
weekly transfer – 12 Gb/wk updates

potentially hourly “near real-time”

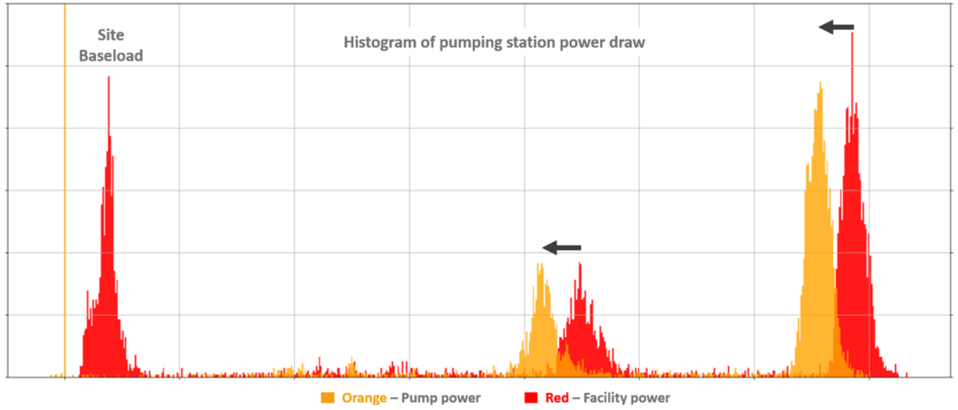
Data aggregation – individual data just isn’t there!

Data aggregation

How to undo Data aggregation

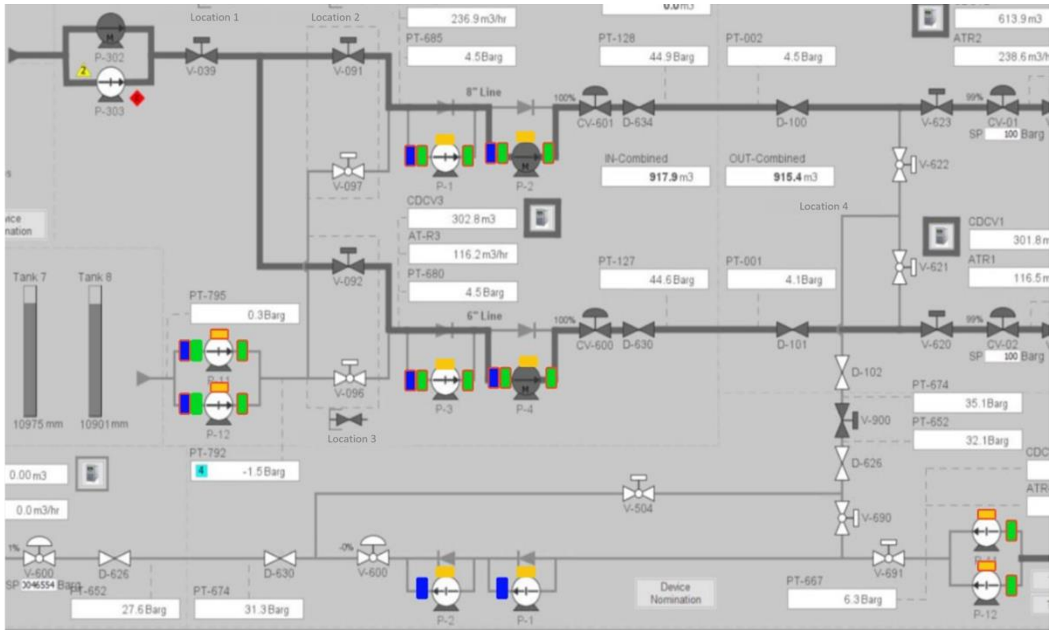


Power consumption for four pumps from aggregated power data using virtual sensors based on operational use and supplier pump data



Site baseload modelled and removed from overall consumption to isolate pumping power use

SCADA systems were not designed for analytical analysis and machine learning exercises. Therefore, it's often necessary to fill in data gaps to achieve desired outcomes. This can be done using analytical means (manufacturer spec, hydraulic equations) or through statistical means (neural network AI etc).
This is an example of power data from a site billing meter being apportioned to the 4 mainline pumps (P1, 2, 3, & 4 on the PFD).



🟩 Pressure 🟦 Flow 🟨 Power □ Lower certainty model

Digital virtual twins

Virtual sensors seeing a problem before event happens

Cross-check/ fall-back for key instrumentation (triggering ESD)

e.g. calibration or performance

Recent pipeline examples

- Carbon Capture System metering required fail-safe -
Virtual flow metering used Pressure & temp to monitor flow meter

- Gas distribution orifice plate meter installed back to front.
Anomaly detection compared real and virtual readings, flagging it to the team to correct.

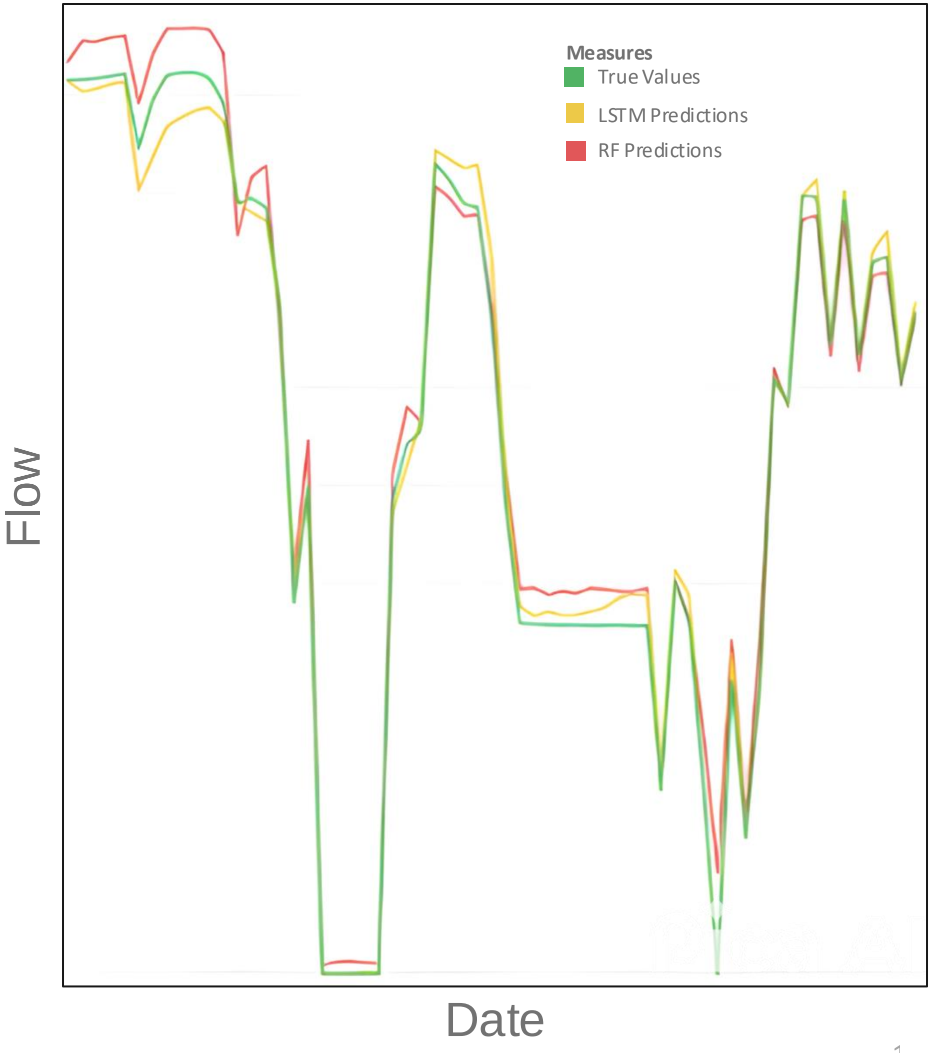
Virtual Sensors - Trustworthiness of Critical Sensor Data

SOME SENSOR DATA IS CRITICAL AND NEEDS TO BE RELIABLE

Catching problems early is essential to safe operations. Pipeline sensors provide a large part of this visibility. Can we always trust them?

- Virtual sensors can act as a complete replacement for a physical sensor, as demonstrated previously.
- A virtual sensor acting as a digital-twin to a physical sensor can provide calibration and accuracy assurance.
- A digital-twin virtual sensor can form part of a predictive maintenance and anomaly detection system.
- Finally, a digital-twin virtual sensor can operate as a backup in the event of physical sensor failure.

Flow-meter	LSTM Model R^2 Accuracy	RF Model R^2 Accuracy
Site 1	0.99	0.97
Site 2	0.98	0.78
Site 3	0.97	0.98



AI analysis, decision machine, statistical model, neural network & virtual sensors

Aim

Reduce “false” activation of ESD

Keep us & the environment safe

Geohazard and Geophysical Environment Monitoring

PROACTIVE TRACKING AND ASSESSMENTS OF GEOHAZARDS FOR FASTER, SAFER MITIGATION

Pipelines are vulnerable to geohazards and the consequences of poorly managed risks are severe. Whether tracking high strain locations, slopes, girth welds, or other vulnerable points along a pipeline route, operators need the ability to visualise this data so teams can prioritise and execute.

Centralised Data Management and Visualisation

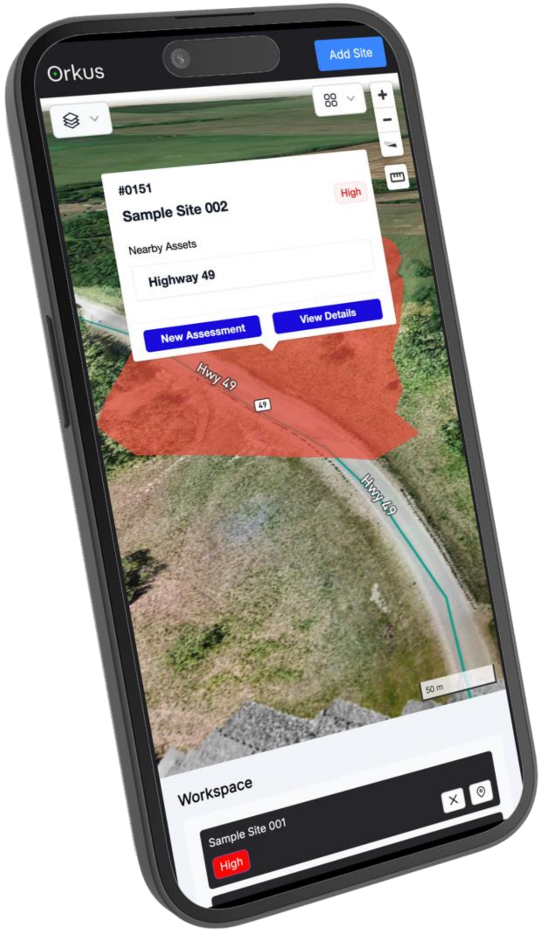
Orkus helps users manage and organise data from assets, external data sources, and site-specific assessments in one place.

Customisable Workflows and Algorithm Development

Orkus allows users to customise asset management programmes with flexible workflows and tools to create algorithms.
The algorithms and how they interact with assets can be defined and updated by users, facilitating automatic warnings and prioritisation based on customer/location priorities.

Bespoke Assessment Forms

Orkus makes it easy to create custom assessment forms to meet your specific needs.


Orkus
Add Site
#0151
Sample Site 002
High
Nearby Assets
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New Assessment
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