Carnot Innovations

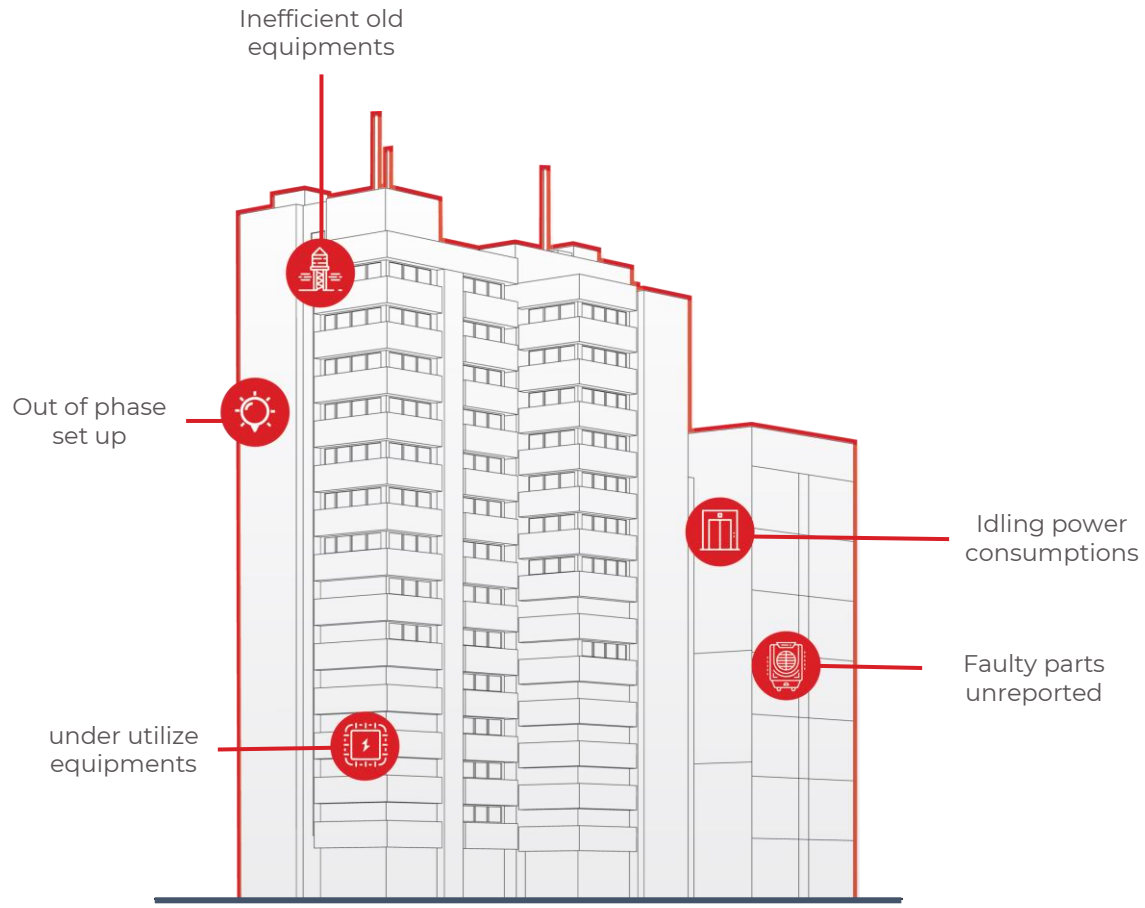
AI Powered Building Optimization Platform

Reducing operational overheads in commercial buildings through AI analytics and controls

BUSINESS OPPORTUNITY

We are an advanced energy utilization and maintenance platform for commercial buildings

Existing energy management and maintenance practices are inefficient and can waste up to **20%** of building operational budgets, globally this incurs over **20B** USD every year!



Skilled Labor Intensive

Skilled labor is required to perform routine checks every month.

Critical Faults are not dealt with in time

Small faults such as pump failures can have a knock-on effect on entire plant.

Faults stays Undetected for Weeks

Causing higher energy consumption in addition to breakdowns

Inefficient Operations Parameters

Unadaptive operations with poor operational efficiency.

Data Driven Smart Building

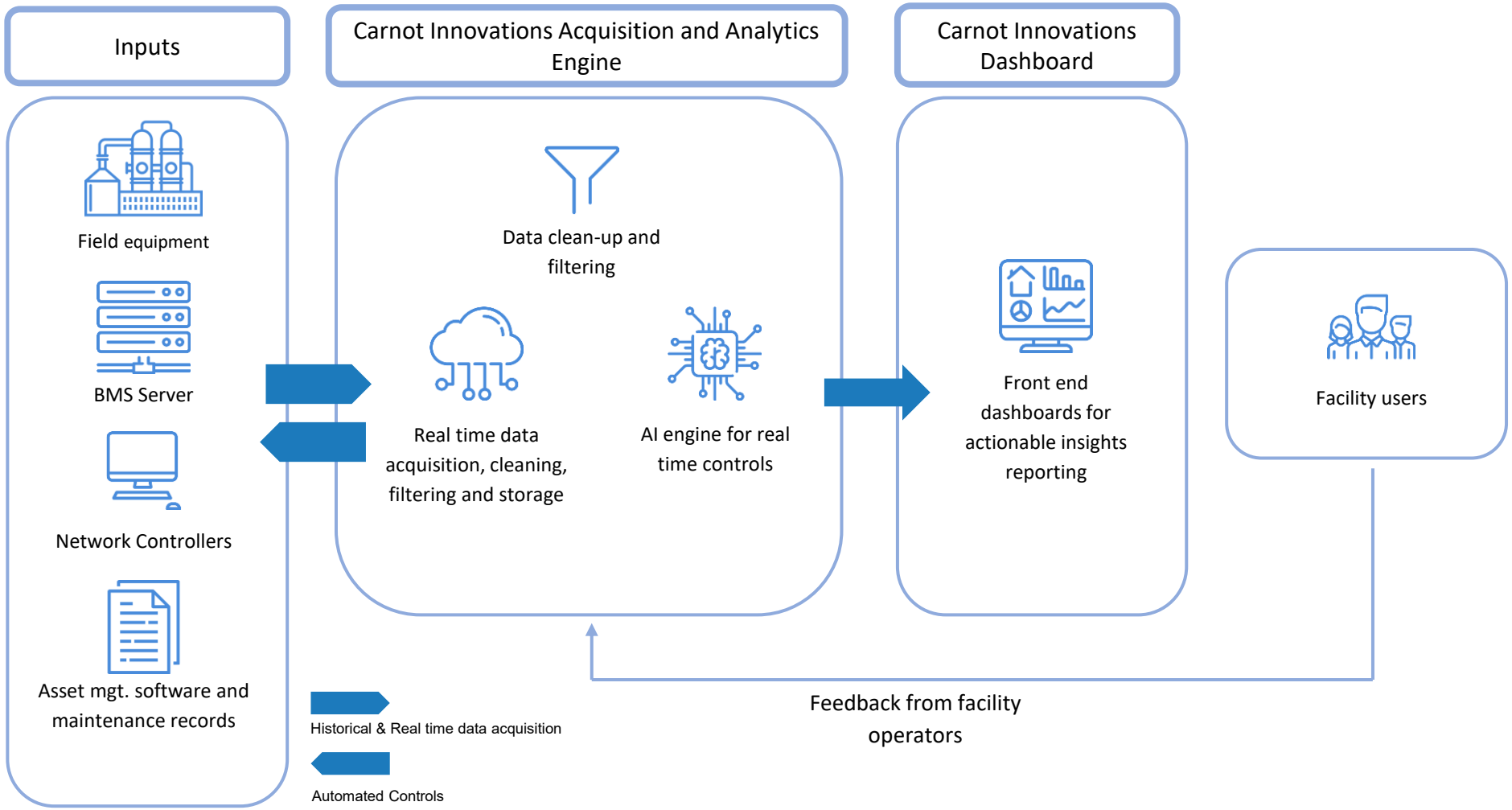
Data driven approach generates unique insights through millions of data points.

Historical data store

Open data protocol

Our process

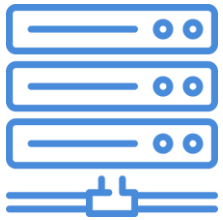
We deliver data-driven actionable Insights & performs automated controls to help optimize maintenance and energy costs



Data-Driven Operation in Smart Building

From Descriptive to Prescriptive Analytics

Data Driven Optimized Controls

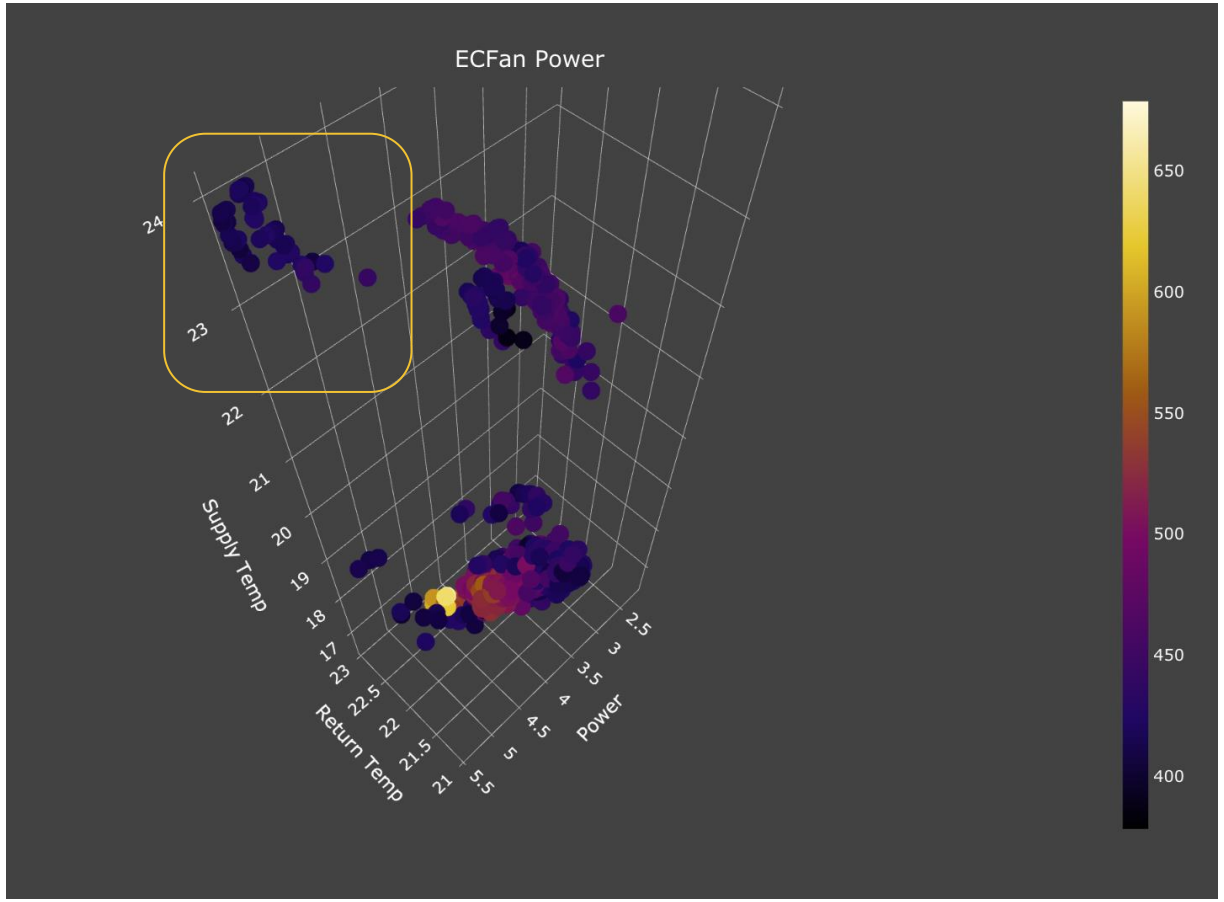


Anomaly Detection Algorithm

Rich Data Visualization

Diagnostics with advanced visualization

Rich Visualization and insights for better diagnostics

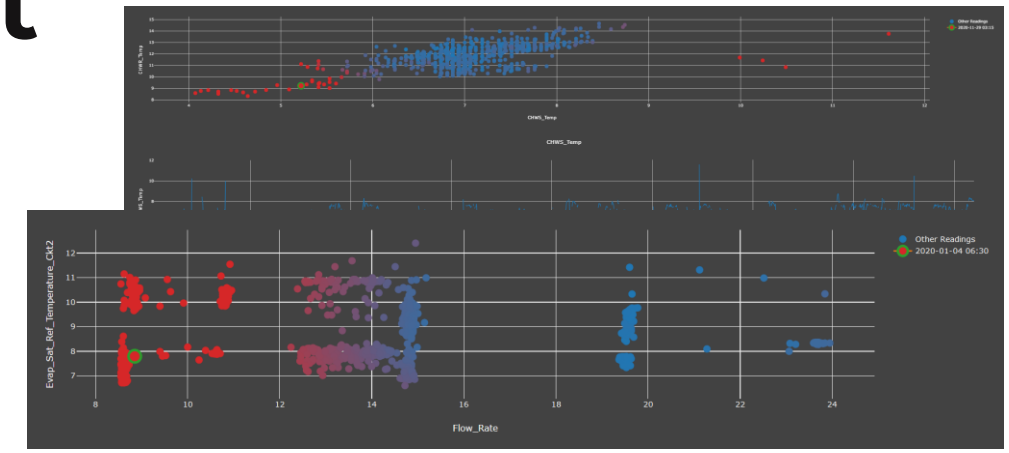


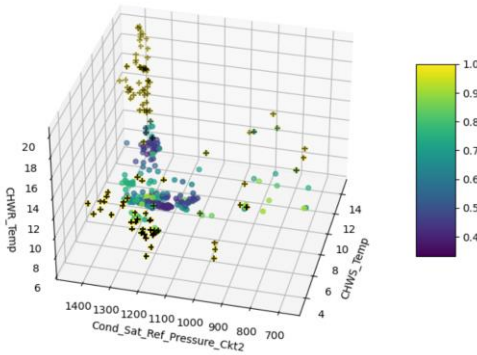
Color indicates CO2 values in ppm

Predictive Fault Diagnostics

We identify, predict and resolve hidden faults before they lead to severe equipment failures

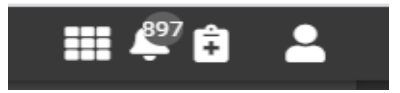
Unsupervised machine learning based fault diagnostics

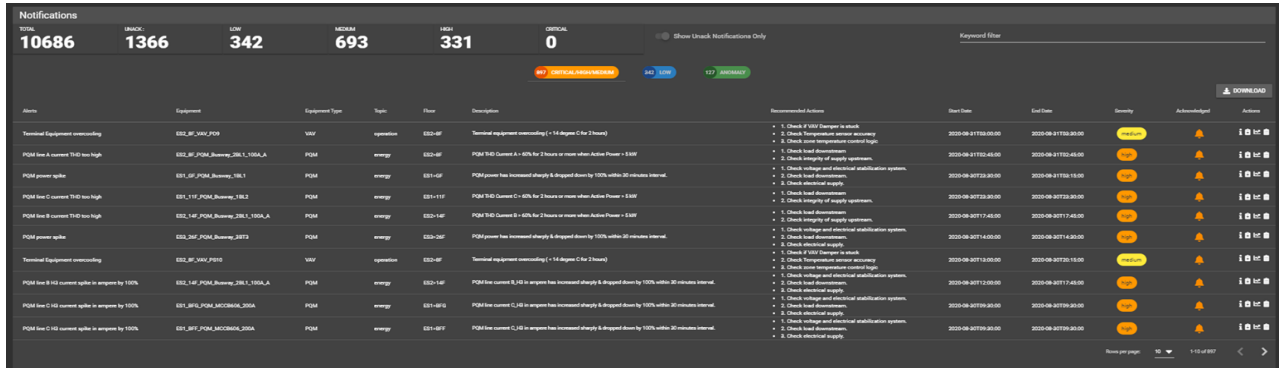




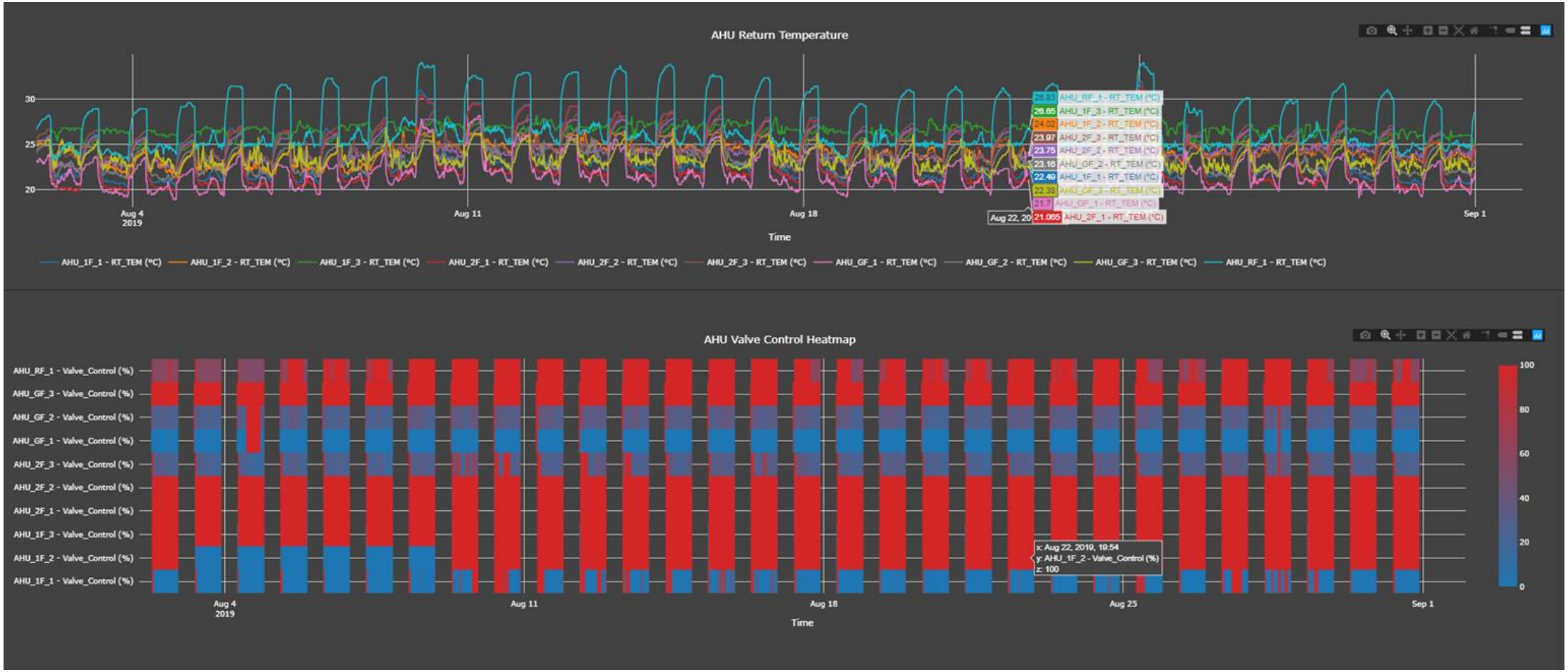
Logic based Fault Detection & Diagnostics

Notifications and real time alerts



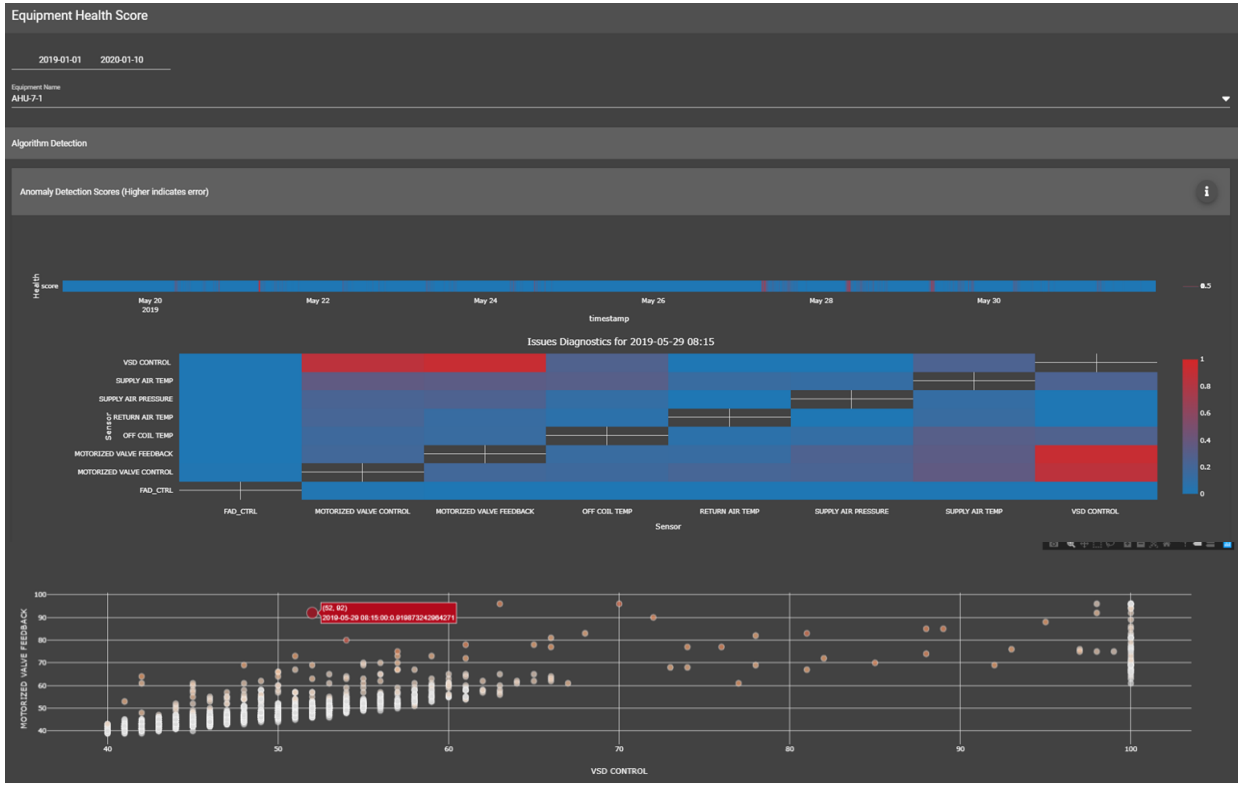


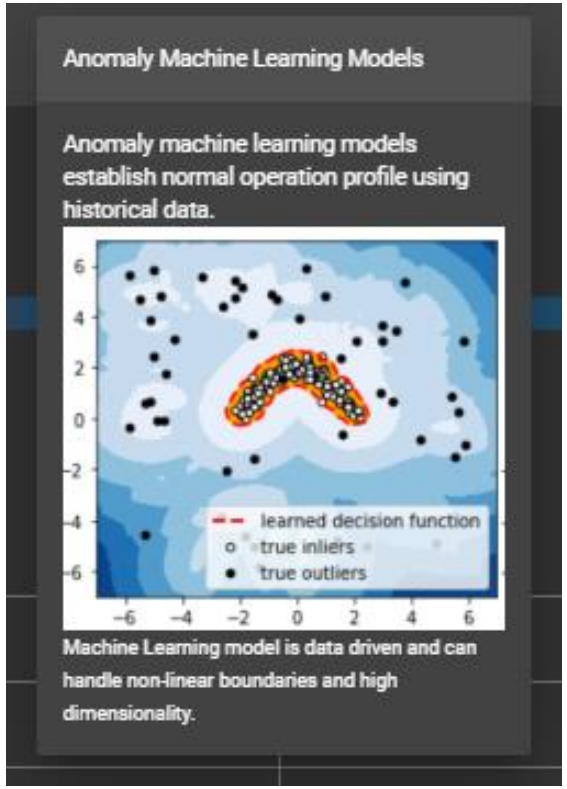
Automated Fault Diagnostics and Prediction – Large Shopping Centre Hong Kong



Automatically identified control logic and sensor issues leading to overcooling phenomenon in multiple air side HVAC equipment and visualized them intuitively. Automated reporting lead to proactive issue rectification.

Anomaly model - Fault Detection



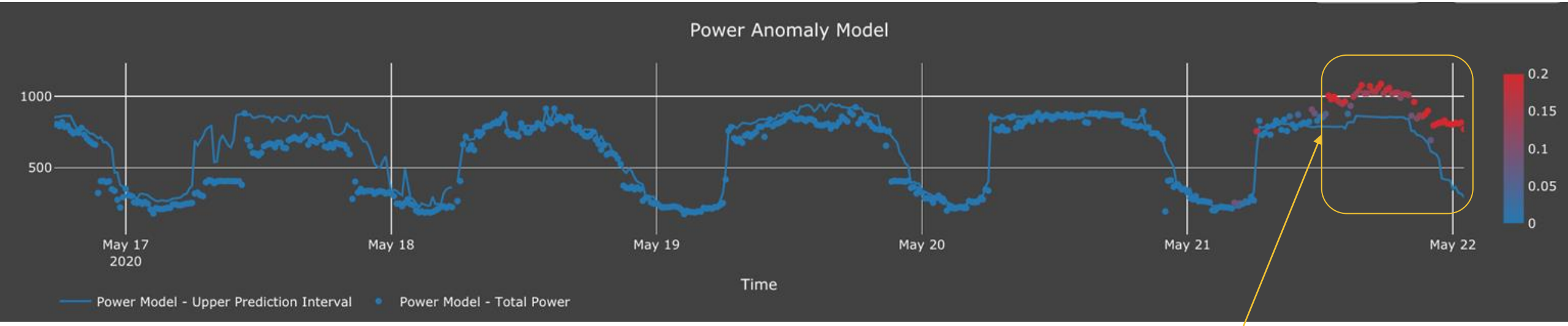


Unsupervised Machine Learning engine detects abnormal deviation of data from normal operation pattern. In this example, VSD control is set to a relatively low value however the motorized valve feedback for the AHU is abnormally high. This suggest faulty controls where supply air is still hot although there is less demand from VAVs.

The engine can detect non linear deviations from normal patterns and predict unknown faults before they seriously affect equipment performance or health.

Anomaly model - Excessive Power Usage

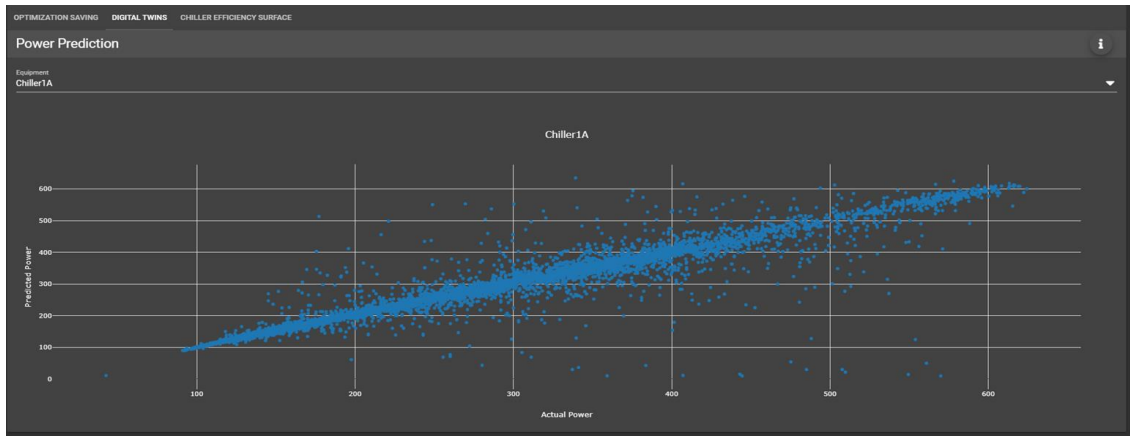
Power anomaly machine learning models



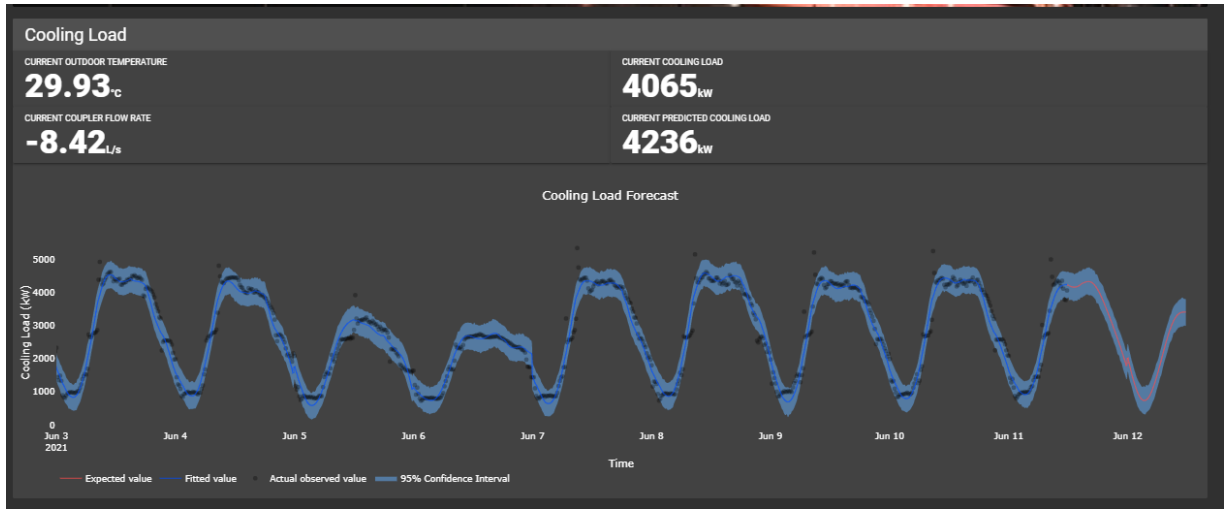
Higher than expected Chiller Plant Power consumption

Prescriptive real time controls and savings realization

Digital Twin and power predictions

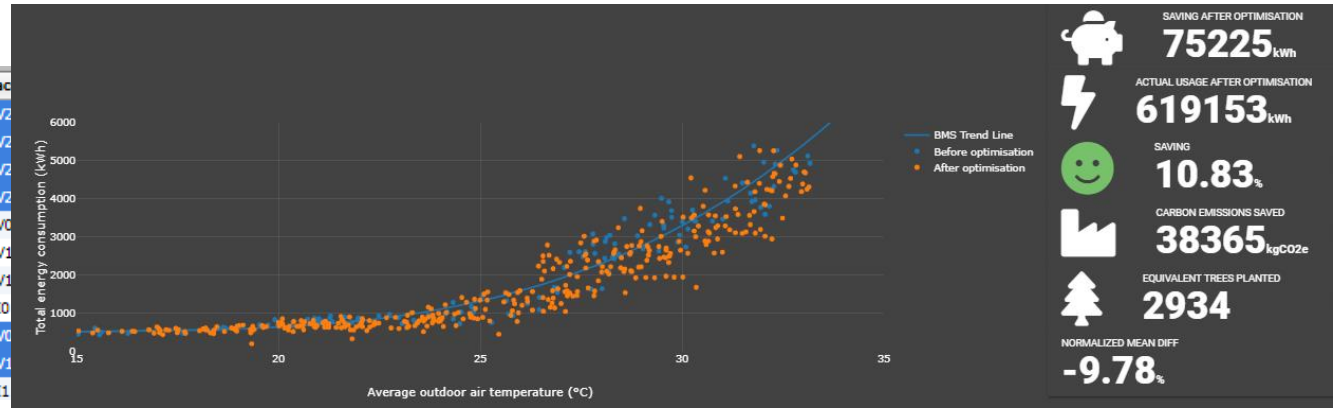


Cooling Load Forecasts



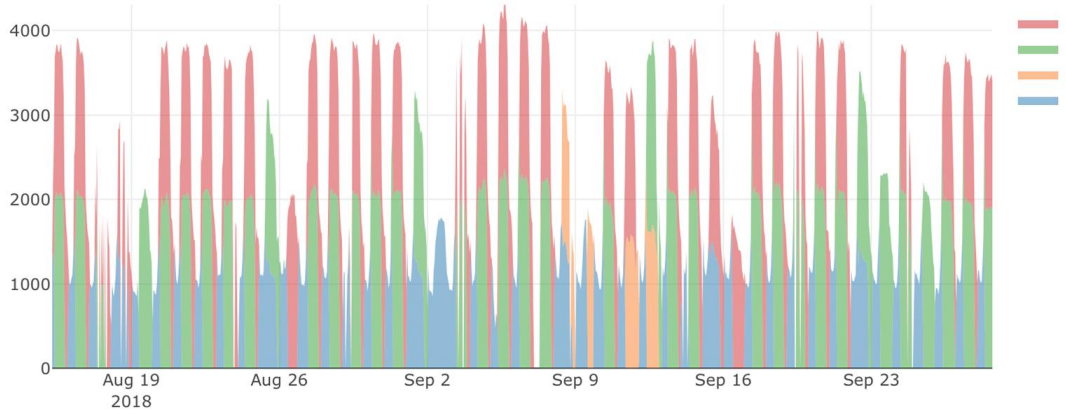
Real Time Controls & Energy Savings Achieved

	dis	bacnetConnRef	cur	write		his	connTuningRef	bac
	Chiller_Plant_Chiller_Header CH_Optm_SCHWP_QTY	Bacnet PB_Chiller	1	1 @ 8		collect 1min		AV2
	Chiller_Plant_Chiller_Header Chiller_Optim_Request	Bacnet PB_Chiller	2	2 @ 8		collect 1min		AV2
	Chiller_Plant_Chiller_Header DP_SP_Optimization	Bacnet PB_Chiller	3 psi	3 @ 8		collect 1min		AV2
	Chiller_Plant_Chiller_Header Heartbeat	Bacnet PB_Chiller	95	95 @ 8		collect 1min		AV2
	Chiller_Plant_Chiller_Header Switch_Optimization	Bacnet PB_Chiller	true	null @ def		collect 1min		BV0
	Chiller_Plant_Chiller_Header Switch_Temp_Reset	Bacnet PB_Chiller	true	null @ def		collect 1min		BV1
	Chiller_Plant_Chiller1 CHWS_Setpoint	Bacnet PB_Chiller	7.4 °C	7.4 @ 8		collect 1min		AV1
	Chiller_Plant_Chiller1 Comm_Fault	Bacnet PB_Chiller	Normal			collect 1min		BI0
	Chiller_Plant_Chiller1 Priority	Bacnet PB_Chiller	8	8 @ 8		collect 1min		AV0
	Chiller_Plant_Chiller2 CHWS_Setpoint	Bacnet PB_Chiller	7.798 °C	7.798 @ 8		collect 1min		AV1
	Chiller_Plant_Chiller2 Comm_Fault	Bacnet PB_Chiller	Normal			collect 1min		BI1

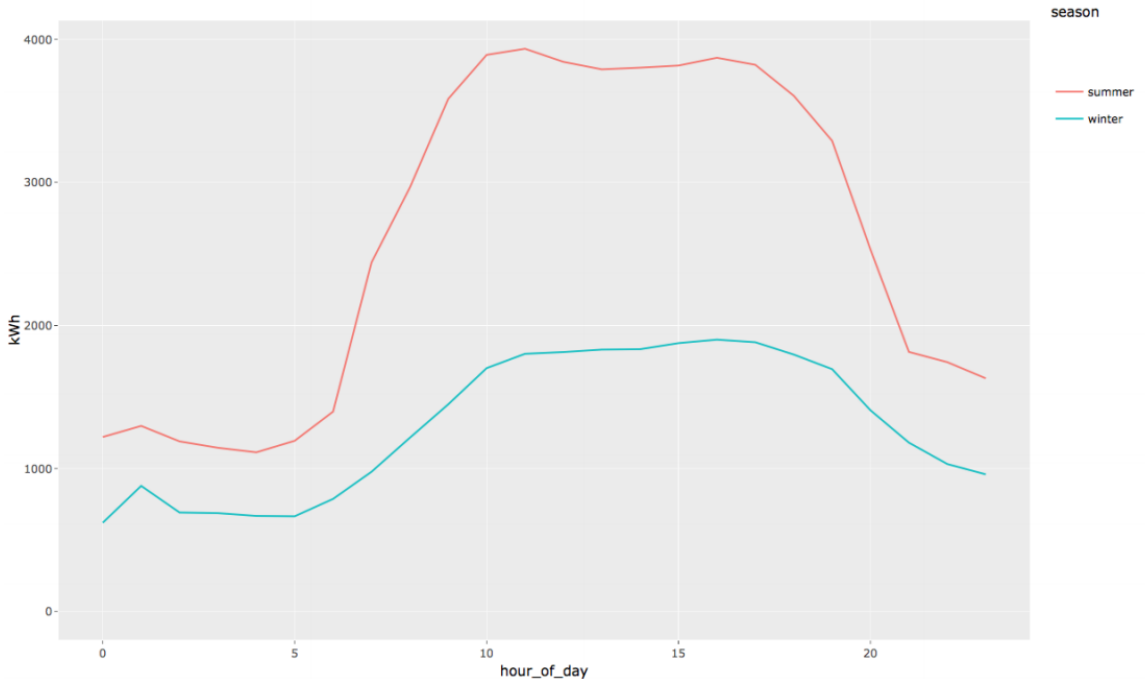


Time Series Prediction of demand

For better staging and peak shifting



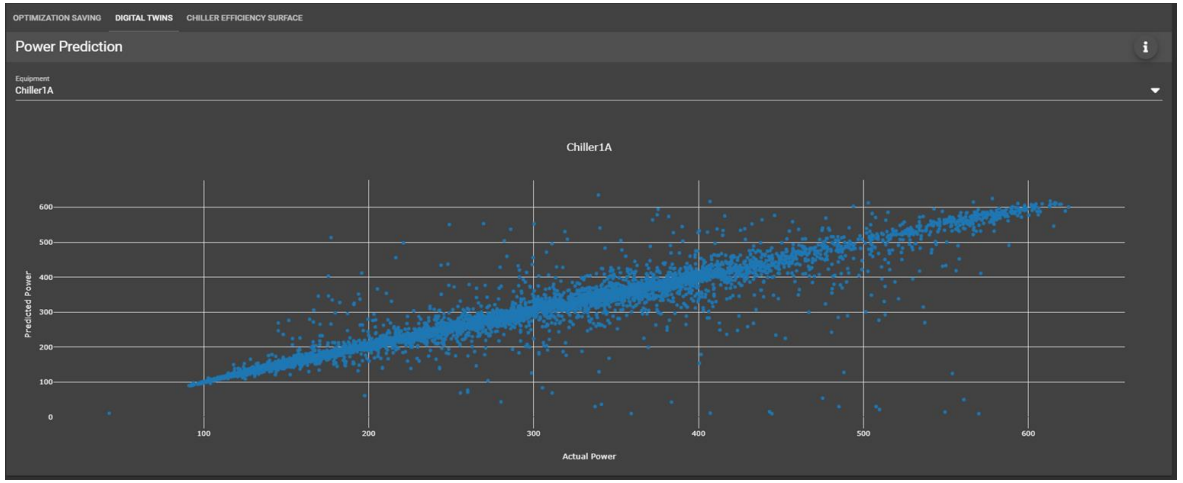
Day of week effect where Sunday the Cooling Load is much lesser.



Cooling Load vary by hour of day.

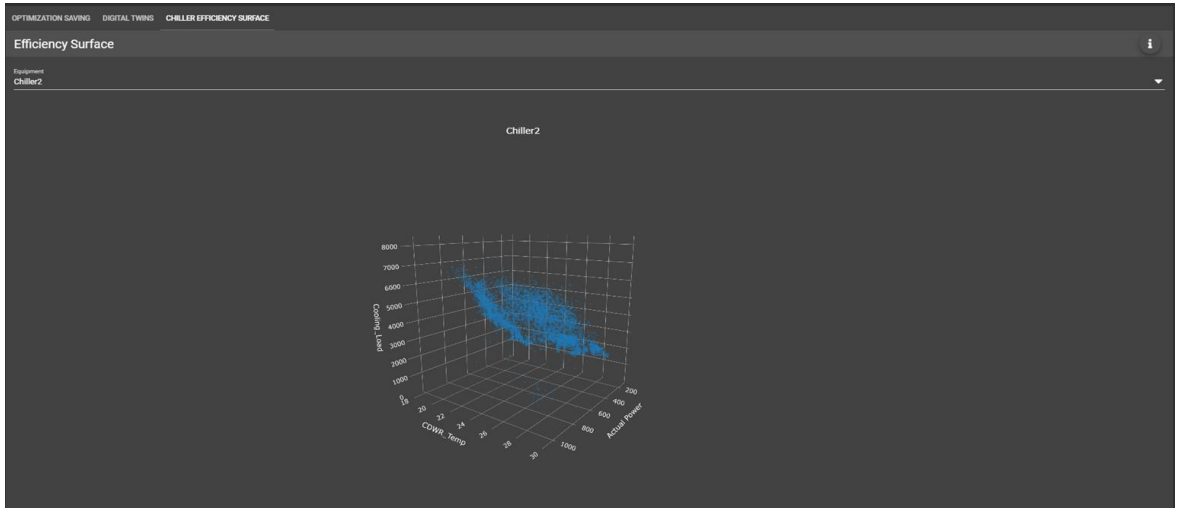
Power Consumption Model of Equipments

Estimate energy consumption under different scenarios



Digital Twins

Energy prediction models for chiller plant equipment are developed to estimate the consumption with new setpoints.



Energy Efficiency Surface

Using the forecasted cooling load and new setpoints, the optimization algorithm identifies the best setpoint combination to achieve highest efficiency. The efficiency surface of a chiller is a 3d variable that is shown here. It depends on the setpoint, the cooling load and OAT.

AI Optimization – Data + Machine Learning + Load Forecast + Optimization Algorithm

Real Time, Data Driven Chiller Plant Optimization

Optimization Formulation

Minimize Energy Consumption

Controls

- Optimal number of chillers
- Chilled Water Flow Rate
- Chilled Water Supply Temperature

Satisfies

- Cooling Demand
- Design Constraints and Specification such as flow rate

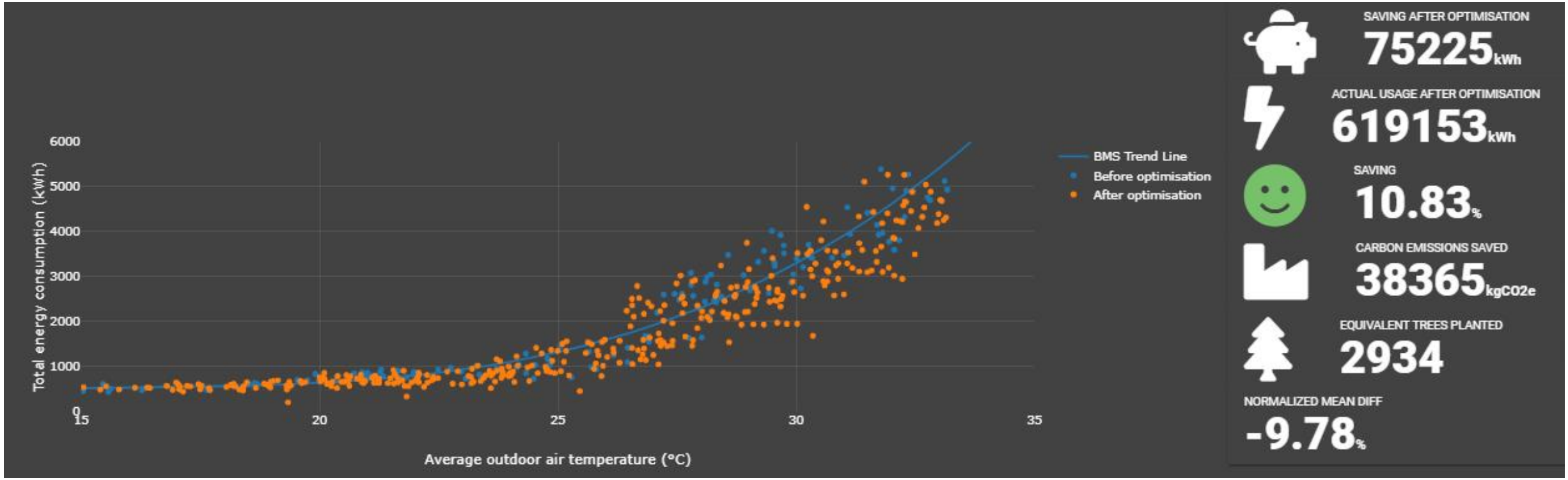
2 Predictive Models + 1 Optimization Algorithm to Achieve the Optimization

2 models to provide us with estimates of

- Future Cooling Demand
- Energy Consumption given the operating parameters

Optimization Algorithm to find the optimal parameters.

Public Infrastructure Facility Chiller Plant Optimization – Hong Kong

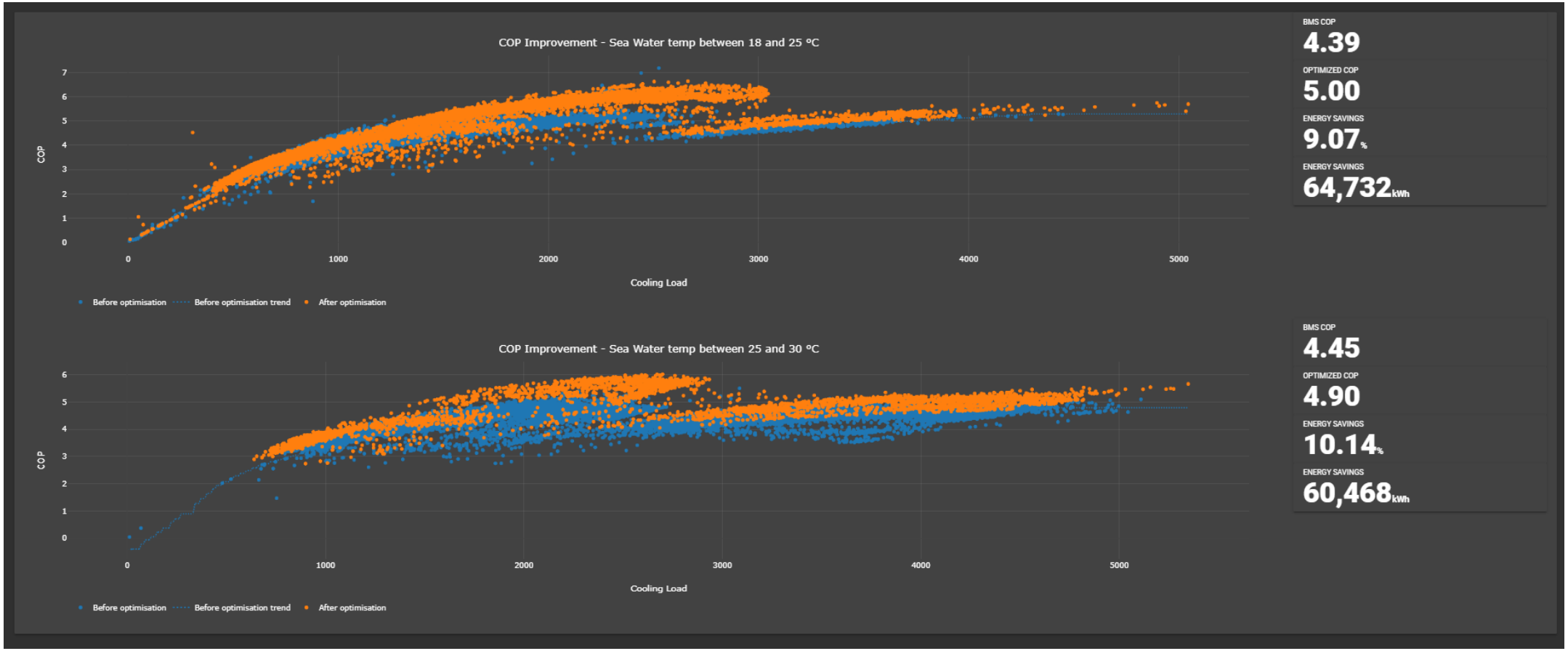


Realized 11% Chiller Plant Operational Cost Savings for a public infrastructure building in Hong Kong without additional retro-fits.

Enabled on-going and continuous commissioning for the facility.

ROI = 1.5 Years

Grade A Commercial Building Chiller Plant Optimization – Hong Kong



Improved the Chiller Plant Efficiency of a Grade A Commercial Building by 10% within 3 months of Automated AI Chiller Plant Optimization Deployment.

ROI = 1 Year

International Hospital Chiller Plant Optimization - Thailand

Optimized Chiller Plant Controls and improved over all plant efficiency by 10% while keeping cooling load and humidity within strict design constraints as required by the hospital.

ROI = 10 Months

OUR PROVEN BENEFITS

15% proven reduction in energy costs over existing controls

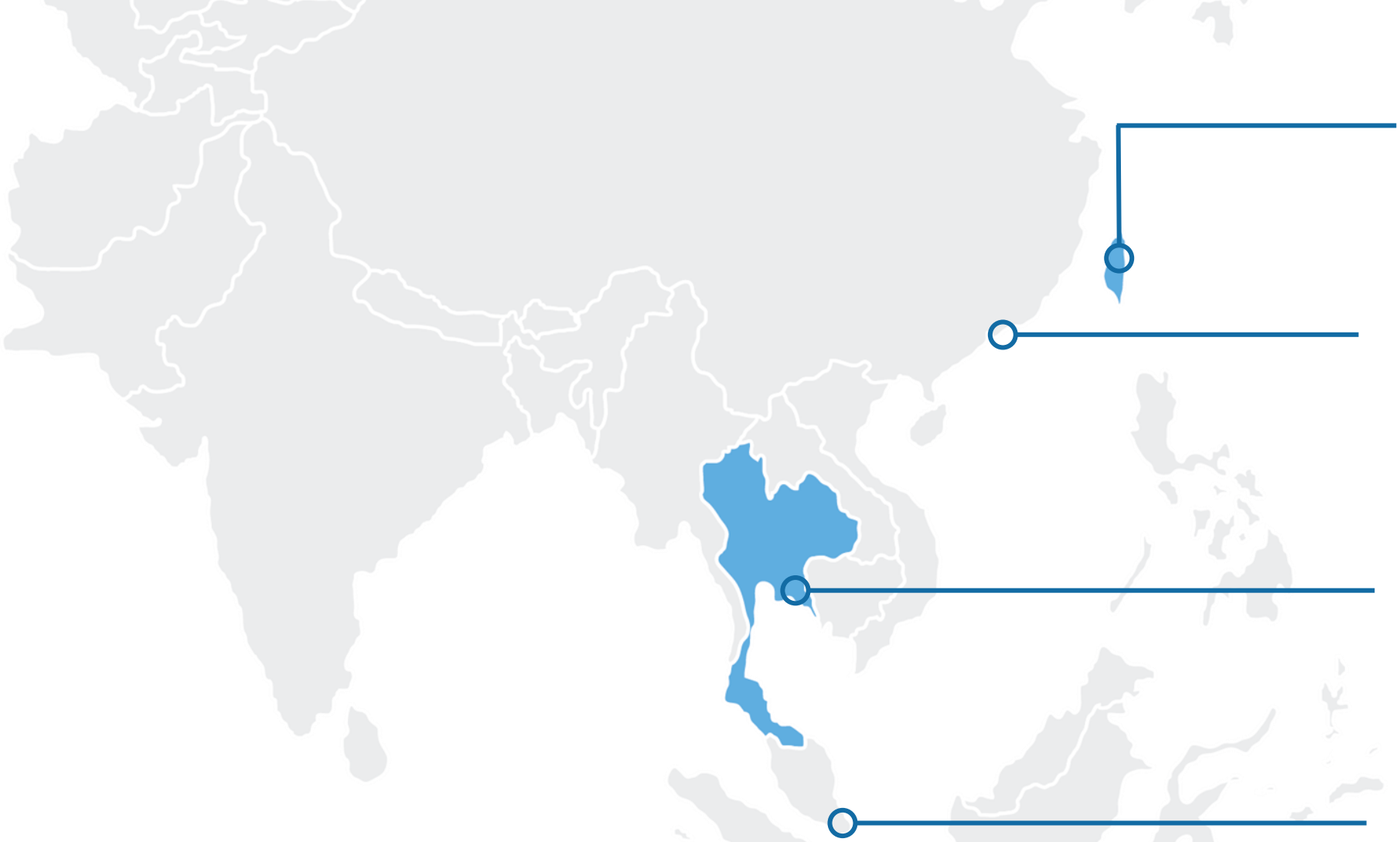
90% hidden faults uncovered

50% reduction key operation faults

Energy Savings > **50,000 USD** per average commercial building* per annum

We are helping companies reduce their **carbon footprint**, meet their **ESG targets** while saving the **environment**!

*Average commercial building is 10 stories tall or has a gross floor area of 75,000 sq. ft.



Factories in Taiwan

Office buildings, Malls and Public Facilities in Hong Kong

Incl. HK's largest property developer in central + large public transport hubs

Departmental Stores, Hospitals, Hotels in Thailand

Office buildings in Singapore

DEPLOYMENTS

>25 Grade A facilities across Asia (600,000 sq. m.), monitoring >130,000 sensors in real time

POWERFUL ALLIES

We are backed by Global Venture Capital Firms.

Carnot Innovations

The brain behind truly smart buildings

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