OAK Case Study

LCC Oxford Circus

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Executive Summary

OAK NETWORK UK LIMITED (OAK) conducted a pilot project at LCC Oxford Circus with the objective of optimising electricity consumption and finding potential cost and carbon footprint savings.

With just 2.5 months of data, OAK successfully identified 9 valuable insights to benefit operations onsite:

1. Equipment-level monitoring and analysis for Air Conditioning (AC)
2. In-house alerting system
3. Voltage optimisation
4. Phase-wise analysis of energy consumption
5. Abnormal patterns of change in energy consumption
6. Pre-emptive interventions
7. Power Factor analysis
8. Predictive AI
9. Safety first

Collectively, OAK identified opportunities to save **£2,770** annually – equivalent to 2 months of free energy – and **5.7 tonnes of CO2**, an equivalent carbon footprint to approximately **7 UK homes' consumption** per year.

Extrapolating these savings across LCC's entire portfolio would yield significant savings at little to no upfront cost and make an important step towards net zero emissions at a time when corporate climate action has never been more important.

About OAK

OAK NETWORK UK LIMITED (OAK) is an innovative energy efficiency company delivering a net-zero carbon plan for all its businesses.

What exactly do we mean by energy efficiency?

At OAK, energy efficiency means optimising the use of electrical energy without wasting it. This in turn reduces businesses' carbon footprints and cuts energy bills.

OAK digitally transforms the issue of energy wastage and expensive bills that 5.7 million businesses across the UK face each month, using insights from *monitoring and diagnostic analytics* to bring about corrective and preventive measures that enable businesses to efficiently manage their operations 24/7.

For retail building operators, OAK is able to plot energy usage during trading hours, non-trading hours and when preparing for and after service ("Prep"). From this continuous data monitoring, OAK provides insights and alerts which save energy.

Double the impact

During these difficult financial times, OAK services help businesses to better understand and manage their energy, making them more economically resilient and returning revenue to their bottom line. As stated by Benjamin Franklin, *"Every penny saved is a penny earned"*.

Efficient energy usage does not just save significant amounts on bills, but also significantly reduces the carbon footprint of a business and their direct impact on the environment. In other words, by using OAK's services, businesses both save money in today's crucial period of economic instability *and* contribute to tackling the climate crisis.

About LCC Oxford Circus

OAK's premier client, London Cocktail Club (LCC), owns a chain of UK bars, including a flagship bar near Oxford Circus at 4 Great Portland Street, London.

This prime real-estate spreads over 3,000 square feet. The bar is operational every day of the week, with Saturdays being the busiest. The average monthly electricity bill for the bar is £1,200.

LCC takes pride in delivering best-of-breed services. However, without the ability to monitor their energy usage, effective management of their consumption was lacking. OAK stepped in to deliver a digital energy solution to make operations more energy efficient and profitable.

The aim for LCC group management was to collaborate with OAK to optimise energy consumption and reduce costs at the Oxford Circus bar, and transfer the best practice learnt to all stores nationwide to maximise impact – saving energy, offsetting the company's carbon footprint and supporting a corporate commitment to climate change.

Digital Transformation

OAK has two core service offerings:

1. Monitoring and Diagnostic Analysis
2. Corrective and Preventive Measures

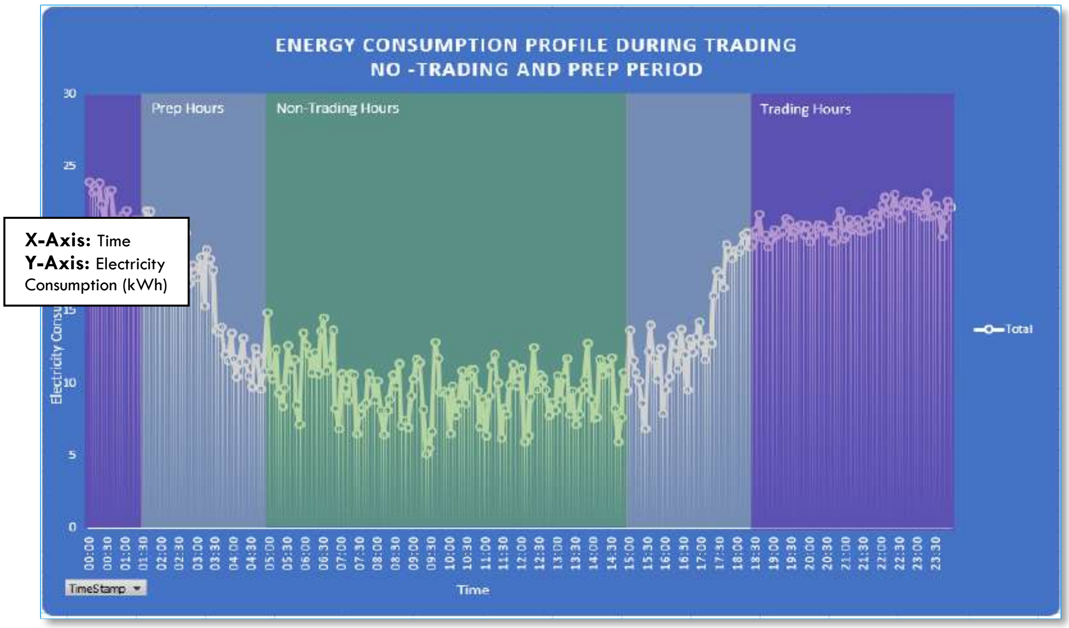
LCC believes in the approach that once they can see and understand their energy consumption, they can proactively do something about it. OAK covers all aspects of their energy efficiency needs with an end-to-end package that delivers:

- Full site analysis
- State-of-the-art mobile energy data loggers
- Real-time mobile energy data collection
- Asset monitoring and management
- Regulatory compliance to industry standard
- Remote monitoring and analytical diagnosis
- Web dashboard for end-users (management and onsite operators)
- Machine learning based predictive maintenance

Together, this full suite of services is helping LCC to better understand their energy consumption, identify where improvements can be made and automate system-wide inefficiencies.

To support energy insights, OAK plotted the site's daily operations and divided them into three functional periods (Figure 1) as follows:

1. **Trading:** time when the bar is open for business.
2. **Non-Trading:** when the bar is closed for any business activity.
3. **Prep:** when the bar is preparing to open at the start of a shift or close down after a shift.



By analysing data logged over several weeks, OAK developed tailor-made "insight" and "alert" features that can inform LCC of periods of abnormal consumption or energy waste.

TRADING CATEGORY	MIN (kWh)	MAX (kWh)	AVERAGE (kWh)	MEDIAN (kWh)	TOTAL DEMAND (kWh)
NON-TRADING	3.2	21.2	7.3	7.0	2072.0
PREP	3.9	23.8	11.6	10.6	1398.4
TRADING	4.5	25.3	15.1	15.0	4783.0

Table 1: Trading Category wise consumption

Metering Configuration

Meter mains show the overall consumption of the site, as depicted in Figure 2. OAK installed tech to measure all three phases of meter mains. From the mains, the metering is divided into two parts through distribution boards into Sub-Mains 1 and Sub-mains 2. Sub-Mains 1 is responsible for all asset electricity consumption except air-conditioning systems (ACs). Sub-Mains 2 measures all the ACs in the property.

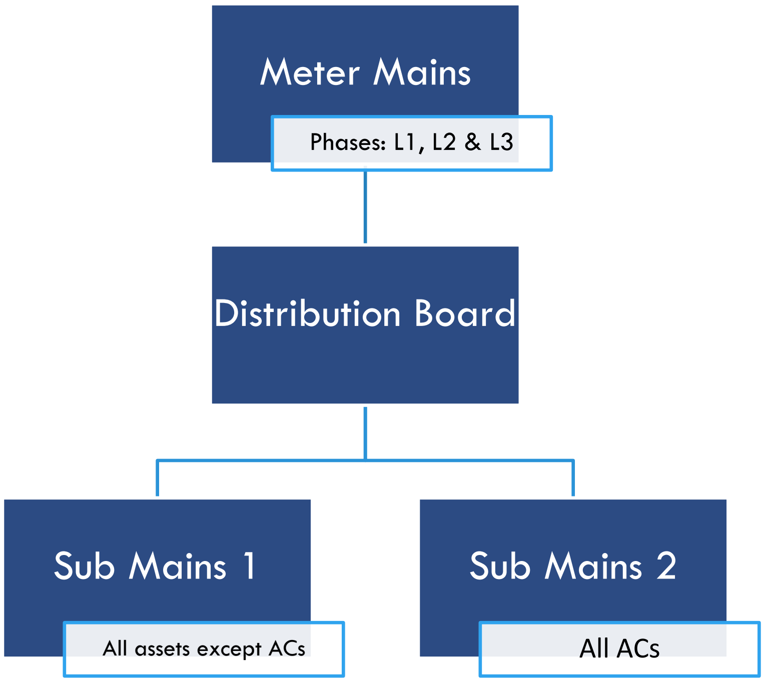


Figure 2 : Meter Configuration

The assets shown in Table 2 are connected to the following Sub Main phases:

Sub Mains L1	Sub Mains L2	Sub Mains L3
• New sockets waiter station • Refrigerator #12 • Ice Machine #1 • Refrigerator #4 • Refrigerator #1 • Microwave • Right-hand till • Ice Machine #2 • Refrigerator #2 • Refrigerator #3 • Refrigerator #9 • VIP Bar Lights and Till	• Main Bar & Kitchen Lights • VIP Room Lights • Sockets under CCTV • Toilet Extraction Fans • VIP seating lights • Kitchen extraction fan • Refrigerator #13	• Front bar sockets (lights under bar) • Refrigerator #11 • Refrigerator #10 • Left hand bar till • Freezer #1 • Office/stock room lights and internet • Water boiler(assumption)

Table 2 : Phase wise asset distribution

Insights

When OAK analysed the energy data for LCC-Oxford Circus, we identified a number of impactful insights that will help LCC management to reduce their annual carbon footprint by **5 tonnes of CO_2** and unlock the savings potential for **£2,770** in a year – equivalent to almost 2 months of free energy.

1. Equipment-level monitoring and analysis for Air Conditioning (AC)

Air conditioning is the biggest consumer of energy at LCC Oxford Circus. It consumes no less than 40-50% of yearly consumption but was being ignored at most of LCC's sites.

OAK installed separate energy meters for ACs to collect granular data. This helped LCC to better understand their ACs' consumption rates. For example, Figure 3 shows that AC1 uses the most power in the most amount of time; AC2 uses the least amount of peak power; and AC3 has the highest peak power demand.

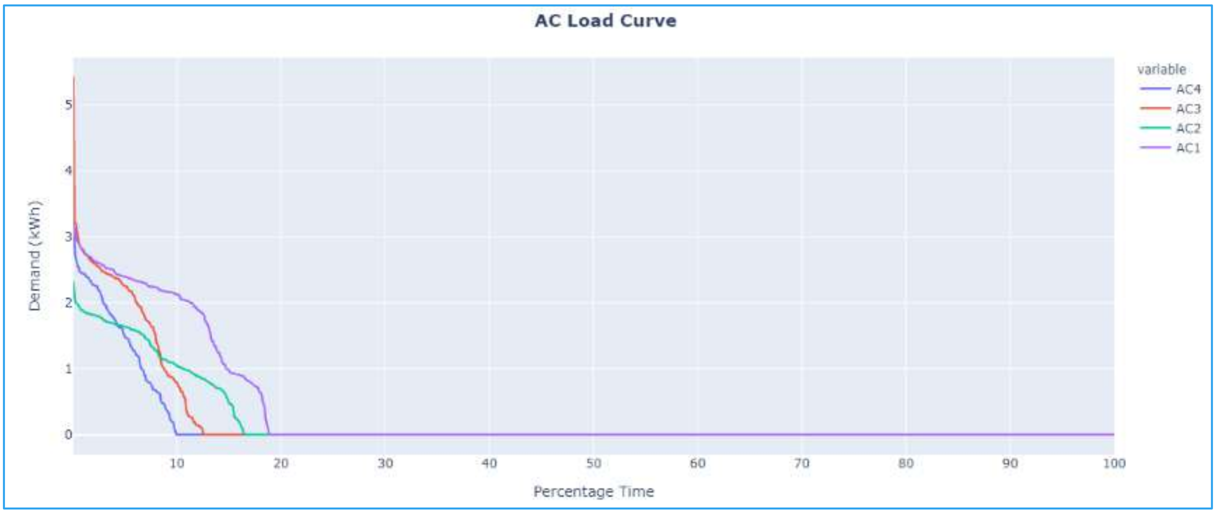


Figure 3 : AC Load Duration Curve

OAK delivered multiple key insights:

1. ***Energy Wastage**: ACs were consuming energy at a higher rate than expected, even in non-trading periods.*
   Human interventions always cause lower efficiencies, and it was identified that after the closing the bar, the ACs were still consuming energy at the same high rate as when the bar was at peak trading time. OAK's monitoring energy management system helped LCC identify all such cases in near real-time and would help to achieve savings of **£200-400** per year on this issue alone.

2. ***Maintenance Alarm**: ACs were consuming higher energy than the rated power settings, even at low load times, indicating the need for maintenance.*
   Energy consumption data analysis enables well-informed management and operational decisions which can help save time and energy. Using this approach, OAK has developed an energy efficiency monitoring service that acts as a management and alerting system. This resource allowed LCC to understand the health of its ACs and get an alert-trigger when to do maintenance which can be directly addressed by a

technician. We identified potential savings of **£400-600** through proper maintenance of ACs onsite.

3. ***High Power Fluctuation**s:*** *The AC data highlighted an issue with a return-air temperature sensor which was resulting in excess consumption.*
   Sudden rise or fall in power consumption of AC is usually connected with the malfunctioning of return air temperature sensor. AC works on PID logic which is governed through the input of return air temperature and setpoint of the AC, in case of any issue with return air sensor the AC switches ON OFF resulting in higher energy consumption and degradation of the health of AC.

4. ***Inadequate use of AC**s: Ambient*** *air could be leveraged for space cooling/heating by altering the set point of the ACs.*
   It is common knowledge that ambient air temperature can be leveraged to save energy consumed by ACs, but this is challenging in practice. OAK combines data insights with expertise to show when the ambient temperature can be used to support optimal cooling-heating by the AC system (by changing the set-point of the AC).

*** the actual savings can be calculated after installing internal temperature and humidity sensors.*
ILLUSTRATION: *In the case of the below consumption pattern, the AC Setpoint could be increased to 26 C. Simultaneously, part of ambient air could be used for cooling, resulting in a reduction in energy consumption of 10-20%.*

Datetime	AC setpoint	Temperature	Ambient Temperature	Energy Consumption
05/09/21 17:35	24	24.5	22.3	5.2
05/09/21 17:40	24	24.5	22.4	5.2
05/09/21 17:45	24	24.43	22.4	5.3
05/09/21 17:50	24	24.4	22.4	5.33
05/09/21 17:55	24	24.32	22.4	5.37
05/09/21 18:00	24	24.31	22.4	5.4
05/09/21 18:05	24	24.2	22.4	5.48

2. In-house alerting system

Whenever there is a significant change in consumption, the site operator can be notified and made aware of the opportune time to act so that improvements can be made faster.

OAK's energy efficiency "Alert" system informs LCC when demand deviates from the optimised consumption pattern (calculated from several weeks of analysis). OAK tailored the service in line with business needs, ensuring the Alerts only nudge when required.

Figure 4: Alert Generation Graph

By enabling prompt decisions onsite, optimal energy consumption is more likely to be maintained. This can also result in reduced maintenance costs through early identification of deterioration of equipment health which keeps a check on equipment failure. This can add up to potential savings of **£100-300** per year. Here, data insight and direct intervention options give operators more responsibility for effective energy improvements, encouraging a 'behavioural' approach to change. Once they learn that they can make a difference, they will be vigilant to support change.

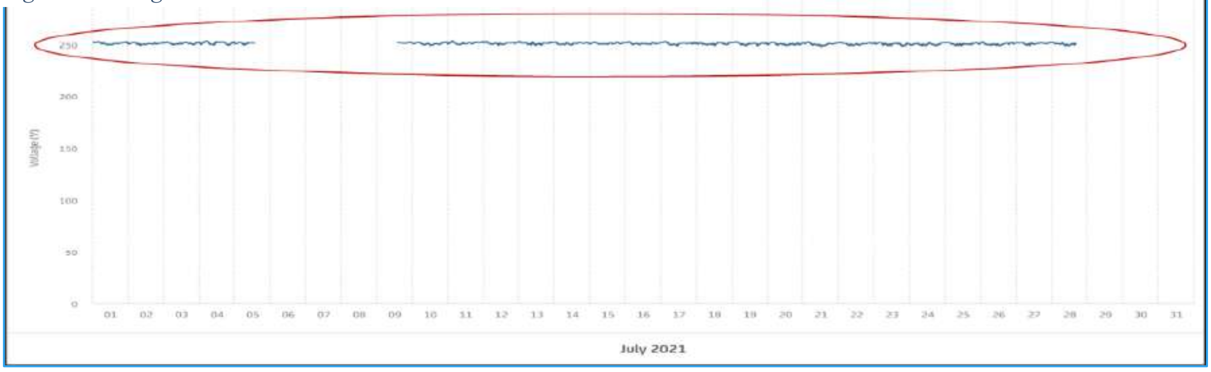
3. Voltage optimisation

Voltage was operating outside the normal expected range of variation, resulting in higher-than-necessary power consumption and higher bills.

OAK regularly monitors not only energy consumption but also other parameters such as Voltage, Power Factor and Reactive Power. Since OAK can conduct in-depth analysis on power performance, we observed that voltage was operating above 250V for the entire period of analysis. The normal range of variation is between 220-240V.

By installing a Voltage Optimiser, voltage can be optimised at ~230V. This can deliver at least 10-20% of overall energy consumption, which results in **£1,850 - 3,700** potential net savings per year.

Figure 5: Voltage variation



4. Phase-wise analysis of energy consumption

Energy profile analysis revealed which electrical phases require the most attention for maximum savings.

OAK dived deeper into the Oxford Circus energy profile and identified the primary area for improvement based on the 80:20 'Pareto Rule' (80% of the consequences come from 20% of the causes).

After analysing the data, it was evident that the **Main_L1** (Phase 1 of Meter Mains) & **Main_L3** (Phase 3 of Meter Mains) phases of the site were the main consumption phases which need special attention (shown by the 'mean' in Figure 6).

	Main_L1	Main_L2	Main_L3	Sub_Mains1 L1	Sub_Mains1 L2	Sub_Mains1 L3	AC2	AC3	AC4	AC_Total	Sub_Mains	Main_Total
count	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000	1032.000
mean	4.308	1.725	4.003	2.630	1.080	2.984	0.090	0.070	0.024	0.329	6.694	10.036
std	2.672	1.007	3.050	1.499	0.602	2.507	0.341	0.342	0.152	1.150	4.190	6.267
min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25%	2.220	1.038	1.718	1.708	0.821	0.408	0.000	0.000	0.000	0.000	4.408	5.547
50%	3.770	1.480	3.455	3.340	1.245	2.610	0.000	0.000	0.000	0.000	6.795	8.495
75%	6.482	2.520	6.543	3.830	1.460	4.697	0.000	0.000	0.000	0.000	9.832	14.710
max	11.300	3.790	11.560	5.380	2.460	7.530	2.310	5.420	2.900	10.560	13.960	25.340

Figure 6 : General Statistics of phases

5. Abnormal patterns of change in energy consumption

Energy consumption was found to be abnormally high during non-trading hours, prompting an in-house investigation to identify the offending assets.

OAK's analysis provides an eagle-eyed view of any anomalies occurring onsite. Typically, the energy consumption during non-trading hours should be less, however, Sub_Main_L1 was consuming similar energy during non-trading hours and trading hours (Figure 7), whilst the pattern was different for other phases. When this was raised with LCC, they found that an ice freezer and oven was left switched on, resulting in the same level of energy consumption during trading and non-trading hours.

Figure 7: Demand Pattern

6. Pre-emptive interventions

Energy data analysis revealed details of when footfall was higher, providing unique customer-facing insights that can be used to manage energy demand accordingly.

It is always helpful if a business can predict client footfalls so that it can manage resources better and provide the best user experience. A Heatmap-Analysis of energy consumption at hourly levels across weekdays (Figure 8) showed that more energy is consumed during Saturdays and Fridays between **10 pm to 12 am**. Hence the question arose: Is the bar more crowded during weekends?

To answer this, OAK web-scraped onsite-related google-data to understand the flow of the customer into the bar and develop a predictive model that informs LCC when to prepare for crowding and at what time of day, providing potential win-wins for customers and the business.

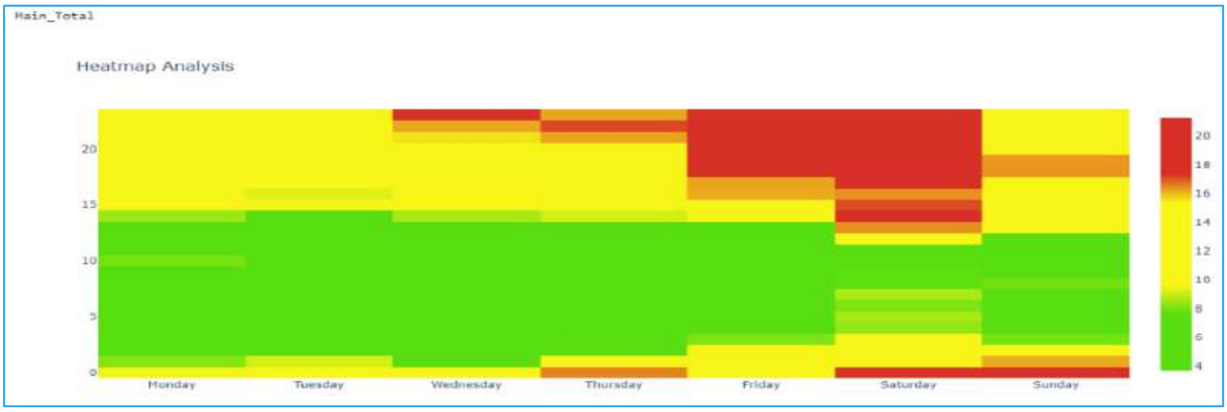


Figure 8: Heatmap showing consumption during hour of the day and weekday

7. Power Factor analysis

LCC's Power Factor varied outside the optimal range at certain times, meaning more energy was being consumed than necessary.

Power Factor (PF) is the ratio of 'true power' used in a circuit to the 'apparent power' delivered to the circuit. The regular PF of a well-managed and efficient site should be around 0.95 to 1 (in other words, 95-100% efficient). When the power factor is lower, it means more energy is needed to run the same machine.

By analysing loads and power distribution OAK is able to improve LCC's PF, which would deliver hidden savings. In this example (Figure 9), an AC system was using more power than it was delivering an efficient cooling system.

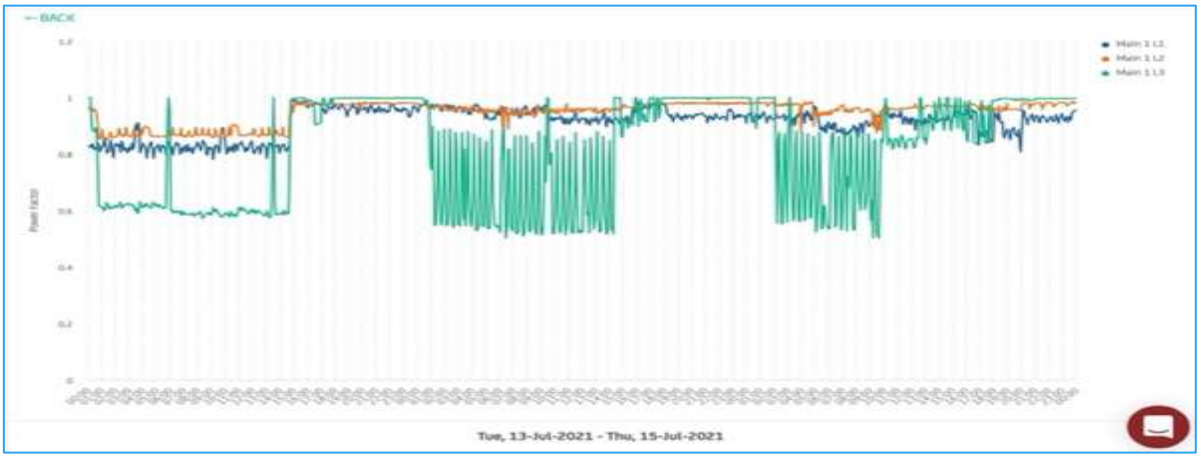


Figure 9 : Variation of Power Factor

8. Predictive ML

Predicting energy demand using Machine Learning allows LCC to accurately forecast consumption, helping them to budget and inform other business improvements in advance.

Businesses need a forward-looking view to manage cash flow and plan interventions for growth. OAK's advanced **Machine Learning (ML) energy model** predicts costs for the near-future (week, month, quarter) that helps in budgeting and calculation of input-cost for the business.

OAK's Recurrent Neural Network (RNN) model considers various attributes such as temperature, humidity, trading category and weekday effects. It successfully forecasts consumption with an accuracy of ~90%+ (Figure 10), allowing LCC to budget and inform other plans. Combined with OAK's alerting system, this predictive engine can provide real-time updates before breaching maximum demand, preventing penalty charges. It can also be very valuable for customers looking to switch to solar or battery solutions, because they can install and optimise solutions according to the predictions made by OAK's model.

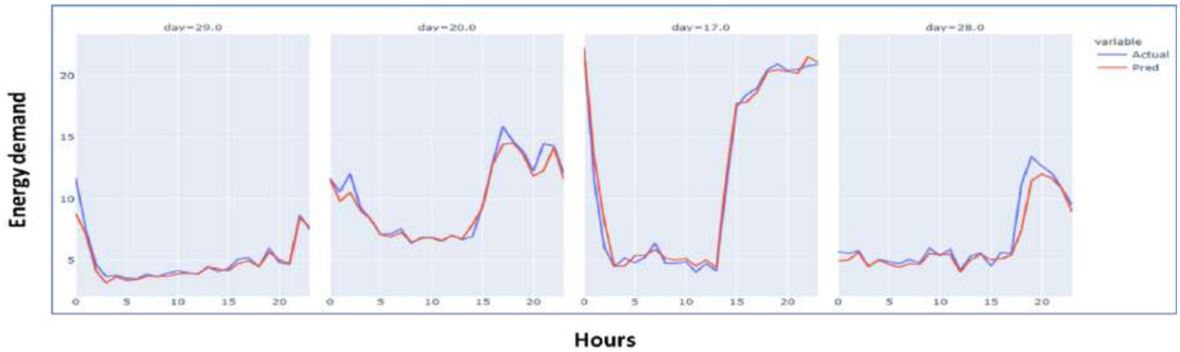


Figure 10 : Prediction vs. Actual

9. Safety first

Tracking aggregated consumption reduces the risk of overloading electricity supply, improving safety and reducing operating hazards.

OAK not only focused on energy efficiency and savings but also on making operations safer for all. Studying energy load leads to better insights into load distribution across the Phase lines, helping to adhere to safety regulations. Failing to do so may result in overloading an existing electrical source – impacting electrical safety and causing operating hazards.

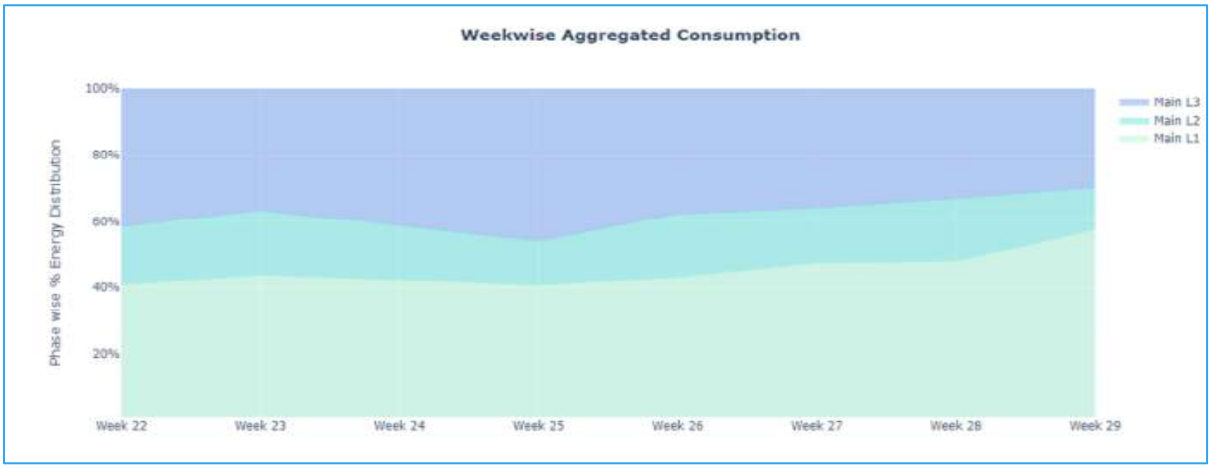


Figure 11 : Phase wise Load Analysis

Conclusion

The 9 powerful insights identified by OAK has identified at least **£2,770** in potential savings over an operational year at just one site, as well as making the site more carbon efficient by reducing its carbon footprint by **5,770 $KgCO_2$**. Extrapolating these savings across LCC's entire portfolio would yield significant savings and make an important step towards net zero emissions.

Service	Potential Savings (Approx.)	CO_2 Footprint ($KgCO_2$)
HVAC Operation optimization	£240	500
HVAC Maintenance	£480	1,000
Automated Alerts	£200	416
Voltage Optimizer*	£1,850	3,854
Total	**£2,770**	**5,770**
*Investment of voltage optimiser required .		

Table 3 : Potential Savings

On average, a UK home emits 777 kg of CO_2 a year through electricity consumption. Implementing the identified measures would therefore offset the carbon footprint of approximately **7 homes** per year. The corporate carbon footprint saved across multiple sites would make a significant contribution towards climate change improvement requirements.

Supporting statement

In the context of decarbonisation, increasing electricity costs and the digitalisation of energy services, there is a strong motivation for UK businesses to be encouraged to raise their energy awareness, so they can be economically competitive, contribute to national climate targets and benefit from these new technology innovations. Those companies who embrace energy intelligence will be better informed and thus prepared to withstanding energy and carbon uncertainties that come about from climate change legislation and policies.

As shown by overseeing the LCC Oxford Circus case study, the range of OAK"s energy services being offered in their analytics platform provide quick and cost-effective insights to consumers on how they use energy. Although OAK is just developing its capabilities, the case study highlights some strong virtues that could be listed as:

1. Visualise, analyse, and benchmark data at different levels of granularity, e.g., time resolution
2. Sub-metering capabilities beyond industry standards by considering power quality metrics for each phase and specific equipment
3. All metered assets are properly documented to help identify and characterise efficient and inefficient energy use periods
4. Analysis of performance for different trading conditions enables the implementation of "smart" algorithms to notify clients of energy malpractice
5. These metering capabilities and advanced analytics allow OAK to provide indisputable facts so customers can take action and bring down costs and emissions

Businesses who want to take control of their utility costs and carbon emissions can rely on OAK's services to inform their strategy and start making a difference in their organisations.

Sincerely,
Dr Salvador Acha
Energy and Sustainability Expert at ICON