VisNet Hub Case Studies

This document shares practical examples of insights provided by monitoring the low voltage network. The data collected for these case studies was obtained by EA Technology's VisNet Hub.

ea technology

Contents

Using VisNet® Hubs to detect Distributed Energy Resources

Background

The transition to a low carbon economy is a prominent goal for many modern day societies, and marks a new age for the energy industry. As such, the widespread uptake of distributed energy resources (DER) has continuously grown over recent years with no signs of stopping. Typically, we are seeing the following types of DER being installed on low voltage (LV) networks:

- Photovoltaics (PV)
- Electric Vehicles
- Batteries

Whilst these technologies represent a welcome change, embedded generating technologies, such as domestic PV, introduces reverse power flow, which is important for network planners and asset managers to be aware of.

EA Technology have developed the VisNet Hub monitoring platform, which provides measurements and insights into LV distribution systems. The VisNet hardware is complemented by a software package, enabling network operators to manage their LV networks in real-time. Alarms, historical data and the dynamic status of equipment for the entire LV network can be managed from one web application.

In this case study, we show how the VisNet Hub can be used to provide visibility of electrical networks by detecting the impact that PV has on power flow at substations.

Our Approach

Traditionally, power flows from transformers to consumers. However, on networks with a high number of PVs, power can flow from the network to transformers; this is referred to as reverse power flow. The graph on the right demonstrates this behaviour. During the day time, when the PVs are generating power, the power taken by the circuit is negative. Whereas at night, when PVs are inactive, the power flow returns to positive values.

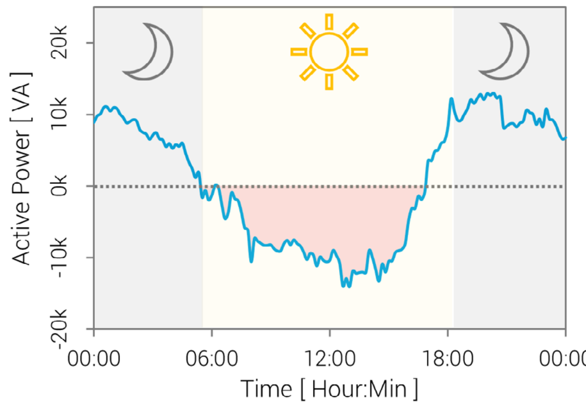
The number of PVs connected to LV networks is not always known by network operators, however identifying and characterising reverse power flow is a clear indication of significant PV penetration. This is useful for a number of reasons. For instance, when design engineers are looking to install new connections on the network, there may appear to be plenty of headroom on the substation for more load. This is misleading if there is undetected PV on the network, and the substation would possibly be at risk of overloading when the PVs are not generating power, in particular in the colder months with shorter daylight hours.

Photovoltaics on a residential property

Asset managers, or asset owners, should also be interested in this information. Understanding what is connected to LV networks provides better insights into asset health projections.

Client Benefits

Visibility of the LV network is an essential commodity for network operators to have in order to appropriately prepare for increased DER penetration. Monitoring substation data and understanding behaviours and trends provides insights into what is connected to networks. This further provides insights for both network designers and asset owners.



Reverse power flow behaviour demonstrated by a substation circuit with a high number of PVs

Using VisNet® Hubs to monitor how energy usage has changed during Covid-19

Background

2020 will go down in history as the year that brought us Covid-19. The global pandemic has had a dramatic effect on day-to-day life, impacting us personally and professionally. By extension, Covid-19 has changed how we, as a society, use electricity.

In particular, social lockdowns dramatically change where we consume electricity. With millions of people working from home, low voltage (LV) networks - the network that connects us to the grid - is operating in a different pattern than ever before. In the UK, we have VisNet Hubs across a number of LV network substations that have been monitoring LV substation data during this unique time.

The VisNet Hub monitoring platform provides measurements and insights into LV distribution systems. The VisNet hardware is complemented by a software package, enabling network operators to manage their LV networks in real-time. Alarms, historical data, and the dynamic status of equipment for the entire LV network can be managed from one web application.

This case study shares some of our observations, providing insights into how Covid-19 has affected electricity usage on UK LV networks.

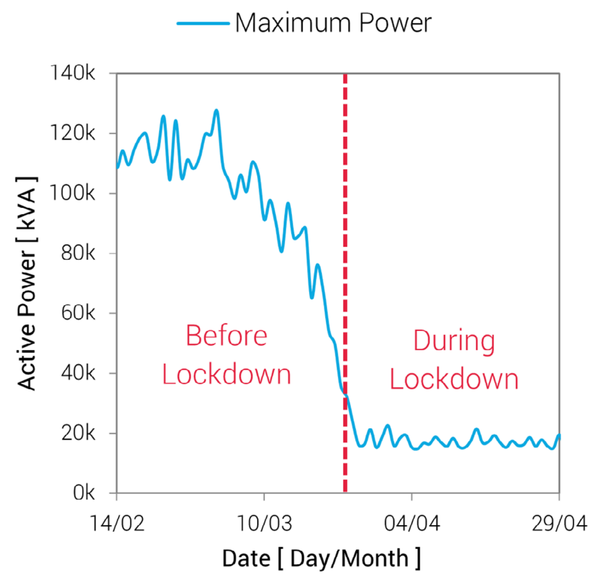


Figure 1: Substation data supplying commercial properties. The red line indicates the start of the UK lockdown.

Observations

As working from home has become the new normal for many during the lockdown periods, we have observed a dramatic shift in power demand when comparing LV substations supplying mainly domestic and those supplying commercial properties.

Figure 1 displays the power flow for a substation supplying mostly commercial users from February to May 2020. As highlighted on the graph, when the UK first announced a country-wide lockdown on March 23rd, the power demand of the substation dropped by approximately 80%. With shops closed, the power consumed by those properties is reduced to a minimum.

In contrast, figure 2 displays similar data, but for a substation supplying mainly domestic customers with a high number of embedded photovoltaic (PV) devices. During daylight hours, the power generated by the PV is greater than that consumed by users. We therefore witness reverse power flow, which is where the power flows from the houses back to the substation; this is shown as negative power on the graph and is typical for circuits with a high volume of PV installed. Again, we observe a near-overnight change in energy consumption as lockdown is introduced.

Interestingly in this example, the peak energy demand does not noticeably increase. This makes sense, as residents are not using more energy at peak times: they are simply using energy at home when we previously would not (during working hours). The demand introduced from home working uses the excess energy generated by the embedded PV, that peaks during daylight/working hours. This is measurable by observing the minimum power levels before and after lockdown is announced. Minimum power flow levels increase by approximately 35% on average.

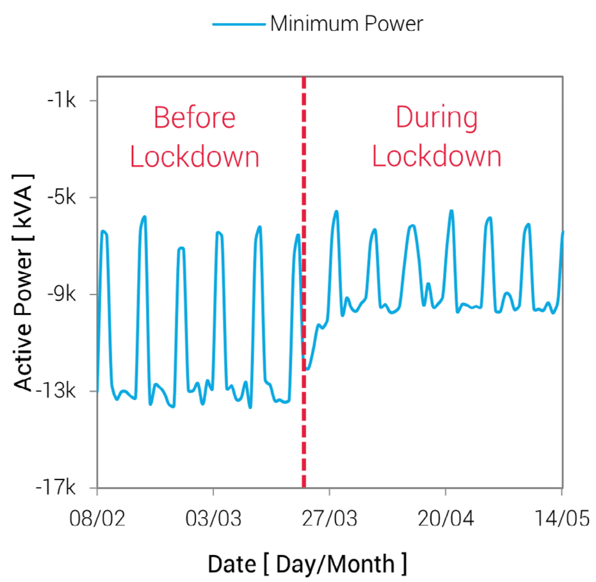


Figure 2: Substation data supplying residential properties with a high number of embedded photovoltaic devices. The red line indicates the start of the UK lockdown.

Insights

Covid-19 is the embodiment of unforeseeable challenges to the electricity network. Emerging suddenly, the global pandemic has had a dramatic and lasting effect on our lives. It demonstrates how little control we have over unknown and unlikely challenges that lay ahead. Network monitoring enables us to track, quantify and understand the impact of such challenges. This allows us to act when needed, ensuring a robust LV network, fit for the future.

VisNet Hub will provide LV network operators the visibility required to manage these ever-changing circumstances we find ourselves in. If you would like to know more about the VisNet Hub and its many capabilities, please click here.

Using VisNet® Hubs to identify and locate large unusual loads on LV networks

Background

Most people don't give low voltage (LV) networks a second thought until they lose supply. There are even some schools of thought that believe nothing really happens on LV networks, and as such they are deemed to be boring. This is not the case. The introduction of monitoring devices provides a window into the world of LV networks. We have observed a myriad of network events and phenomena occurring on a day-to-day basis that we can now detect and visualise. This ultimately provides us with a much better understanding of these networks, which is crucial moving forward as LV networks take on more responsibility in the form of:

- Embedded generation (domestic photovoltaics)
- Electric vehicle charging
- Heat pumps
- Energy storage

EA Technology have developed the VisNet Hub monitoring platform, which provides measurements and insights into LV distribution systems. The VisNet hardware is complemented by a software package, enabling network operators to manage their LV networks in real-time. Alarms, historical data, and the dynamic status of equipment for the entire LV network can be managed from one web application. In this case study, we show how the VisNet Hub can be used to provide visibility of electrical networks by detecting unusual loads at substations.

Our Approach

During a routine substation inspection, it was noticed that regular fluctuations were occurring on the transformer load ammeters. In fact, the needles of these ammeters were described as "bouncing every 10 seconds or so", which piqued the interest of the substation inspector. As a result, a VisNet Hub was installed to ascertain which feeder was experiencing the load fluctuations and to hopefully discover the route cause.

There were a number of concerns expressed, not least that there were vulnerable customers fed from this substation. In addition, there was also concern about tired LV fuses leading to reduced network resilience and ultimately loss of supply to customers. There were a range of different customers connected to this substation, including a small industrial estate, a large scrapyard with heavy machinery and a domestic housing estate.

Once installed, the VisNet Hub was able to continually monitor network data, and by configuring the waveform capture settings, we were able to automatically measure the number of irregular current events; this is graphed in Figure 1.

Within 48 hours, several hundred abnormal waveforms had been captured linked to phases L1 & L2 on network feeder No.4. Phase L3 represents nominal current values for that network for comparison. From analysis, the waveforms were being captured every 10 seconds (on average) and the peak load drawn was in excess 900 A, but only for very short durations (less than 1 second). These events occurred exclusively during the working week, with no activity over the weekend. With these insights at hand, we could deduce that the source of disturbance was either the scrapyard, or one of the companies on the small industrial estate which were fed of the same circuit.

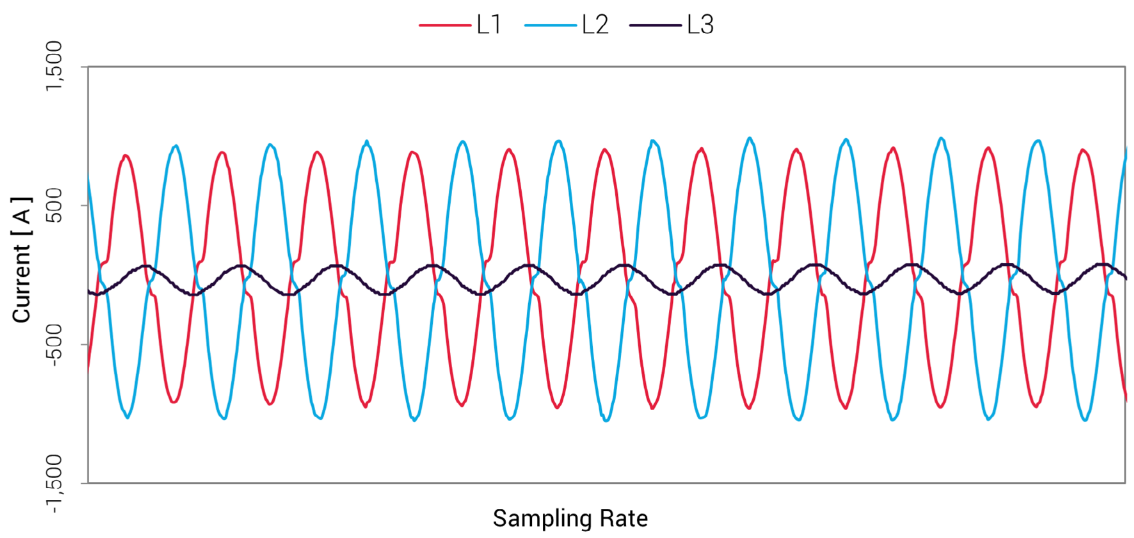


Figure 1: The current waveform of feeder 4 captured by VisNet. The "L" labels denote the feeder phase measured.

By a process of elimination and discussion with the relevant parties, we discovered that a small metal container manufacturer was the cause of the 2-phase unusual load on the network. The manufacturer was using a spot welding machine for attaching the metal handles onto the metal container lids, as shown in Figure 2.

Although no fuses had blown, the network is being continuously monitored and has been put on a watch list to check for tired fuses. In addition, a fuse-blow application has also been deployed to detect and notify of any fuse operation.

Client Benefits

Drilling down into the data provided by the VisNet Hub can bring important insights with valuable benefits, as outlined in this case study. Visibility of the LV network, coupled with the expertise of industry experts, provides actionable insights that enable network operators to respond appropriately and promptly to network issues.

The VisNet Hub will provide LV network operators the visibility required to manage and understand situations like these. If you would like to know more about the VisNet Hub and its many capabilities, please click here.

Figure 2: A spot welding machine used to weld handles on to metal lids

Using VisNet® Hubs to investigate power quality issues

Background

Our everyday lives are dominated by a broad range of electronic devices, each of which requires a steady source of power to reliably operate. Power quality refers to the characteristics of this electrical power. Modern day electricity distribution systems, that directly supply homes and industries, are run with currents/voltages at a nominal magnitude, frequency and in a clean sinusoidal waveform. Any unwanted irregularity of these three characteristics is considered a power quality issue.

Poor power quality can affect and damage commercial and domestic electronics, leading to frustrations for customers and penalties for network operators. Such issues have many causes, from brutal acts of nature, to faulty network, to simply switching large loads on and off.

This case study shares an example of how VisNet Hubs can be used to investigate power quality issues. The VisNet Hub monitoring platform provides measurements and insights into low voltage (LV) distribution systems. The VisNet hardware is complemented by a software package, enabling network operators to manage their LV networks in real-time. Alarms, historical data, and the dynamic status of equipment for the entire LV network can

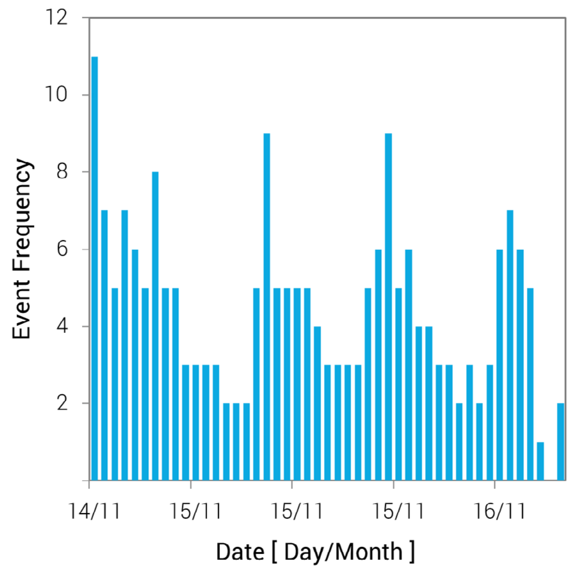


Figure 1: The frequency of irregular current events captured by the VisNet Hub.

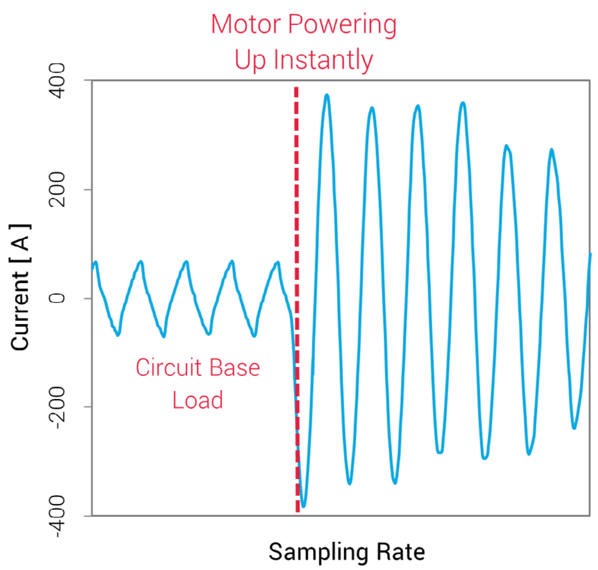


Figure 2: The network current before and after the motor powered up with a direct on-line setting (instantly). This waveform coincided with the events shown in Figure 1.

be managed from one web application.

Our Approach

In this example, a major network operator was contacted with a complaint by one of their vulnerable customers. Over several weeks they experienced dimming lights on a regular basis. This was affecting the wellbeing of the customer, as they spent most of their day at home due to illness.

Traditional power quality monitoring equipment was installed but discovered no evidence that power quality standards had been breached. Further to this, the network was reconfigured to remove a large local commercial plant off supply; this again failed to resolve the issue. VisNets were then installed to assess the situation.

Once installed, the VisNet hub was able to continually monitor network data, and by configuring the waveform capture settings, we were able to automatically measure the number of irregular current events; this is graphed in Figure 1.

By examining the data, we were able to determine that the incident affecting the network occurred routinely (approximately 5 times an hour on average). We also learned that this was a three-phase issue. By inspecting the current waveform (shown in figure 2), we found that the events coincided with an inrush of current (typically five times nominal values), which is commonly associated with the start-up of large machines. From Figure 1, we can also see that the peak current values steadily decrease with time. This is characteristic of a motor powering-up and then reaching steady state.

With these insights at hand, the team took a closer look at the cable records and identified a previously overlooked water pumping station connect to the LV network. The network operator, with help from EA Technology, was then able to identify and locate the water utility to carry out repairs within 24 hours. We found that the issue originated from a pump motor powering up. The "soft start" mechanism designed to limit the start-up current had failed to operate correctly and instead reverted to direct on-line starting; this was causing a large start-up current to be drawn leading to the dimming of lights.

With the VisNet installed, we can continuously monitor the pumping station to ensure that current bursts are within tolerable limits. Figure 3 shows the current waveform after repairs had taken place. As you can see, the peak currents reached are less than previously recorded with no detrimental effects on domestic lighting.

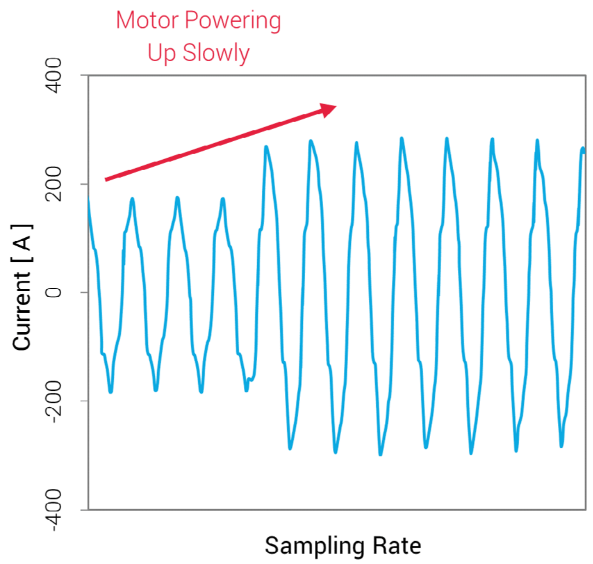


Figure 3: The network current before and after the motor powered up with a soft start setting (slowly).

Client Benefits

Visibility of the LV network, coupled with the expertise of industry experts, provides actionable insights that enable network operators to respond appropriately and promptly to network issues.

The VisNet Hub will provide LV network operators the visibility required to manage situations like these. If you would like to know more about the VisNet Hub and its many capabilities, please click here.

Using VisNet® Hubs to locate LV faults

Background

The energy sector is currently undergoing era-defining challenges with decentralisation and decarbonisation movements. Electricity is quickly becoming the fuel for not only our household appliances, but also our transport too. Consequently, the low voltage (LV) network that connects us to the grid has more responsibility than ever before. Ensuring a robust LV network has therefore never been more important.

LV networks are ubiquitous in modern life, spanning through most roads and pavements wherever electricity is required. Such an expansive system of assets is inherently susceptible to a range of faults, originating from environmental damages, to aging equipment. Such faults can lead to customers going off supply and network operators incurring regulatory penalties, notwithstanding the cost of finding and fixing the fault to restore supplies.

This case study outlines how VisNet Hubs can be used to locate faults on the LV network, which leads to shorter repair times and ultimately outlines the importance of network monitoring.

EA Technology have developed the VisNet Hub monitoring platform, which provides measurements and insights into LV distribution systems. The VisNet hardware is complemented by a software package, enabling network operators to visualise and manage their LV networks in real-time. Alarms, historical data, and the dynamic status of equipment for the entire LV network can be managed from one web application.

Our Approach

Network operators have historically dealt with faults by reacting to off supply customer calls. Once they know customers are off supply, depending on the severity of the fault, it can take many hours to find and fix. VisNet Hubs offer a modern solution to this perpetual problem by using network data to pinpoint the location of faulty assets, thereby aiding the engineers to locate the fault more expediently.

Once installed at LV substations, VisNet Hubs collect a range of network data. When a fault occurs on the network, unique events are automatically detected by the VisNets; these events are in the form of fault waveforms. With knowledge that a fault has occurred, and a fault waveform has been generated, this can be used to determine where on a cable circuit the fault is located.

An example of predicted and measured fault location

The network cable records provide the geometry, length, and type of LV cables, enabling us to map an impedance-to-fault measurement directly on to the records. The result of which estimates how far the fault is down the cable. By comparing this length to the geometry of the cable, we can estimate the location of the fault; this is demonstrated in the figure above.

With the fault located on paper, the last piece of the puzzle is for a network engineer to act. An experienced fault engineer on the ground can use the information to its full potential and locate the fault in a much shorter time period.

Client Benefits

In this case study we have demonstrated how VisNet Hubs can locate faults on the LV network, leading to faster repair times. However, this process would not be possible without accurate LV cable records and experienced fault engineers in the field.

Moving forward, reducing fault repair times has never been so important as the LV network continues to power our homes, businesses and is now being asked to support a whole range of distributed energy resources being connected, such as photovoltaics and electric vehicles etc.

VisNet Hub will provide LV network operators the visibility required to get the lights back more quickly in times of fault. If you would like to know more about the VisNet Hub and its many capabilities, please click here.

Global Footprint

At EA Technology we specialise in asset management solutions for owners and operators of power network assets.

Founded in 1966 we have over 50 years' experience in the industry and 6 regional offices around the world to support our global customer base.

We work with a lot of our clients on a long-term basis to help them safeguard their power networks.

We advise our clients on strategy and implementation of a range of technology solutions to manage power assets, delivering maximum life and minimise cost.

ea technology

Safer, Stronger, Smarter Networks

EA Technology Pty Ltd
381 MacArthur Avenue
Hamilton QLD 4007
Australia

t +61 (0) 7 3256 0534
e au.sales@eatechnology.com
www.eatechnology.com/australia