Report to the head teacher's study!

It's all very well to write about what portable energy loggers (PELs) can do and the sort of benefits they might provide but how do things work out in a real application? To answer that question, an 11-day energy monitoring exercise was carried out at a secondary school in Kent. **Julian Grant** of **Chauvin Arnoux** discusses the results.

Tight budgets that always seem to be getting tighter are a way of life for almost every organisation and business, but arguably schools have some of the tightest budgets of all. It's vital, therefore, that they squeeze the maximum possible value out of every pound they spend and, as energy bills make up a significant proportion of that expenditure, it's clear that energy efficiency is a major concern.

With this in mind, a secondary school with 700 pupils was offered a period of energy monitoring with the objective of identifying areas where efficiency could be improved, and savings could be made. The school governors responded enthusiastically, and arrangements were made to install a Chauvin Arnoux PEL103 portable energy logger at the school's main incomer.

This innovative instrument uses flexible current transformers and clamp-on connections, and has a magnetic base for rapid mounting, which meant that it could be installed quickly and easily with a minimum of disruption. It was left in place for eleven days, thereby capturing comprehensive data for school days and for weekends.

The results were both interesting and useful. One of the first things noted was that there was a substantial imbalance of phase currents, as can be seen in Figure 1.

The peak current on one phase was 219.2 A, compared with 172.8 A on the second phase and 150.3 A on the third. This clearly shows that the loads in the school, most of which are single-phase, are badly distributed across the phases. This is undesirable as imbalance increases the current in the neutral conductor and can result in excessive heating. Current imbalance can also lead to local voltage imbalance at various points in the installation, which may affect the efficient operation of three-phase loads like motors.

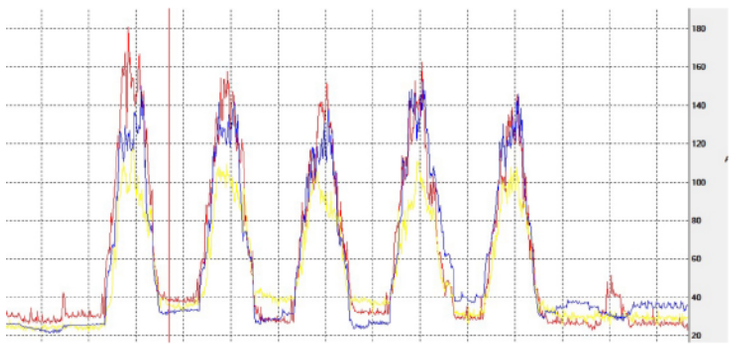

Figure 1: Phase currents over the monitoring period

Also notable was the high level of harmonics in the supply system. As Figure 2 shows, the third and fifth harmonics were particularly high. Given the growing numbers of 'electronic' loads in today's schools this is not surprising: personal computers, office equipment and LED lighting tend to introduce third harmonics, while uninterruptible power supplies (UPSs) and servers are a common source of fifth harmonics. Nevertheless, the harmonics are potentially problematic as, once again, they can lead to unexpected heating in neutral conductors, and can also cause electronic equipment to malfunction.

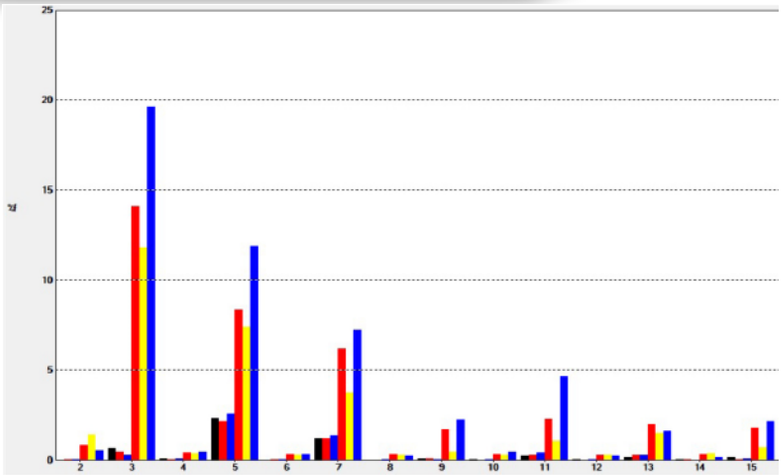

Figure 2: Harmonic levels

By far the most startling revelation from the monitoring results, however, can be seen by referring again to Figure 1. As would be expected, this shows that the peak current is drawn from the supply during the day on weekdays when the school is occupied. However, the results also show that in the evenings and at the weekends, when the school is closed, a current of around 30 A per phase is still being drawn. While some of this probably relates to things like emergency lighting and is therefore unavoidable, the overall figure was unexpectedly high.

In fact, the school investigated this out-of-hours consumption and found that the portable electric space heaters, which were being used to supplement the poorly performing HVAC system in part of the school, were often being left on during the night and at the weekend. This is a perfect example of a quick energy saving fix at zero cost since all that was necessary was to ask the teachers to be more diligent in switching the heaters off at the end of the day!

One final parameter that was carefully evaluated during the monitoring period was power factor, but this was found to be good at all times, with little opportunity for further improvement. This was probably because the school had few inductive loads, and those few were balanced out by capacitive loads such as LED lighting. In other applications and even in other schools this may not be the case, so careful attention should always be given to the power factor results when a monitoring exercise is carried out.

The power system monitoring exercise at the Kent school clearly identified some issues of concern but unfortunately, shortly after it was completed, the advent of the COVID pandemic meant that the governors and staff were beset by more pressing challenges which prevented immediate action on its results. Nevertheless, the exercise has produced some clear recommendations for the future, which should provide large benefits.

The first – turning off portable heaters out of hours – has already been implemented but this is only an interim solution. Longer term, larger energy savings will be achieved by upgrading the HVAC system so that heaters are not needed at all. There may also be other unnecessary out-of-hours loads, such as lighting and computers left on when not needed, and it would be worthwhile for the school to check on these and, for example, fit automatic lighting controls that respond to room occupancy, and time switches to turn off supplies to computers at the end of the day.

The high level of harmonics should certainly be addressed. It would be beneficial to identify the individual sources and, where necessary, fit filters. The result will be cleaner supplies, reduced cable heating and longer equipment life. Finally, it would definitely be worthwhile to look at redistributing the single-phase loads on the power system to provide better balance between phases. Again, this would reduce heating in neutral conductors, and help to ensure that any three-phase loads on the system operate efficiently.

Monitoring power quality and usage at the Kent school was an exercise which was easy and inexpensive to carry out, and which did not affect the normal operation of the school in any way. It did, however, provide results and insights that will allow the school to use electrical energy more efficiently and to reduce its energy bills. It can be confidently stated, therefore, that the answer to the question posed in the introduction about how useful portable energy loggers are in real applications is that they are very useful indeed!

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