Optimising the management of district heating – CHP systems

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Executive Summary

This work reports on an investigation of a Local Authority (LA) owned, 4.5MWth Combined Heat and Power (CHP) Network.

The study has examined the network at decreasing scales, starting at the generation level, then moving onto distribution, building and finally user level. During the assessment at the generation level, data which had been collected by the LA was reviewed to determine the management and output history over recent years.

Our findings showed that a significant reduction in electrical output had occurred and has not been fully rectified, which more than likely resulted in a loss of income to the LA.

Success Metrics

The CHP management strategies and the level of heat network optimisation were identified, using data that is theoretically available from all CHP-lead heat networks.

The data showed that due to 2 events, of which one was not quickly rectified, losses of income to the LA of over £18,500 are likely to have incurred.

About

The Combined Heat and Power (CHP) systems have become a popular choice for heating and electricity generation in the UK. CHP systems, often as part of a district heating network (Figure 1.1), are expected to bring economic and carbon saving benefits because of the on-site electricity generation. Poor design, sizing and management of the systems can however negate a large part if not all the benefits from their use.

This study is monitoring and reviewing the efficiency of a district heating-CHP system in a social housing site In Portsmouth, South of the UK. The heat network provides heat to over 500 residential dwellings within 8 housing blocks (~ 30,650m2 lettable floor).

Figure 1.1 Image of the two 2MW gas-fired boilers within the Energy Centre.

Approach

Local Authorities in the UK are under increasing pressure to reduce spending and prioritise staff workloads to core tasks due to cuts in government funding. As such, there is limited capacity for LA employees to regularly interrogate the data to look for anomalies or inconsistencies against historical data.

The network studied here has long been considered successful for heat delivery to residents due to the maintenance support provided by a Public–Sector Company (PSC). However, there are suspicions that network performance might not be as successful as initially has been thought.

Goals

The aim is to provide evidence based guidance to the Local Authority (LA) who owns the network as to the best management strategies and on the economics of the network.

How has this research helped?

Where it is not uncommon for management personnel to change, and hence historical knowledge of the evolution of heat network or CHP management strategies to be lost, this method of analysis can be used to better understand a heat network operational history. Furthermore, the method can be used to enable staff without an engineering or relevant background to understand how and why a CHP is run.

Results

The results (Figure 1.2) identify an issue before the end of September which prevented the CHP from operating appropriately. A CHP would not commonly be prevented from running during October through December. The Energy Centre Gas Use during this period shows an increase in demand, as would be expected in the UK, which is met through two gas boilers.

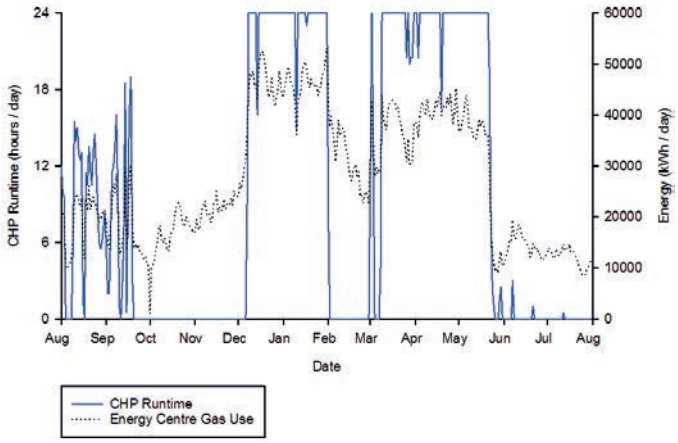

Figure 1.2. Daily gas use and CHP runtime for a year in the studied period.

The analysis shows that over the past 6 years there have been several management strategies deployed at the case study site. However, since 2011, there has been a clear evolution in the strategy, progressing from a year-round, 24-hour run strategy, to one which sees the CHP run on weekdays only, with limited run hours. This is difficult to explain as the electricity export to the grid is a source of income for the LA.

The 2014/15 heating season, appears to follow the same operational strategy as used for the 2 previous heating seasons, although the CHP run season is only until the 1st of April, 1.5 months shorter than 2013/14. The CHP is clearly supposed to run from the 1st of October, however it runs for only 3 hours and then is shut down until later in the month, and once re-started, the engine runs inconsistently until mid-December (Figure 1.3).

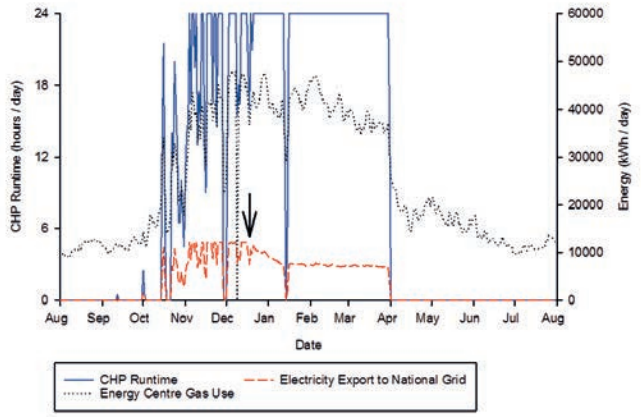

Figure 1.3. The electricity generation (red line) and the runtime (blue line) of the CHP. The arrow shows the event that led to the decrease in electricity generation.

From the time that the CHP runs constantly until it is shut off at the end of March, the electricity export to the national grid gradually decreases, while CHP runtime remains mostly consistent at 24 hours per day. Export to the grid shows a 34% reduction.

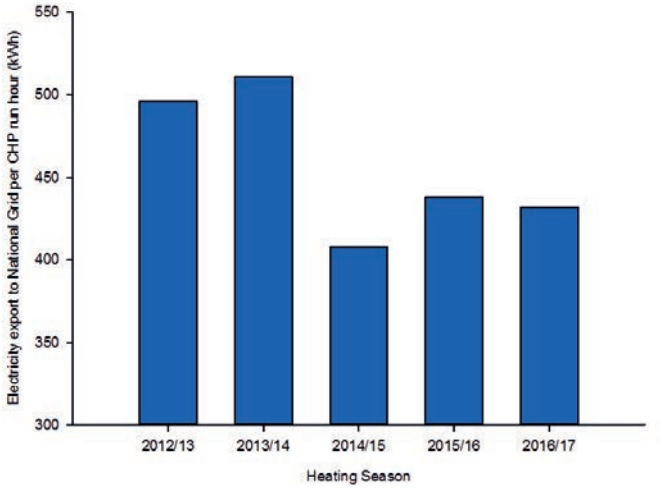

Figure 1.4. Average electricity export to grid per CHP run hour by heating season.

The electricity export to the national grid decreased significantly during the 2014/15 heating season, from which the network never appears to have recovered fully. The electricity required to operate the site is increasing on a yearly basis, which may be due only to aging mechanical plant but this would typically represent only around 1% of the reduction in grid export (Figure 1.5).

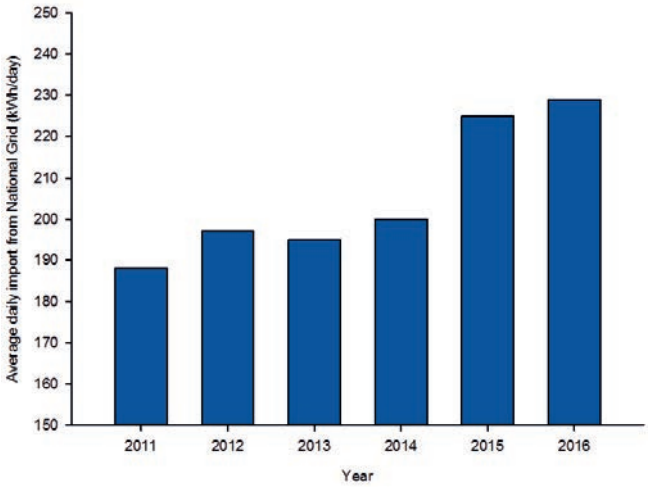

Figure 1.5. Electricity import from the national grid for the days the CHP did not run (June, July, August 2011 – 2016).

Parts of this study have been presented at SET2017 conference and an extended version will be published in the International Journal of Low Carbon Technologies.1.5).