Case Study: *Energy Surveillance for reducing cost*

Like all businesses reducing energy costs and in-turn reducing the impact on the environment are prime considerations for companies. But where to start with such a large site with a variety of cooling systems?

Industrial Refrigeration Service Ltd found Energy surveillance was the first step in assessing what energy savings could be made at one of our customer's sites, with the 'the Basement' identified as the first area to be scrutinised.

IRS have developed a simple, yet comprehensive means of measuring temperatures and electrical energy usage, which clearly demonstrates what the current situation is and a possible solution.

- ***Energy efficiency review of basement area***
- ***Study highlighted many areas could be improved***
- ***Utilisation of Fresh Air (Free Cooling)***
- ***Ensure appropriate areas are insulated to conserve energy***
- ***Thousands of pounds saved from day one***

Conditions in the basement

There are five main areas in the Basement including the Plantroom (15% of the area), Stockroom (70% of the area), Electrical switch/panel room (5% of the area), Sub station (5% of the area) and the stairwell (5% of area).

Although the initial review of energy efficiency was to focus on the stockroom, which is currently controlled at 12.5°c by means of two refrigeration systems, it was clear right from the start that all areas could benefit from a detailed review.

Identify Opportunities

- ***Could ambient air be utilised to provide cooling to the stockroom when temperatures are below a certain level?***
- ***Could fans be used rather than mechanical refrigeration for a large percentage of the year?***

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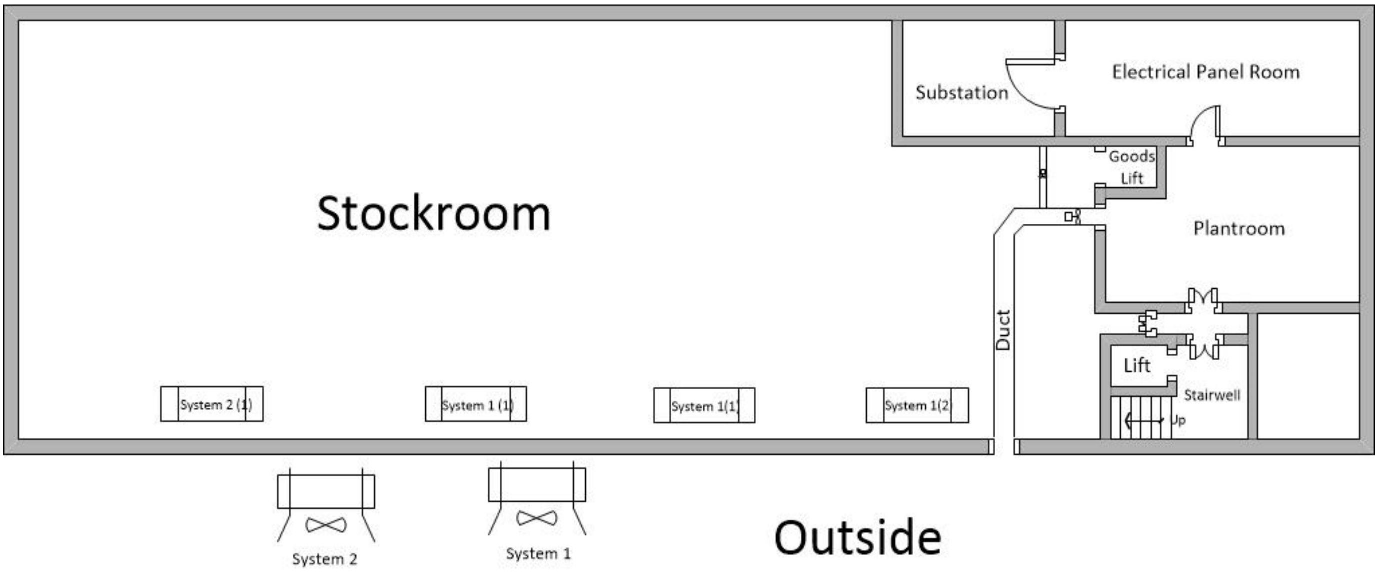

The stockroom was measured for sources of heat and heat loss based on 12.5° C set-point. Heat gain was analysed from the plantroom adjacent wall, plantroom ductwork and substation. Plus because the pressurised plantroom has vents in the plantroom door, but not in the door to the stairwell which pushes hot air back into stockroom. There was also heat gain from product loading and from lift pulling and pushing air when going up/down.

Only one area was identified as having heat loss and that was from exposure of walls to ambient (when ambient is lower than 12.5°C).

Detailed monitoring and analysis of all areas

To retrieve the current conditions, temperature and electrical current probes were attached to each refrigeration system and temperature probes within the store and on the outside wall. Surprisingly the survey revealed that the heat load and refrigeration capacity of one of the two systems appears completely matched within the period measured. If the heat load was greater than that of the refrigeration capacity, the second system would be called for more regularly. Equally if the heat load was less than the refrigeration capacity you would see the system cutting in and out.

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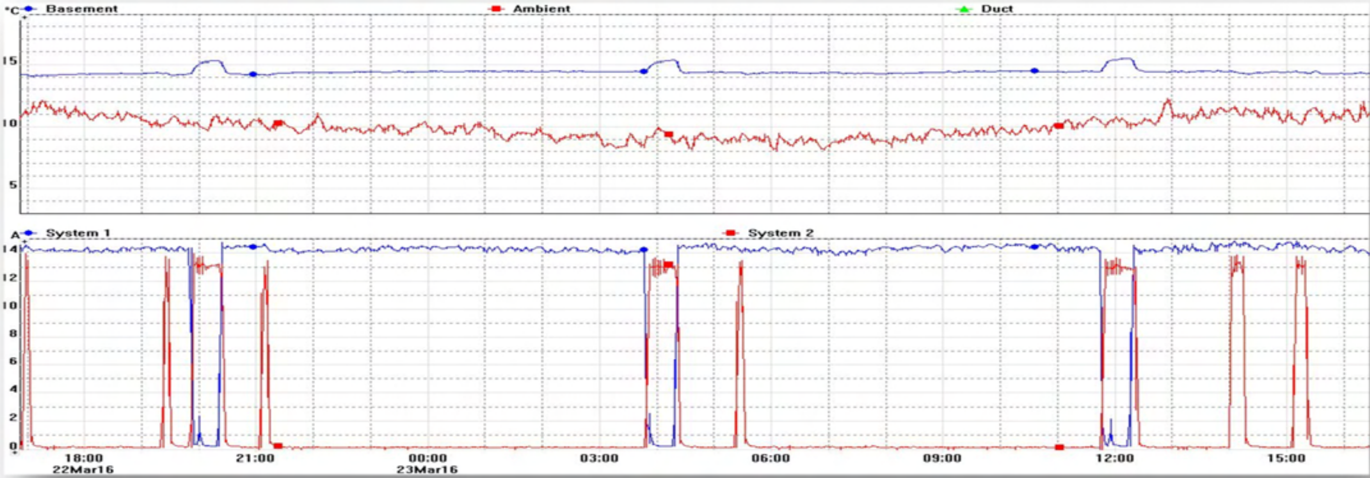
The graph below shows the significant background in heat load.



In comparison an ideal scenario, figures should reflect that the produce load (new stock) to be 75% of the cooling load, but there appears to be little influence between daytime (stock movement) and night-time loads.

A clearer picture from Energy Surveillance

System 1 is located at the north end of the stockroom where there is the goods lift, computer equipment and most significantly 15 metres of 500mm, uninsulated circular ductwork. This runs from the plantroom to the outside wall and a wall backing onto the plantroom which is measured at 21°C. Measuring the temperature and air flow it was determined that more than 70 Kw's of heat is being rejected from this ductwork. As well as heat being transmitted into the stockroom. This heat was being generated by the power plant and being rejected to atmosphere using conditioned air from inside the site, was **resulting in potentially 70 Kw's of wasted energy** each and every hour.

"70kw's of energy is the equivalent of running 23 tumble dryers on full power"

Could energy be saved in the Plant Room too?

It could be seen that ductwork had been installed to remove excess heat from the plantroom and substation. But was this an energy efficient solution?

The plantroom houses pipework and heat exchangers and steam from the main site heats water, which is used for hot water and building heating purposes. It was clear to see that heat within the plantroom was from poorly/uninsulated pipework and heat exchangers.

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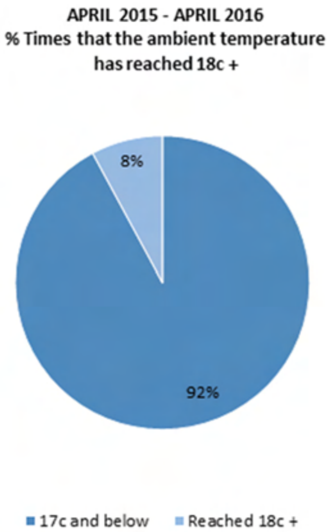

The fan draws air from within plantroom, through ductwork in the stockroom and out to atmosphere. The air to replace this is rejected air that is pulled through vents in the plantroom doors, but there is no provision on the outer doors, causing a partial vacuum in the corridor leading back into the stockroom.

What we recommended and implemented

Insulation on key components within the plantroom would certainly improve the situation. We installed insulation on all key pipework for a dramatic improvement from day 1. We also **opened the plantroom and outer doors** to improve airflow to allow heat to dissipate more quickly.

The simple idea **of reversing the fan direction** to pull cold air from outside and carry the heat from the plantroom into the stairwell, instantly took the load off the heating system. We also raised the **temperature within the stockroom from 12.5° C to 18/20° C** (the temperature regime adopted by the distribution centres that hold pre date stamped product).

By using ambient air to keep the stockroom at 18°c means that the refrigeration systems will only be enabled for 8% of the year, rather than the current 100%

Heat transfer a major issue

The wall between the plantroom (40°c) and stockroom 12.5°c) was of conventional brick, thus acting as a substantial storage radiator, equating to around 15Kw (electrical cost of around £5 per day). Thus we also recommended further thermal insulation of equipment pipework and walls.

Could utilising fresh air be the answer?

Based on previous years' data, the ambient temperature is below 18°C for 92% of the year, which is the revised temperature of the stockroom.

Currently mechanical refrigeration is the only form of cooling in the area. By having fans installed on the outside wall the room could be cooled with ambient air when below 18°C. A relatively simple control philosophy could determine outside air temperature and either enables refrigeration or fans. If the ambient is below 18°C the fans could continue to run below the 18°C setpoint of the room, giving a thermal reservoir before mechanical refrigeration is required.

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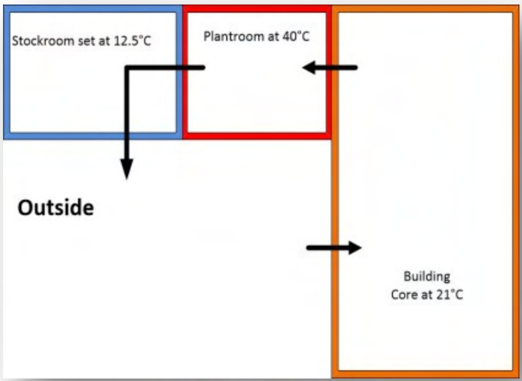
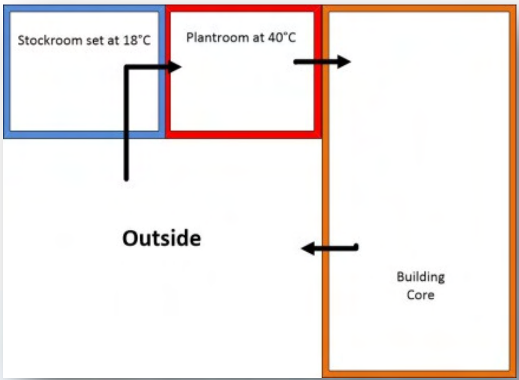


Old situation

Energy flow through the site

At some stage in the past a fan and ductwork was installed in the stockroom, pulling hot air from the plantroom to the nearest available outside wall.

No consideration was given to the energy flow principle; 40°c air goes through a 12.5°c room. Air flow to the 40°c plantroom is taken from the 21°c building core, therefore, makeup has to be from the outside air temperature. This represents greater than 50 Kw of heat rejection from the plantroom plus a similar amount of conditioned air from the building core – **Total waste energy around 100Kw. (£70+ per day in Gas cost from the power plant).**

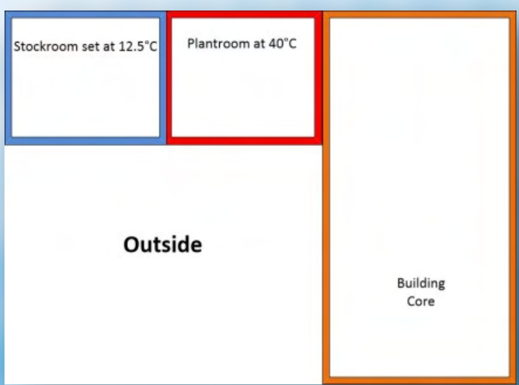


New Solution - Winter

The new solution for Winter conditions

As before, but **fan direction reversed.**

Now the fan pulls cold air through the stockroom (now at 18°c, following the lead of Mondelez distribution centres), into the 40°c plantroom and discharging into the building core. 11°c air goes through a 40°c room. Air flow from the plantroom is 23°c, therefore, adding heat to the building core, taking the load off the heating system.



New Solution - Summer

The new solution for Summer conditions

During the Summer Months, the fan would cool the plantroom down by taking air from the building core, which has been air conditioned at great expense, ultimately being replaced by outside air.

By turning the fan off during the Summer this loss will be eliminated. The plantroom will reach around 40°C with no negative consequence to the equipment.

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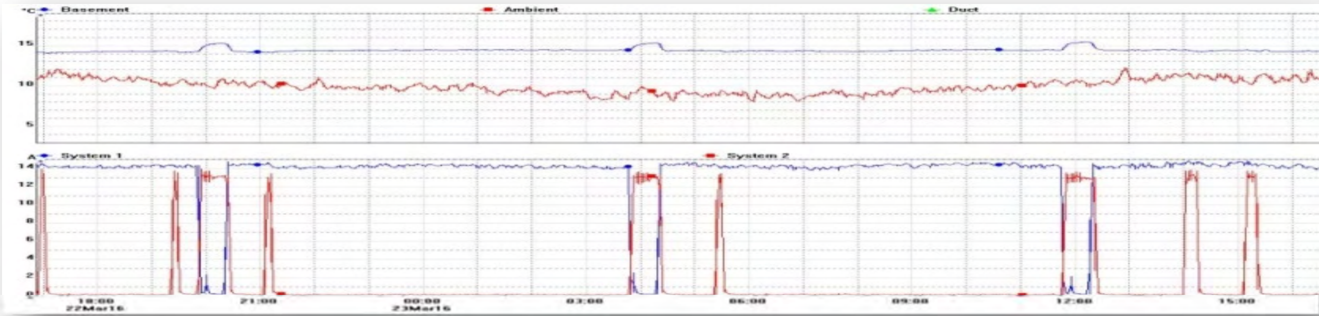
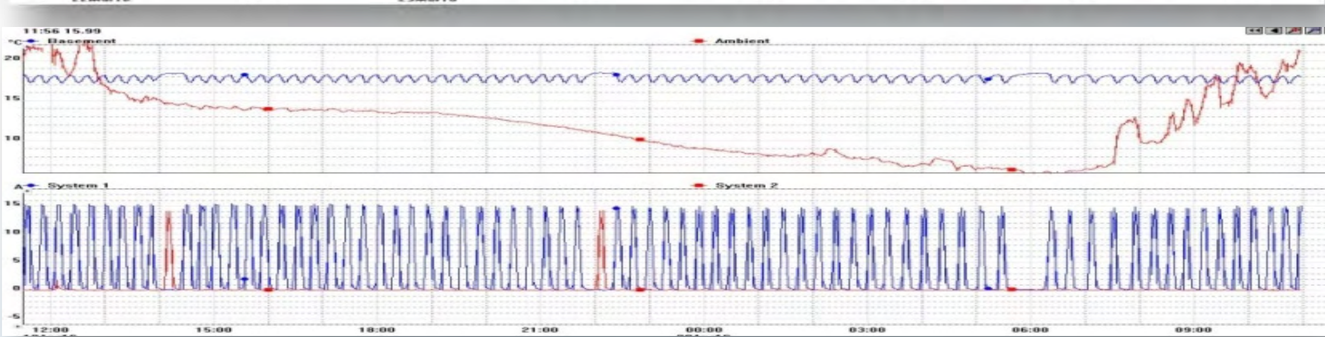
The Before and After - Analysis

Demonstrating that the base load from the plantroom still remains after the changes, however, system 1 runs 25% less, regardless of ambient conditions.





Saving energy and money… a bright future!

Initial savings can be seen by reversing ducted fans and openings, uplifting stockroom temperature and improving basic insulation within the plantroom. Further energy savings will be seen by installing fans to draw in ambient air when it is below 18° C (and disabling the mechanical refrigeration) and thermally insulation the walls between the plantroom and stockroom.

It is estimated that total savings in the first year to be nearly £16,000 where investment is needed to initiate energy efficiency, with annual total savings estimated to be nearly £28,000. This does not include the potential saving on breakdown of refrigeration equipment due to the vastly reduced running hours.

Summary

- ***Energy Surveillance is a sound investment***
- ***Free fresh air has no impact on costs or the environment***
- ***Energy savings nearly £28,000 per annum***
- ***Energy Efficiency is a long term strategy***

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