STAR REFRIGERATION

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Smart Thinking

Topic

Minimising Cold & Chill Storage Energy Consumption and Carbon Emissions

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Find out how to optimise the efficiency of your temperature-controlled storage unit, thus reducing energy consumption and minimising the costs incurred to your business.

An average increase of 30% in energy prices across the last 12 months, alongside a 2019 escalation of the Climate Change Levy, means that energy costs are now second only to labour and transportation expense in the budget of most temperature controlled businesses. When it comes to refrigeration systems, energy is undoubtedly the biggest outgoing, comprising 60% of the total cost of ownership over a 20 year period, along with installation and maintenance (which make up 20% each). As such, the efficiency of a refrigeration plant has a huge impact on the environmental and financial performance of a business.

Taking stock of the situation

As with any problem, the ideal route to overcoming it begins with understanding it. To do so temperature-controlled facility owners and operators should take a long look at the current situation on their premises and ask themselves the following questions:

How much does my cold/chill store cost to run? In general, this is a widely known metric which most CEO's and COOs will be able to find out with little difficulty

How does this compare to my competitors and to best practice guidelines?

By contrast, this is an important detail which is often unknown to many cold storage unit owners. Investigating both the going rate for other facilities of a similar size to yours and the industry guidelines on best should give you an idea if and

where savings can be made.

How will increasing energy prices affect profitability?

Unless you are able to pass the increased costs onto

your customers, price rises will undoubtedly eat into your profit margins. That may be an option for some companies, but a more attractive one is to reduce energy costs altogether, thereby maintaining a healthy bottom line without impacting upon your relationship with your customer base.

How much does my cold store cost to maintain?

As indicated above, maintenance is another major factor in lifecycle costs of a refrigeration system, comprising around 20% of its overall expense. As such, it should not be neglected when it comes to looking at how your outgoings can be curbed.

Is my refrigeration plant fully optimised?

For most businesses, the honest answer to this question will be that they simply don't know. But this is not a surprise since optimisation and efficiency have not previously been a key area of focus for many contractors or end users. Having said that, knowledge of your plant's state of optimisation is perhaps the biggest factor in allowing you to keep energy consumption costs to a minimum.

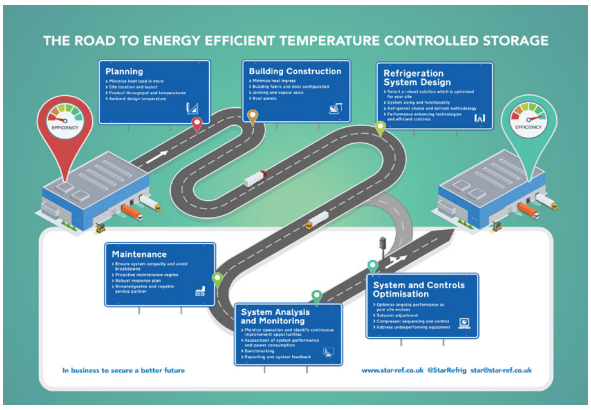
A roadmap for success

The most effective approach to improving your cold store's efficiency is a holistic one – each phase of the process, from planning, design and construction, right through to operation,

maintenance and ongoing analysis, is key in ensuring that your refrigeration plant is fully optimised. At Star Refrigeration, a long term focus on energy efficiency has produced the industry's foremost experts on energy minimisation of refrigeration plant and lowest life cycle costs. Through practical insight into effective techniques which have been proven to reduce energy costs and carbon emissions for dozens of customers, Star have developed a

toolkit that allow businesses to carry out accurate assessments of their cooling plant energy consumption and environmental impact– from inception and throughout the life cycle of the refrigeration system

Understanding the answers to these questions will not only give you a clearer picture of the current situation when it comes to your plant's efficiency, but will also make it easier to map out a route to optimising its performance, reducing your energy costs and boosting the bottom line of your business overall.



Each individual point on this journey is important in achieving a comprehensive optimisation of your plant, although the first three are only applicable to new builds. Here's a closer look at each of those phases in succession:

Planning

Putting in place robust plans from the outset are key in ensuring that not only are installation costs kept to a minimum, but also that the ongoing running and maintenance of the plant are optimised to reduce outgoings as much as possible. There are plenty of things to consider – here are some of them:

Site location – will your facility be situated on the coast, and as such be susceptible to adverse external weather conditions which may corrode external equipment? Will it be exposed to periods of high humidity, which can cause build-ups of ice within the store itself? These factors must be considered when deciding which materials to use in the plant's construction.

Ambient design temperatures – your plant must not only be equipped to deal with the current ambient temperatures of its surroundings and peak temperatures during summer, but also future-proofed against the possibility that global warming could see an increase in those temperatures over the next few decades.

Room temperatures – taking into account the temperature profile for your specific product, it's always advisable to target as high a room temperature as physically possible without detrimentally affecting the product itself. For context, a general rule of thumb is that every one-degree increase will see a 2% to 3% improvement of the energy efficiency of the plant.

Building operational usage – minimising the ingress of moisture into the store is crucial in bringing down energy consumption. Possible solutions could include the dehumidification and temperature control of the loading bay itself, as well as proper controls over door opening and closing to optimise air flow.

Product throughput – products which arrive onsite above the desired temperature will place a greater demand on the refrigeration systems and incur substantially higher heat loads. At the same time, companies should plan for the possibility that throughput temperatures will increase in the future and take the required preventative steps to future-proof against them.

Refrigeration plant layout – while the configuration and layout of the plant is often something of an afterthought, ensuring it is designed with energy efficiency in mind can not only reduce installation costs of the cooling plant itself, but also of the accompanying infrastructure of the facility, including mains electrics, plant rooms and civil works.
Building construction

After the planning stage, it's imperative that the construction works themselves are carried out by trained experts. Particular attention should be paid to:

Panel installation – the installation of robust jointing and vapour seals on each panel is instrumental in minimising heat load coming into the store in the first place. Additionally, a rigorous and ongoing maintenance schedule is important to keep the panels in a good condition as possible for as long as possible. Thermographic scanning – thermal scans can identify any weaknesses in the building fabrics, isolating temperature hotspots and other areas of concern which may not be immediately apparent to the naked eye.

Door suitability and operation – appropriate doors must be specified from the project's very beginning. The use of unsuitable doors could lead to improper closure of chill store doors, which can impact upon efficiency (and therefore, on overall costs) by as much as 60% or more.

What's more, responsible operation of doors, including control of the number of uses on a daily basis and proper closure each time, is critical to reducing energy consumption. More information about door control in temperature controlled storage facilities at: https://www.star-ref.co.uk/smart-thinking/energy-matters.aspx

Roof panel colour and absorptivity – the use of reflective materials for the exterior of the plant can deflect heat from the sun's rays and minimise absorptivity into the building itself, which can have a

Refrigeration system design

As well as the particulars of the site's layout and construction, the actual design of the refrigeration system itself is another key element in ensuring optimum efficiency is maintained at all times. Some important considerations include:

Design load and average load – it's essential to ensure that plant is designed to meet peak load on the hottest day of the year. However, the average load is another important metric that's often overlooked and may be less than 60% on a regular basis. Ensuring the plant is set up to operate efficiently at that load is important for annual performance.

Adjustability – with different loads required at different times of the year, it's vital that the plant is set up to adjust to the fluctuating demands of the season. Energy-efficiency solutions which can help achieve this include variable speed drives on compressors, pumps and condenser fans as well as EC fans on condensers and in-room coolers. All of these must be controlled in harmony to deliver the full potential they can offer.

Floating head and suction pressure – in addition to fluctuating cooling demands the refrigeration plant will typically operate at ambient temperature far below the design condition. The UK average ambient is somewhere between 10 and 12 degree Celsius depending on location. The systems controls can be designed to take full advantage of this and reduce annual energy consumption.

Defrost – defrosting is a necessity in temperature controlled storage to remove ice from air coolers but also it requires energy and adds heat into the room that must then be removed by the refrigeration. The frequency and duration of defrosts should be kept to a minimum to reduce energy consumption. The type of defrost has an effect of energy consumption. For higher temperature applications, off cycle requires only heat from the room to melt any ice formation. However, at room temperatures below 3 degrees Celsius some form of other defrost will be necessary. Electric defrost is common but also the most costly as it relies on electrical elements to warm air around the cooler coil to melt the ice. More efficient defrosting systems system rather than electricity.

Air-cooled vs evaporative – air cooled systems may consume more energy at peak summer operating conditions, but less in cooler months of the year. They eliminate the costs of chemical treatments, water and general maintenance and deliver overall running cost benefits of around 13% compared to evaporative alternatives. Evaporative systems also require compliance with additional legislation and regulation.

In a technical paper entitled "Comparison of evaporative and air cooled condensers in industrial applications" for which Star's engineers John Clark and Angus Gillies received the prestigious Lightfoot Medal from the Institute of Refrigeration, it was demonstrated that even with the higher cooling capacities of 2000kW, the payback for an air cooled condenser when compared with an evaporative condenser is less than two years, with life cycle costs reduced by an impressive 14% per year thereafter. The paper can be downloaded for members only at the IOR website: https://www.ior.org.uk/app/images/downloads/ClarkGilles4Dec2014London.pdf

If 9 GW of the overall 90GW heat capacity currently required for domestic and commercial sector in England can be generated using heat pumps instead of using gas boilers, 3.9 million tonnes of CO2 could be saved in 2017.

Maintenance

Aimed at plant owners who already have an existing facility in place and are interested in maximising the efficiency of their asset, the key to effective maintenance is a proactive, well-executed capital plan for identifying any potential issues before they become a major problem and taking the necessary steps to address them. Some items to consider include:

Bespoke maintenance plans – Planned Preventative Maintenance (PPM) programmes should incorporate both scheduled maintenance tasks and fully documented record keeping to satisfy statutory and business requirements. More information on the benefits of maintenance at https://youtu.be/c4wN1umrY2o

Remote monitoring and analysis – as well as flagging up wear and tear of machinery and equipment before it begins to affect operation, remote monitoring and analysis (including oil analysis, vibration analysis, and thermal scanning) can also inform more focused maintenance visits. This will also ensure that plant components are performing at their highest possible efficiency for the full duration of the lifespans. Find out more at https://www.youtube.com/watch?v=k-9PRRHIgLY

Regulatory inspections – the outputs and verdicts of regulatory inspections should be fed into future budgeting for maintenance plans and reviewed on a regular basis, in order to avoid unplanned spending wherever possible.

Organised documentation- after collecting data via the two aforementioned methods, it should then be organised and made available on a collaborative platform to both contractors and end users. This will not only maximise efficiency, but also keep you compliant with the relevant legislation.
Refrigeration Plant analysis and monitoring

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As with any system, constant monitoring and analysis is key to spotting inefficiencies and addressing them as the situation evolves and new developments arise. Plant owners should pay close attention to:

Power consumption – the first step is reviewing current protocols for monitoring power consumption, individual metering for each component of the system is a minimum requirement in ascertaining how much power is being consumed.

Specific Energy Consumption (SEC) – SEC is an energy efficiency measure which enables cold and chill store operators to benchmark their energy performance and energy improvements. It calculates how well the plant is performing based upon total energy consumption and total volume of the refrigerated space on an annual basis – kWh/m3/yr -. Star Refrigeration have devise a free SEC tool which allows you to make sense of the raw data collected in the previous step and understand whether your practices are good, bad or indifferent.

Benchmark – once you have a working SEC for your plant, you can then compare this against your competitors, best practice, UK and European averages and other systems in your store. This will allow you to set goals on an annual basis and improve your energy consumption progressively. You can benchmark your store free at https://www.star-ref.co.uk/news/star-refrigeration-encourages-cold-storage-businesses-to-assess-energy-usage-at-tscd-show.aspx

Refrigeration system analysis tool – installing this can give you a more detailed picture of where and how your plant is underperforming.

Low capital measures first – it's sensible to first concentrate on the low-hanging fruit of measures which won't incur a huge expense. After reaping the benefits of reduce energy consumption from those, you can then move forward and plan investment in other areas which make sense for our business. Check how Star's performance optimisation software, Ethos, saved The Ice Co Storage & Logistics £100,000 a year https://www.star-ref.co.uk/case-studies/the-ice-co-storage-logistics.aspx

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System and controls optimisation

The final piece of the puzzle in achieving an energy efficient cold and chill store facility is using all of the information gleaned from the data collection and analysis phase to introduce adjustments to fine tune your system's controls and optimise them to produce tangible savings annually. These could take the form of:

Reduced operating pressures – the system analysis tool mentioned above can identify operating pressures which are higher than they should be. This can be addressed by improved head pressure control (or indeed, the implementation of any head pressure control where none previously exists), additional purging of non-condensable elements in the system or even something as simple as regular cleaning of air-cooling condensers.

Underperforming equipment – this could take the form of any faulty piece of equipment, including an easy fix like a loose condenser fan belt.
Set point adjustment – under-sized kit or often just underperforming equipment can mean that actual temperatures never come close to their set point. This misalignment in the set point can cause the plant to strive for a target that can it has no chance of reaching, meaning it's operational 24/7 and consumes an incredible amount of energy.

Compressor sequencing and control – if the lead compressor is the least efficient in a sequence, it can have a detrimental impact on the overall efficiency. A simple rearrangement of the lead-lag sequencing can solve this issue. Meanwhile, better control of compressors themselves can avoid simultaneous running of inefficient machines.

Energy analysis vs ambient – this can allow for the creation of a benchmark of how the plant is performing on any given day or week and help to understand where problems are being created or if they even exist in the first place (since a discrepancy could simply be caused by external weather temperatures).

Load profile – this can help you to understand the breakdown of how your plant is running, but also identify spare system capacity which can be reallocated to other areas to maximise efficiency.

Bringing in the experts

Following this roadmap should ensure that you fully optimise all facets of your cold storage facility to achieve maximum efficiency and reap the biggest

possible financial savings. However, without the assistance of trained professionals, it can be challenging to know how to begin. That goes not just for amassing the data in the first place, but interpreting it to gain a comprehensive idea of where your plant is performing well and which areas require improvement. What's more, it's essential that each of the suggestions outlined above form part of a cohesive strategy that is devised with harmony in mind and our plant will reach its full potential.

Star Refrigeration have been dedicated to investigating and furthering energy efficient processing with the cold storage sector for over two decades. This long-term focus has meant that many of the industry's foremost experts on the subject are within our employ and can lend their expertise and insight into developing a cogent plan of action your plant.

We also have the capability to devise customised energy and carbon reduction programmes and implement them on behalf of cold store owners and operators who do not yet have energy efficiency and carbon reduction strategies in place. These programmes are effective for both conceptual and existing refrigeration plants.

Whether you choose to leverage the experience and proficiency of Star or go with another industry professional, it's essential that you do work alongside a industrial refrigeration expert to ensure you fully optimise the efficiency of your plant and your business.

For more information on optomising your refrigeration plant, please contact **star@star-ref.co.uk**

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